

NOTE

“L’Addition, s’il Vous Plaît !” (No. 3)
“Who afaids of Born • Wolf ?”

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ABSTRACT

- (1) A New Mechanism of the Diffraction of Light is suggested.
Hope, this mechanism may take over the 17th Century old Huygens' Principle. Incidentally, "A Principle is replaceable by Another Principle, Theorem, or by another experimental facts".
- (2) Matter wave double-slit experiment is supported strongly, by the analysis of the experiment as the mostly direct and the strongest candidate to verify the Schrödinger-de-Broglie wave interference. Other experiments, such as electron-beam or light quantum are not free from the Classical-Electromagnetic Theory.
- (3) A straight forward field to get to the Goal, where Dr. Einstein is waiting for us, is felt to be glimpsed : starting from the calculation of variation, through topology, (homotopy), via special relativity, with path-integrals. Hope a theoretician should make a touch down.

§ 1 Introduction

As You Know it well, Light Wave has 4-way features :

- (1) Reflection, [反射]
- (2) Refraction, [屈折]
- (3) Diffraction, [回折]
- and
- (4) Transmission. [透過]

The last one, Transmission, may not be regarded as the intrinsic character of light. Since it can be derived by the relation as following ;

$$\text{Transmission} = 1 - [(1) + (2) + (3) + (\text{Absorption})].$$

Items (1), (2), (3) show up only when there is a *geometric boundary surface*. However, Transmission is related with *bulk* Absorption, which depends on the character (or quality) of material ; more sharply than to (1), (2), (3). (I won't stick to this sort of games of categorizing arguments, since I'm not a scholar who is living in the Ivory Tower). At any rate, these features from 1 through 3 show up only when there exists The Boundary. Otherwise, Light Wave travels straight ; let's decide not to call Dr. Einstein for our Party for a while.

The common reaction of physicists towards the items (1), (2), (3) is, "There's nothing interesting left over. Let's give'em to opticians !" Physicists normally think that the item (4), Transmission (or Absorption) is most

important and interesting among them. Since it is more or less directly related with physics.

However, I realized that a Geometric Boundary raises a much more serious problem to physics, in *some cases*, than I have ever thought. It is a challenge to physicists. Mathematically speaking, the boundary generates a drastic change of the Space Quality. It raises the space from a "Simply Connected Space (or Set)" (単連結空間・集合) to a "Multiply Connected Space (or Set)" (多重連結空間・集合). Once the change took the place, it is a metamorphosis of the whole world.

When I realized this, I quickly looked back many subjects I knew. I found, we were lucky enough for some cases, however, we were almost dead for the other cases. "The Main Dish of Today's Special" (Le plat du jour; 本日の特別料理) is, "Connectivity and Physics" (連結数と物理). Chatting will be served with it, since the taste may be full of bitters for some people.

As a matter of fact, I have noticed for a long time, that Theoretical and Experimental Japanese Solid State Physicists (T-, E-JSSP) are dwelling in a desperately confusing world. Incidentally, those folks were once denounced as a "Specialist-idiot" (専門バカ), I heard, in a period from the end of 60's to early 70'. You know, it was the harsh time of Student Riot Season, that covered from Quartier Latin a Paris to the most shabby university on Japan island. (Lucky enough, I was in the States, and "ate hamburger on Xmas eve".) The season of "Sturm und Drang" may be over. It sounds good, or bad, I don't know. But, the mediocracy still remains. In short, I got to invent some terminology for my own use, which should not be as violent as the old one. Finally, I got it made: A variation of perfectly accepted term

in Japanese Society, i. e., “Mr., who has difficulties in Intelligence” (知能の不自由な方). I am not at all blaming any personel. On the complete contrary, those are the patrons of Jpanese Culture. Legally speaking, those are The Legitimate Children of Japanese Culture. I beg readers’ patience, but I will tell you briefly about the reasons why :

In about BC 400, a brilliant king named Shan-kan appeared in the Han-state in China (韓の昭侯). He fell into a drunken-*nap* one afternoon, they said. When he woke up, he found a clothes (maybe made of gorgeous silk) was covering over him. He asked who did it for him, and soon found, it was a man who was responsible for the Crown-handling business. You know, he was to keep the crown shiny, to fix, and to put it on to the king when necessary. So, the king *punished* the Crown-handling man. The reason was, “You are in charge of Crown-handling. This is the work for Clothes-man’s business!” The true reason, they said however, was that the king worried, “Once I praised the man for his good will, then every other men will rush to do the same sort of violations, pretending to show me their good will. It will become until eventually out of control, and it will grow up to turnover of my empire!” The king thought this would be much more serious than he will get cold-flu and fever ! Thus, Bureaucracy started, and it came to Japan.

Here is the typical origin of the Japanese Bureaucracy. The point I want to stress is, however, it is percolated even into the Scientists’ Society. One of the reason is this ; peoples who were on the job for Natural Science, Engineering during the world War II, were not be punished, nor be purged, nor be blamed, nor be accused, nor be arrested, nor be sued, nor be executed, at all after the End of The World War II. This was quite different from the case of Dr. Heisenberg. So, they thought, they were foregiven. More than

that. They began to praise the junk works during the War. Now you see what I mean ; they are the Legitimate Children of Japanese Culture. Of course, peoples past away, but the Culture remains.

Small wonder-The Best and The Brightest Physicists can be so mediocre and dark, sometimes. They have nothing to worry about their creativity. They were taught to chase after the West from the beginning of the New Government after Edo. (I'd say, they chase but speak ill of the other side of the Pacific.) They hate those who don't pay respect to their specialty. There are not a single stubborn scientist among them. Those the most stubborn feathers, who should had been joined their fathers group, all died waving their wings for Kamikaze Flight and/or within the desperately tiny Sub.

Such as it is, if the author, who wrote the book titled “Elements of X-rays *Diffraction*” [Ref. 1], may realized one evening after dinner, that he had been actually working with “*Reflection* from the Lattice Plane”, then he will be awake next morning by the roaring traffic jam sound out of his idiot box. That will be due to those who are rushing to their customised publisher in Japan, so that their book-title should be quickly revised to “X-rays *Reflection Analysis*”. I guess, you see what I mean by “They are dwelling in a desperately confusing world !”

★Light Wave

§ 2 What is the optical slit ? How it works ?

Theorists regard that the Optical Slit is “tiny opening” on the plane. They need a Boundary Condition for functions. I've been feeling for a long

time, that some thing weird about their theory. Finally, I found myself that I don't know what is the optical slit. Then, I put my question for the Exam at The University of Electro-Communication where I was working as a half-time staff, asking ;

“Why light doesn't go straight after the optical slit?” (光はなぜ直進しないか)

Of course, I gave a lecture by introducing the famous Born-Wolf's “Principles of Optics” [Ref. 27]. In the series of the lecture I realized they employed a Point Light Source ; which emits Spherical Waves as the incident light [Fig. 1]. The boundaries were just geometric lines to form an opening. That made me feel as if they picked up an answer before they solve the question.

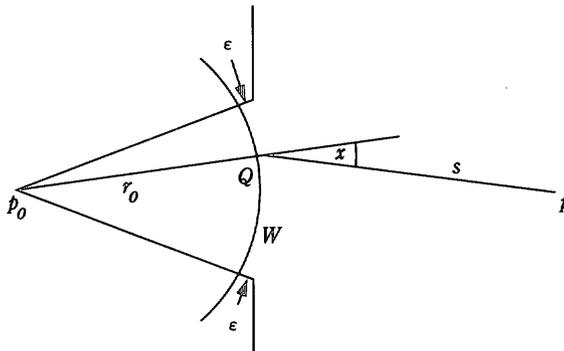


Fig.8.4 Illustrating the diffraction formula (18)

Fig. 1 The Layout for the Diffraction Theory; which employs a spherical light wave from a point source, and a geometrical plane with opening. Ref. 27.

Walking through the desks in the exam class, I was disappointed; there were none who were writing more than the stuff given at the lecture. Half of them who did not show up the class at all were drawing the primitive figures of the Huygens' secondary spherical wave business. I am tired to get angry about this sort of degradation of Japanese Education. Students never try to study by themselves any more. They are very sick of Student-Apathy. Reasons? Obvious. There's not a glimpse to get a better job than the graduates of Tokyo University.

What's more, every T-JSSP do not write beyond the 17th century's Huygen's Principle in their textbook. They talk about the same thing in the lecture on TV Broadcasting University; which covers all over this country. No wonder. Not only the students but also the public do understand that this is the highest Knowledge on Optics. Actually, this is the boring story for them, because they heard the same tales at the Junior-high school. Those are the real parasites who have got rotten this nation. However, the same thing is with us. Let me tell you, especially to T-JSSP; "What a weird consensus we have made on The Optical Slit?".

In my small experiences, I worked with from Vacuum Ultra Violet (VUV) to Infra Red (IR), all through the Visible Light. So, the question of the Exam was asking to myself; "What were the optical slits that I've been working with?"

A Formal Answer to the question is easy to make :

An optical slit is "A Device" to spread the light beam into a wide angle behind it (by diffraction); it is *not to limit* the width of the incident beam.

(Hope Theorists do understand well this statement). The reason of “letting the beam spread widely” is, we can cover (or shine) the wider area of optical Grating by using a narrower slit than a wide-opened slit, due to Diffraction. Narrowing the slit width, *The Numbers of line* upon the grating surface, which will be really *illuminated*, is increased. This working number (not the catalogued number ; lines/mm) gives us the resultant resolving power of the monochromator. So, the system goes contravercial way ; the wider the slit width, the poorer the resolution becomes : vice versa.

The phenomenological answer to the above Exam is evident :

”It is because the light diverges due to Diffraction after the slit.” But, the real question is “How and Why light is diffracted by the slit ?”

It was a matter of time before I recalled the day’s surprise, when I first saw the entrance slit of the Perkin-Elmer’s IR monochromator, at the RCA Tokyo Lab., 1969. It looked like a tubing ; say about 5mm thick, and 1cm wide. It was such a different thing from the most sensitive slit on the VUV monochromator. I will show you [Fig. 2], for readers’ convenience sake.

It was not so long before I’ve succeeded in to get out of the trap, when an idea flashed out ;

”The Slit can be the same thing as the ANTENNA for the Microwave people”. In order to convince readers, I might give you following estimations :

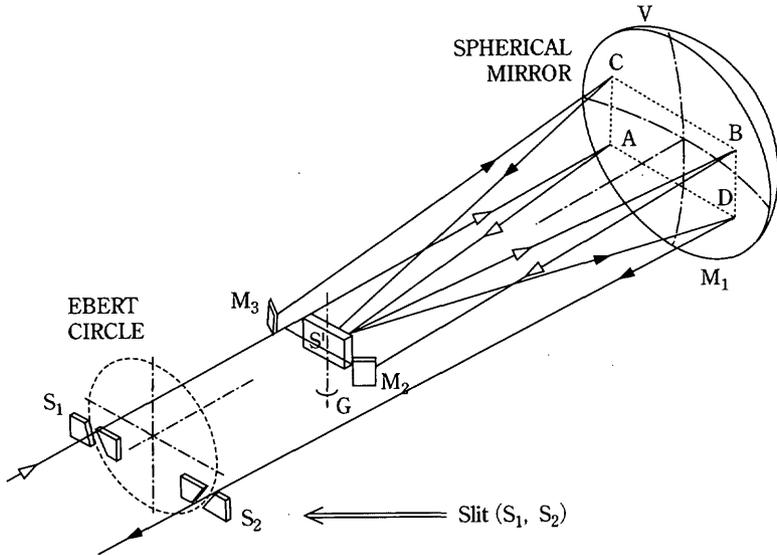
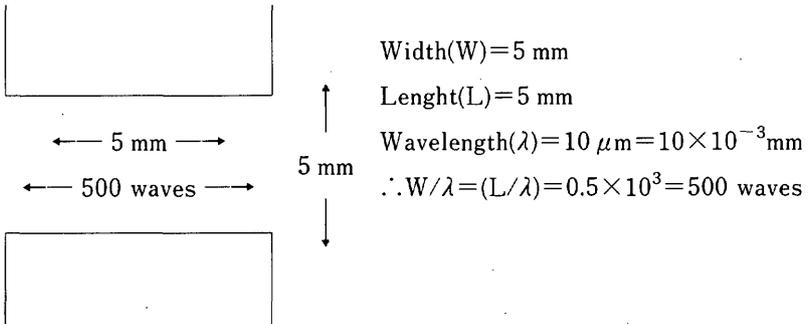
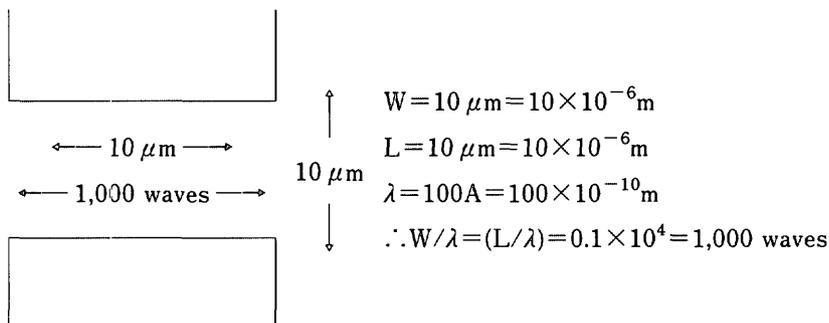


Fig. 2 An example of optical light-path-system for the Infra-Red (IR) Double-Path-Monochromator (Perkin-Elmer's).

【For IR Monochromator Case】



【For VUV Monochromator Case】



Now the Figures came out. It appears “The Phenomenological Conclusion” is evident. “The Optical Slit is nothing but a simple CHANNEL or STRAIT for the Electromagnetic Waves to go through”. This conclusion was not a surprising for me at all. As I told you, I’ve felt for a long time, that there is something unrealistic just to draw a simple line to represent a plane and put an opening on it as an optical slit.

But now, here comes the real tough question :

If the Optical Slit is just a Channel (or HORN) for Electromagnetic Wave, then why the Light Wave get Diffract from the end plane of the Channel? The channel looks like a wide enough free space for the electromagnetic waves to go through.

Sure. I looked back into the book “Classical Electrodynamics” by Dr. Jackson. [Ref. 54] However such a channel which has $100 \sim 1,000$ times wide width in wavelength, can’t be regarded as a Wave Guide at all. You know, there is no Cut-Off Wavelength for such a wide channel.

Incidentally, there is no serious change between the two editions, '65 and '75, as far as §8 and §9 concern where diffraction is handled. However, there are big changes and additions for the rest of the places. What's more, the colour of the cover, the style of the printing characters, the way of illustrations, all lost the previous flavour and elegance. In short, I thought, this could be the way that Berkeley goes, i. e., the big difference of the way for Univ. of Illinois goes, in the midst of the unbounded corn field.

Back to the optics, I don't want to get back to the spherical wave for the incidence light. Since, I know quite well, that the He-Ne laser, which emits parallel enough plane wave, order of milli-radian divergence, gives me much nicer FRAUNHOFER diffraction pattern than the conventional light. I found this fact, when I was working for RCA Res. Lab. Tokyo. So, I definitely want to put parallel beam in the [Fig. 1], which I borrowed from Dr. Frenel-Kirchhoff, which appeared on [Ref. 27].

Before we step further, I want to make it 100% sure, whether you could agree with me ; "This is A Problem of *Classical Electrodynamics*". Another words, the equations that we have to deal with are Maxwell's Equation : It is not Schrödinger's Equation. I hate to hear any more, the Japanese way of "counter arguments". It starts always this way ; "Yes, I *think* you maybe quite right. However,—". We cannot get to any conclusion with this sort of argument. (全くおっしゃる通りだと思います。しかし、それはこういう事ではないでしょうか…)

By quick looking into Dr. Jackson's book, I found in Chapter 8, he is dealing with the boundary condition problem of electromagnetic waves with matter. [Fig. 3] I might reproduce the Fig. 8. 1 and Fig. 8. 2, from Dr. Jack-

son's 2nd ed. (The Fig. number is the same in 1965's 1st ed., 4th printing)

As you see it, the figure is for "The Electromagnetic Field near the surface of a good, but not perfect conductor". Incidentally, it will be understood that the Coherence of the electromagnetic (light) wave can be reduced down to the "Partially Coherent Light", due to this boundary effect of the Channel (or Strait).

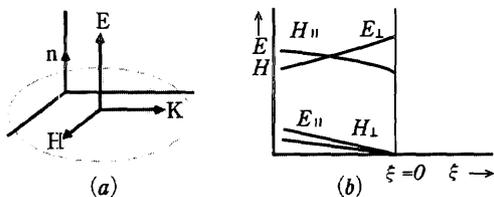


Fig.8.1 Fields near the surface of a perfect conductor

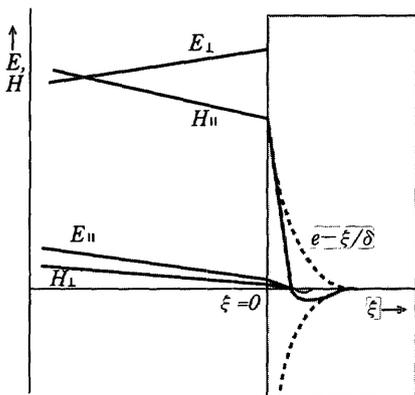


Fig.8.2 Fields near the surface of a good, but not perfect, conductor. For $\xi > 0$, the dashed curves show the envelope of the damped oscillations of $H_c(8.9)$.

Fig. 3 Theoretical Intensity Distribution of Electromagnetic Wave near the surface of the "Good but not perfect conductor". Ref. 54.

However, it appears there’s no possibility at all to let light waves to force generate diffraction by the boundary conditions, shown in the [Fig. 3].

What’s more, if we look down into the Section 9. 12, p. 441, there comes the rigorous results on “Diffraction by a Circular Aperture, Remarks on Small Apertures”. The section looks like for the “Bethe Hole” on the Wave Guide. However, the final results are very miserable. The Fig. 9. 16, what Dr. Jackson crains for the “Fraunhofer diffraction pattern” is out of the question. There is no hope for this modern vector result can win in the tough International Contest against the old scalar theory performed by the Saints.

Then, why don’t we look back into the Saints’ work first, and let’s consider why “The Rigorous Modern Classical Electrodynamics Results” don’t work better for the diffraction problem for the Optical Slit ?

§ 3 Saints : Huygens-Fresnel, Kirchhoff-Helmholtz, Fraunhofer ; Oh marchin’in !

In the famous Born-Wolf’s book, [Ref. 27], there are two Chapters dedicated to Optical Diffraction : Chap. 8, and Chap. 11. The Chapter 8 is so-called scalar theory, which manipulates with only light intensity. For the steady state case, D’Alembert Equation reduces to a Laplace Equation.

However, it is handled with the delicate care for the Phase Difference, or what we call, Optical Path Length Difference. On the contrary, Chapter 11 shows the development of the modern theory, which employed modern mathematics ; Complex Variable Function Analysis. To say “modern” means,

however, it is developed in 19th century.

Ironically enough, the scalar theory got far much Beautiful results than the Beautiful Modern Theory! You know, here is one of the target that I want to smash with The Horse and The Lance! As I wrote in the former paper (No. 1), I felt again, the same sort of smell of "False Start Line". I happened to read a Japanese mathematician's essay. He says, "Once we've got started from a wrong starting point, then the more we proceed rigorously, the more we get the monstrous results!"

You will see, why I call the scalar peoples as Saints. I won't hesitate to call those Modern Results as Monsters. Those who acted high-hat toward us led us through the heavy darky forests of Vector and Complex Variable Analysis. All of the sudden, they left us in the midst of garbage dump, and they all disappeared.

I feel very sorry for Drs. Born and Wolf. How much they were anxious to show better results than those, in order to decorate Chapter 11. When I got the copies after the citations therein, I could not utter even a word. I don't want to be rough on The Born-Wolf. I have learned quite a lot from it in my various phases of small research life; ever since I bought The Book at the basement of Follett's Book Store, Urbana-Champaign, Illinois.

☀ 3-1 The first saints are Huygens-Fresnel.

It is quite a surprize and anger to notice that a retiree professor of Ivory Tower is still speaking on TV Broadcasting University Hours, on the 17th century's Huygens' principle, [Ref. 55]. They speak as if it is the soundest Treasure for the Start Line. They are disgracing so badly The Wave Op-

tics. They are the real "Enemy of Science" in this country.

The reason I denounce them as The Enemy of Science is, The Huygens' Principle never works out well, without "Fresnel's *Inclination Factor*": $K(\chi)$. This factor is the very ingenious invention of Dr. Fresnel. Readers are recommended to look back the [Fig. 1]. You may find the angle χ that makes between the normal and the direction vector to observation point, P.

The Inclination Factor, $K(\chi)$, is looked for by Dr. Fresnel such as, "K is maximum in the original direction, i. e. for $\chi = 0$, and that it rapidly decreases with increasing χ , being zero when $\chi = \pi/2$, tangent to the wavefront". [Ref. 27, p. 371]. Dr. Fresnel went on his calculation and by using the series expansion on K, such as,

$$K = K_1 + K_2 + K_3 + \dots,$$

He finally got to the astonishing results as follows;

$$K_1(\chi) = -i/\lambda = e^{-i\pi/2}/\lambda.$$

Pure imaginary! I don't know this result may have any relations with the evanescent field. This is the electromagnetic vector field, which is revived lately, after about half a century's negligence. Too bad, I can't find that much time to study the New Near Field Optical Microscope. I have never met, even 1 out of 1,000 T-, E-JSSP and the retiree professors, who spoke about the Huygens' Principle with Dr. Fresnel's "Inclination Factor", altogether. Yeah, very simple. They have never opened the book "Born-Wolf" at all.

●REMARK :

So long as the Huygens' Principle is a "Principle", Dr. Huygens was not asked to verify it. Since, "Principle" is defined as such that "A FACT that no one can verify it, but it is taken as a granted by everybody to be true". Such as it is, I think I can say for my own use ; "I don't like this Principle. And if I can say the same thing without this Principle, I also won't be pursued to verify it."

●REMARK :

Dr. Fresnel was not a simple THEORIST. He must had been a THEORETICIAN. His prediction was tested by the Experiments, by making Zone (Space) filters. After some struggle, he became the winner. The main light intensity was coming from the 1st and the 2nd Fresnel Zone. [Ref. 27, p. 375] Obvious. Any theory, be it Modern or Post-Modern, it must agree with the Scalar Theory, which explains beautifully, as far as the intensity concern.

●REMARK :

Dr. Fresnel also showed that, there are Near Field pattern, which is different from the Far Field pattern, known as the Fraunhofer Diffraction pattern. Fresnel's near field effect also shows up in Single Edge Diffraction. So, after all, there are so many points we must be careful enough. The Problem is not that quite simple as previously thought.

☼3-2 The Next Saints are Kirchhoff-Helmholtz.

Dr. Kirchhoff, who obviously liked Math better than meals, got the Huygens-Fresnel's results by putting the simple conditions on the Wave Equation. These are ;

- 1) Separation of variables, such as, $V(x, y, z, t) = U(x, y, z) \cdot e^{-i\omega t}$.
- 2) Boundary value problem technique, known as the Green's theorem, in the vector analysis.

These are for the General Solutions. When it comes to applications for the real case, they handled the results very carefully, shch as;

- 3) The direction cosines were carefully handled with the Optical Path Length, which is equal to take the *Retardation Effects* into account.

Surprisingly enough, they got the theoretical form for the Fresnel's Inclination Factor in a closed form as follows;

$$K(\chi) = -(i/2\chi) \cdot (1 + \cos \chi). \quad \text{【Ref. 27, p. 380】}$$

Again, pure-imaginary thing came out! However, please remember, the Saints above, all employed the spherical wave for the incident light.

☀3-3 Saints Fraunhofer-Fresnel and the Diffraction Pattern.

Finally, The Experiments came out; The Fraunhofer Diffraction Patterns are printed beautifully, in Chapter 8. The associated phenomenological equations are the most sound bases for designing and analysis for the monochromator even up today. Of course, many modifications are put upon them due to the progress of computer analysis. However, these Saints' works still keep the positions second to none.

§ 4 They did it again !

Readers of this work would agree to my opinion ; “The Rigorous Diffraction Theory ended up with the more shabby results than the Saints’ work”. The Modern Theorists hitched their wagons to a Too Big Star. Probably, they did not imagine that the problem could be such a tough thing. Another possibility for their failure maybe that they were too strongly established peoples to accept any critical arguments. Lastly, it seems obvious for me, that they didn’t have a good friend of optical experimentalist. At any rate, they were too much confident about their own skill about contour integrations.

They worked from 1896 to about 1937 ; from the period before World War I, until middle of World War II. It was respectably long endeavors, however, with the old “ Modern Analysis”, and without computer.

The weak point of Saints that they ganged upon is, “In the early theories of Young, Fresnel, and Kirchhoff, the diffracting obstacle was supposed to be perfectly *black*; that is to say, all radiation falling on it was assumed to be absorbed, and none reflected.” “It is indeed, incompatible with electromagnetic theory.” [Ref. 27, p. 556]

To make long story short, they swung the pendulum to the other extreme ; “a perfectly conducting (and therefore perfectly reflecting) body.” “In general, however, the assumption of finite conductivity tends to make the mathematics very complicated.” [ibid]

As for the geometrical shape for boundary conditions, they simply "drew a line". Nevertheless, the problem turned out still complicated enough. They got to struggle besides the vector analysis, with the *Reflected Light* from the boundary surface. This is actually, the *Front Side of the Slit*. This was the reward for their picking up the perfect metal! Does reflected light beam want to make a return match to sneak back through the slit? Or does it collide with the incoming new-comers? They might not be realized that the inside wall of the optical instruments is normally painted by the black stuff. They knew the contour integration, but they didn't know the Optical Slit.

They struggled, or maybe enjoyed, the integration upon the Complex-Variable-Plane; Principal Values, Fresnel's Integral Equations etc., but in vain. Such as it is, it is quite reasonable that all the theorist tends to pick up the easy functions for diffraction analysis. I'll show you one of this thing [Fig. 4], that appeared on Dr. Feynman's book. [Ref. 56] Once Dr. Feynman showed up any thing, then all the T-JSSP rushes to follow. They rise up like pavement-stones, wherever the beauty (Dr. Feynman) walks around! [Ref. 57, 58]

As [Fig. 4], Dr. Feynman employs The Gaussian-Slit. He says the Fresnel's Result is easy to let us lose our way. However, there is no Gaussian slit in this world. I wonder if Dr. Feynman aware of that, even single slit, or opening, can provide the Fraunhofer DIFFRACTION. What's more, Light Wave Does Diffract by even Single Edge! Please remember, Single Edge Diffraction is not due to a tiny hole, nor a slit, nor an opening; it is just due to One Boundary. This is the problem that we all are challenged. [Ref. 27]

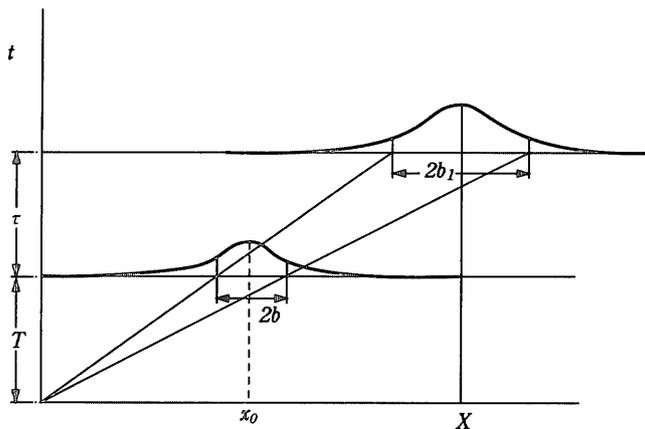


Fig.3.5 The paths of particles moving through a gaussian slit. If the particles obeyed classical laws of motion, then the distribution of particles at time $T + \tau$ would have the same form as the distribution at time T . The difference would be only a spreading out proportional to the time of flight. The characteristic width of the distribution would be increased from $2b$ to $2b_1$, where $b_1 = b(T + \tau)/T$. For quantum-mechanical motion, the actual spreading is greater than this.

Fig. 4 Theoretical distribution of Particles, which got through the "Gaussian Slit". Ref. 56.



Fig. 5 Example of the Most-Primitive way for explaining the Diffraction of light. They employ "Huygen's secondary wave principle" only. What's more, they pick up the nostalgic words, i.e., "very tiny PIN HOLE". Question is "How tiny is it?". Most of them don't realize that "The Inclination Factor" should be coupled with the Principle. Otherwise, the explanation ends up with the most poor way as shown here.

Obviously, all the Dr. Feynman's men in Japan, never aware of this point. Incidentally, in another book [Ref. 13], Dr. Feynman shot the electron GUN in the class room ; which was equipped with the Infinite Cartridge for Western Movies, I'm afraid. Someone should have called for a University Police to let him quit shooting in his class.

I will show you the most primitive nonsense picture, on [Fig. 5], that we can see very often. This is the same thing as the most idle student in my class was drawing. You know, they think the exit slit is a narrow enough point source. They only know the point source and the Huygens' Principle! Who taught them this way ?

§ 5 What is DIFFRACTION ?

Before you would be get tired to listen to me, I must come to the point :

- 1) I need a Spherical or Cylindrical Wave after the slit. This is because, I believe in the Saints' calculations. Their way of handling the problem with the Optical Path Length, after the slit, is perfect. The only point that can be questionable is they have set the Spherical or Cylindrical Wave for the incident light. This is because, as I said, they put a point source from the beginning.
- 2) I have to find some “Principle” to obtain The Spherical or Cylindrical Wave out of the *Incident Plane Wave*. Another words, I got to invent A Trick somehow, which can change the plane electromagnetic wave into the cylindrical shape. There is no place except within the Slit (Channel), that I can hide the Magic, you know. My trouble is, as

you can imagine, the channel is so wide enough, as if the Free Space ; order of about from 100 to 1,000 wavelength unit wide. I gave you this figure already.

- 3) Needless to say, if there is no boundary, there is no Diffraction either. This is "The Boundary Problem". We got to find out how to deal with it.
- 4) The only good thing for us is, it is clearly shown that the Substance of the slit does not make any important role at all. Thanks to Born-Wolf and The Saints, and the line of manias of Contour Integral. The secret must be in Slit's Shape !

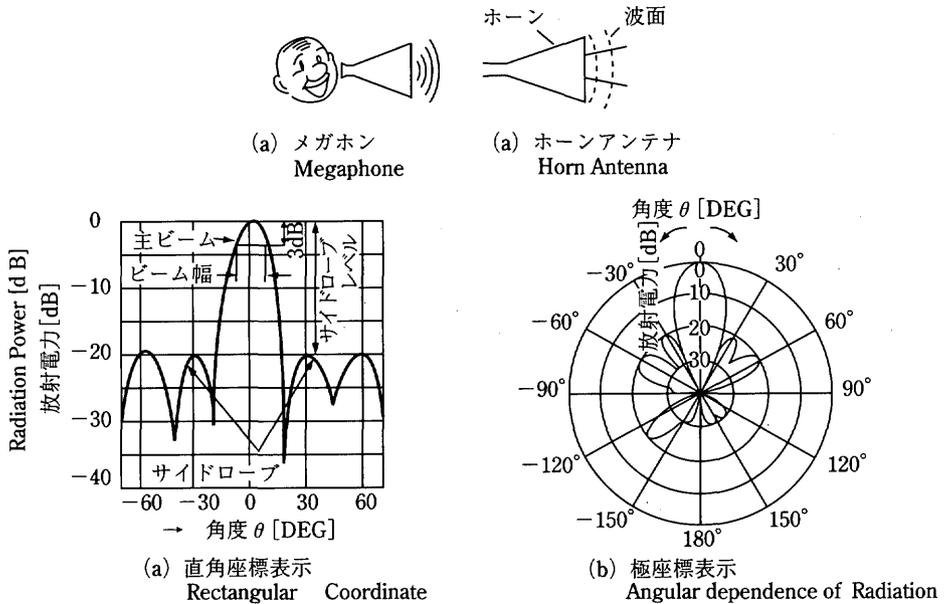
I have to confess that I've been got stuck at this stage, quite a long time. However, the showdown came at last, when I asked to my friend, Mr. Takaji Kuroda, Corporate Chief Engineer, NEC Corporation ;

"What if I suddenly cut off a Microwave Wave Guide, and let the EM wave get away ? What the shape of wave front could be ?"

Kuroda : "Well, that can't be called ANTENNA at all. But surely some EM will go out forward. No body will be happy with such a poor efficient Open END !"

"But how poor, do you say ?"

Kuroda : "Well, you know, even at the case of well designed ANTENNA, some electromagnetic power go back even to minus 180 degree.



[after Ref. 59]

Fig. 6 The Intensity Distribution of Electro-magnetic waves (microwave) after the ANTENNA : The comical illustration (shown above) is for introduction of the front surface problem. The lower left is the “Observed angular distribution” of Electro-magnetic (micro) wave. The lower right is the plot of the distribution on the Angular diagram.

So, for this case, a substantial energy will go back along the SURFACE. It is like water wetting. Somehow or other, EM likes to stick and go backward along the surface.”

I was almost jump up on the coach. Couple of days later a copy of Report on Antenna Designing for Communication Satellite was arrived by mail. Yeah! That's it! It was of September 18, 1995. However, there were still more struggles left to do. [Ref. 59] [Fig. 6]

In [Fig. 6], there are two points that I would like to stress ; especially to theorists. On [Fig. 6] (a), an easy illustration of Mega-phone, you know, the guy got the Spherical Wave so easily! Because of the Boundary Condition! The Electric vector got to be normal to the inner surface. (Suppose it's metal.) Looking from the outside, it appears as if the wave front got some delay on the boundary surface, as I showed in [Fig. 6] (a). However, once there were no Horn, then there is not a bit of guarantee that the wave form is spherical.

Another point in Fig. 6 is, as you see in Fig. 6 (b), the angular distribution is far much complicated than theory tells us. According to Kuroda's comment, the reason behind them is that the size of horn or mirror is *not infinity!*

I thought I came far away from Dr. Jackson's book. Still, however, the book stuck heavily for me to dragg. I knew clearly that I needed some trick to retard a part of electromagnetic wave, at near the surface. I recalled the days, when I worked for Latex Particles to measure the particle size, in RCA Tokyo. In that case, I assumed the Hagen-Poiseuille velocity distribution within the capillary. They say there is Friction due to the wall to fluid. But, how can I get Friction to Electromagnetic Wave from the wall? By Joule's effect due to the skin depth? Oh, stop nonsense. It must be prminor.

Another couple of year past without idea. Then the last flash, I hope, came out, when I bought the book, "Chaos in dynamic systems", G. W. Zaslavsky.; actually the book is translated from Russian into Japanese. [Ref. 60] In Chapter 3, I found Dr. Fermi's acceleration mechanism for cosmic

rays, or for Ulam model. I knew Dr. Fermi by name since when I was studying the Liquid Ionization Chamber filled with purified normal-hexane, for my PhD work. [Ref. 61]

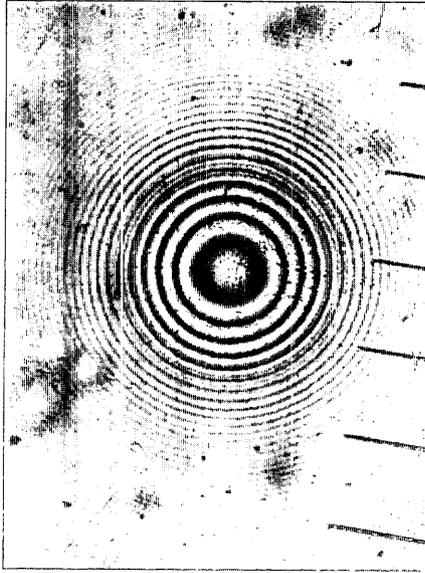
I’ve never realized, Dr. Fermi left his big finger print over here also! It appears he touched almost everything; from the famous atomic pile under the Chicago Staggfield Stadium, through Fermi Surface to Fermi Statistics. And more, he did such a big work on Cosmic Rays, or upon Chaos either!

His idea is to bounce a particle back and forth between two walls. This is what I need; I thought. Of course, I knew I could not bounce the “PHOTONS” backand forth between the slit walls; please recall the width of our Grand Canyon is about 500λ wide, and the k-vector (of photon) is parallel to the wall surface.

Soon, I realized how stupid I was! I forgot about the Surface Conditions! Due to the strong impression of wave guide, due to the golden-shiny-flat inner wall, I was fooled as stupidly as the Theoretical Japanese Solid State Physicists! I was not free from the prejudice of completely flat surface.

I have been thinking how I should invent A TRICK from a perfect plane! Lucky enough, I happened to recall the day’s surprize when I got the Fabry-Perot Etalon at RCA, Tokyo.

In order to purchase Etalon, we usually write the request for flatness to make such as, $\lambda/4$, $\lambda/10$, or $\lambda/100$ quality. These figures request the accuracy of the final flatness should be less than $\lambda/100$, for example. In this case the vender should finish up the hilly up-and-down slope on the sur-

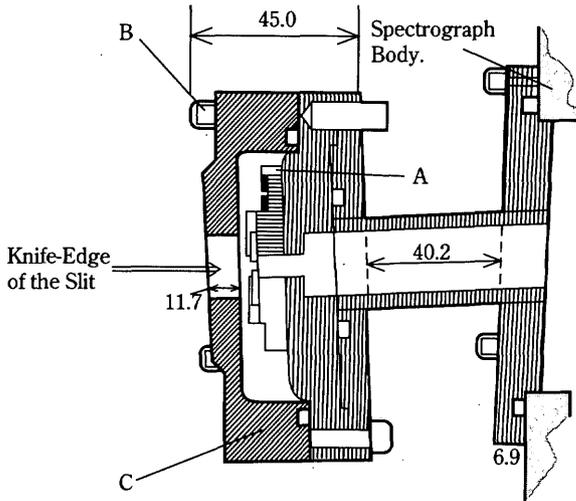


《自然界の標準尺》といわれる光波干渉縞
 を応用した干渉測微機
 薄膜の膜厚測定や超仕上げ面の表面アラサ
 や硝子のヤケなどを、測定精度 0.001μ で
 測定できる繰返し反射干渉計
 (Interference Fringe of Etalon)

Fig. 7 An example of the Optical-Flat surface of the Etalon of Those Days.

face within 50 A maximum, if the working wavelength is supposed to be 5000 A. In [Fig. 7], I will show you the part of the manual of those days. They state, we can limit the accuracy of the measurements down to 0.001μ ; which is equal to 10 A.

The point I want to stress is, this is the job for, what we called, the “optical-flat” (光学研磨; this is a Japanese English I believe) surface quality. Now my question is, “Who on earth will be able to make the wall of the slit (channel) so flat enough like this?” Sure, they may grind or polish the “knife



EXTRACT THREE SCREWS (B) AND
REMOVE END CAP (C) .
SCREW (A) IS THEN ACCESSIBLE.
Fig.8 ENTRANCE SLIT ATTACHMENTS

Fig. 8 An example of the Slit-Assembly for the "Vaccum Ultra-violet (VUV)" monochromator ; Hilgar-Watt-Engis.

edge". But it can't be compatible to the etalon surface. More over, I had a cheap slit which is made by just punching. Sure it showed hell amount of scattered light, but still it showed good Fraunhofer diffraction pattern, when a He-Ne laser was used. In [Fig. 8] and [Fig. 9], I'll show you the drawing of the real slit, that we used in Physical Sciences Lab., University of Wisconsin, Stoughton.

My way to turn the trick is like this ; we have bumpy (or wavy) surface wall on the channel. Then, why don't you imagine a skier who must rush down on the wavy part of the slope. He must slide through the longer length

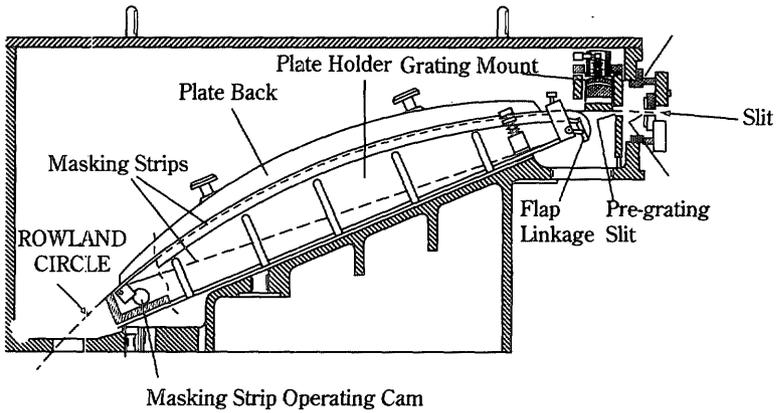


Fig. 9 The layout of the monochromator, which equips the slit shown in Fig. 8.

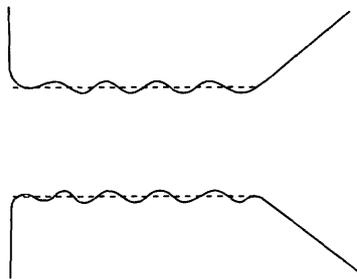
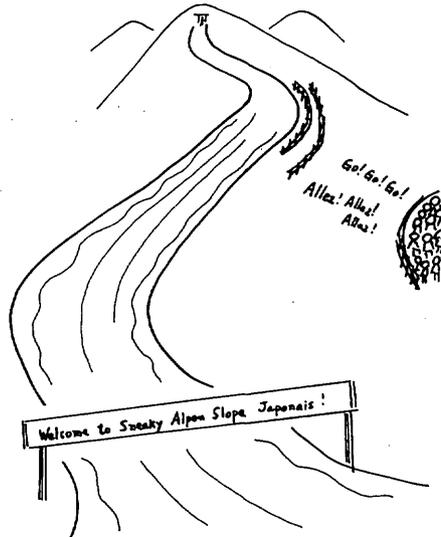


Fig. 10 Exaggerated and imagined surface at the "Knife-edge" of the optical slit.



than other skier who can rush down on the flat part! He has no choice to win. [Fig. 10] Light Wave cannot skip or jump from top to top like the skier, because it is nailed down on to the surface by The Electromagnetic Boundary Conditions!

Once you could approve my way of trick, then next is just to figure out *the Delay Time or the Phase Difference*; phase lag from the central part of the channel to near the wall surface. This effect should also distort the Plane Wave! [cf. Appendix I]

As shown in [Fig. 11], the estimation of Phase Delay i. e., Optical Path Difference, ended up with about 20 times the wavelength (λ). If we would go further bravely, then we can draw a Triangle as is added in [Fig. 11]. This

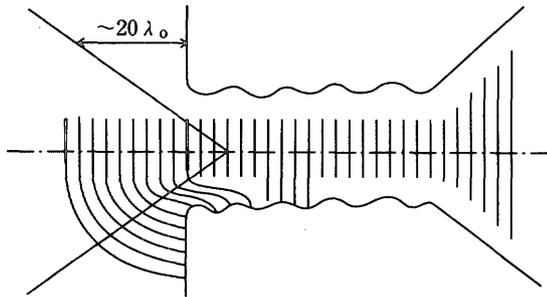


Fig. 11 An example of the light wave, which goes through the optical channel (optical slit). For the Fig. 11, a set of "Optical Roughness Parameters" were chosen, however, readers can take any other parameters. The phase delay were represented by the wave numbers (20λ) in Fig. 11. However, readers may get any numbers by employing the reasonable set for the roughness parameters. (see Appendix 1). The important point is it is "The Phase-Difference" which causes the Interference of the Light. It shows up even when there is single-wave-difference (delay). And a big wavenumber difference is not necessarily needed. Please feel free, to compute the delay by using a computer. The author simply did not have enough time to finish up the Rigorous-Results.

is the way that the microwave people are trying to find the effective point of source for designing the Antenna.

Now we can say farewell to the 17 Century's Huygens' Principle. I would suggest we should call "The Boundary-Effect Principle for Diffraction" as "FERMI PRINCIPLE of Diffraction". [cf. Ref. 60, Chapt. 3] This is because, as you see in [Fig. 12], the electromagnetic wave vector gets plus-minus k -component, Δk , when it slides up and down along the wavy surface; which is exactly the same mechanism that Dr. Fermi suggested for Cosmic Ray people.

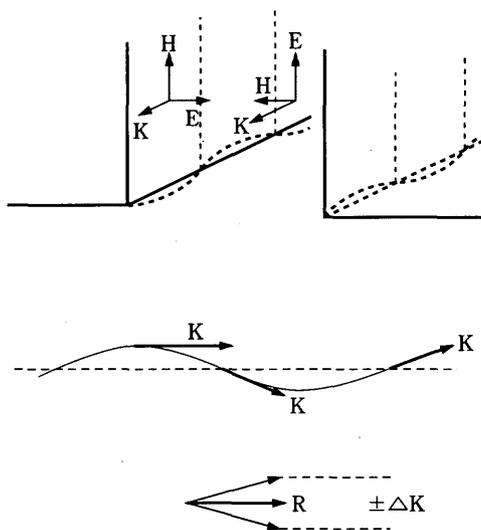


Fig. 12 The macroscopic figure of the End of Optical Slit, and a hint to get k-vector distribution, which in turn, gives us the "partially coherent (in-coherent) light.

In Appendix I, I employed a very simple model ; the surface is assumed to have sinusoidal form. I won't say this model SOLVED the problems, but I would rather say, it has Illucidated the way to solve the weird things. (It is left for reader's choice to make the story more sophisticated one. "Please feel free".);

- 1) I understood, at least for myself, the reason for the old wander since I was a Junior-Hi. The teacher said, "A wide slit gives straight beam, which shows Particle Character. A narrow slit, however, shows the Diffraction [why?], which is the direct evidence for wave character of light. [Then he told us the Huygens secondary wave principle]

I think the slit-width dependence of diffraction is just a matter of Mixing Ratio, between the Edge effect and the Straight part. When you get slit narrower, you get higher contribution from the edge wall effect. There is definitely No Game of appearance and disappearance of Particle-Wave Duality. (I believe, Dr. Einstein didn't say such a thing !)

- 2) My feeling is, whenever we put an instrument like optical slit, we made the (pure) coherent wave to deteriorate into partially coherent state. This effect has nothing to do with Quantum Mechanics, but absolutely a matter of classical geometry. Why don't you quit any more to play with the optical gear to make an analogy to Quantum Mechanics? The other optical elements like mirrors are the same thing. I will show you later.

§ 6 What is the double slit ?

Many readers would approve that the reality of the "double slit system" is well shown by [Fig. 13]. If we strengthen our imagination, then the double slit system is quite similar to a floating island in a stream. Generation of the interference fringe pattern has nothing to do with the mysterious statements : "When we have only one slit there is no fringe, therefore light wave, or photon shows the pure particle quality. On the other hand, however, when there are two slits, the wave quality of the particle shows up. The evidence is the Fringes ! Believe your own eyes ! We can't tell which slit the particle had past ! More than that ! The particle past two slits at a time ! This is the essence of the Quantum Mechanics !" (What's more, even such a Grotesque skier showed up in a book, whose foot on his ski boards did pass

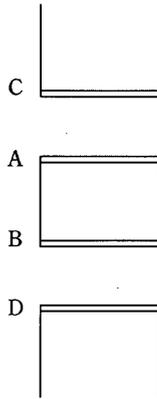


Fig. 13 A Topological-map of the double-slit system. This is very primitive, I must say.

the both sides of a tree, but his body itself sits at the center of the boards without crushing to the tree! This sort of a book for public sale doesn't do anything good to educate people, but just to give them confusion and unnecessary scares for the established modern physics.)

I will repeat 1000 plus one times, if they repeat this Knaben Physik (kid's stuff physics) statement 1000 times :

"Wave is wave, from beginning to the end. It is the results of your Hullusionation and Ignorance of Optics that you relate the wave-particle duality with the double slit experiment. Optical slit is a macroscopic device for the classical physics."

Then which channel has the Particle (electron) past, do you still ask? All right, I will tell you later!

Let's go back to the sincere subject ; readers may agree that the important contribution for the interference fringe generation comes from the both side surfaces of the Central Island, as named [A] and [B]. Theoretically, I can even say, "We don't need the other side of the channel, named [C] and [D] at all, in order to give you the interference fringes."

Now you may become uneasy, that the above statement is too serious, or too strong. However, the point of my argument is not here. You might notice that the island does separate the stream, and thereby we are left with "Not Simply Connected Space". This is the very shivering awful situation.

I will give you a "Bad Joke" in order to understand how serious our situation is. Suppose, I occupied an island at the dangerous edge of the Niagara Fall. And, if I fly up the "Rising-Sun Frag" and declared ; "This is Our Territory!" then, I'm quite sure to be shot down by a sniper within half an hour ! Now you've understood, how serious the Space Problem is !

In [Fig. 14], I will show you the more topologically simplified layout of the double slit system. Now you might see clearly, how serious the double slit system is. This is just a 2-dimensional case. I will invite you to a more terrible 3-dimensional case, later in §7. I hope you would be enjoying it.

To live in the "Not Simply Connected Sapce" is full of disaster : For the simplest example, you might realize that your favorite Valiational Principle falls down on every front in such a space. This is because, as you know quite well, you need a closed loop which should be able to move, continuously, within the plane. The loop get to be shrinked down to a point. In mathematical words, you need a loop like Jordan's closed loop upon the complex

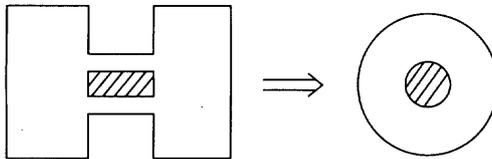
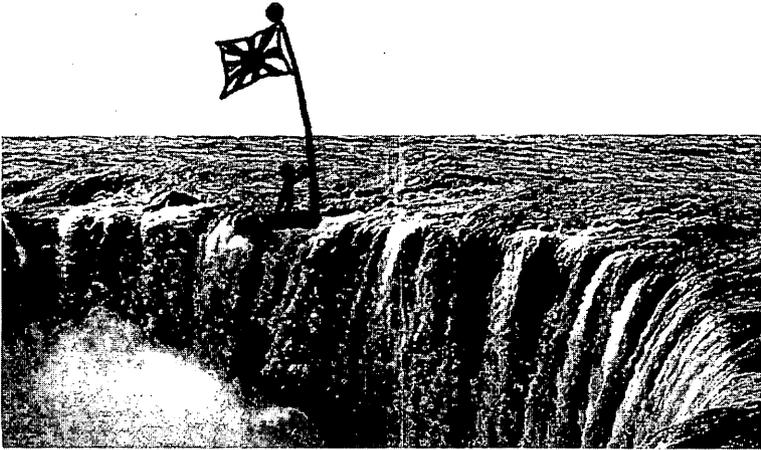
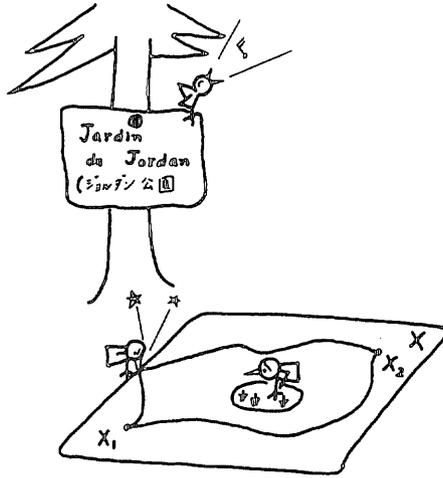


Fig. 14 The Topological metamorphosis of the Double-Slit system in Fig. 13.

plane. The Space that saticefys this demand is called “Simply Cinnected Set.” (単連結集合)

More serious point is, you have forgot that the classical particle mechanics is fomulated within the “Simply Connected Space”. Such a thing is well known for every average Americans. They know quite well that Pitcher NOMO is enjoying to throw the Sneaky Drop for batters. But once a batter stood in front of the home base, NOMO had no choice but to throw a Dead



Ball. Actually, a swinging bat is Topologically equal to the Closed ball B^3 . So, the base ball is essentially The Game of Collision; That makes the match very exciting. Everybody knows such a thing, except University Professors!

Now what went wrong with the classical mechanics? Why don't we ask to Dr. Goldstein, in his famous book, "Classical Mechanics", second edition? [Ref. 62] In the very beginning of the book, in section "1-3 CONSTRAINTS" p. 11, he states repeatedly about the exceptional cases for further development of the theory. These are the cases that keep the "particles" on a "boundary". This is the old fashioned style of the theory to start. Actually I heard about it in 1954, on Dr. Hidetoshi Takahashi's lecture on Classical Mechanics. After all the winding and entangled arguments, they kick out these cases out of their territory.

Incidentally, this sort of "mechanics with an auxiliary conditions" were

the main subject of the mechanics for Japanese “Old-High-school”; which makes me feel awfully out of dated musty stink of Physics.

Why don't we start by saying that “Our platform must be upon The Simply Connected Space, first of all”. This statement excludes automatically, the same things that Dr. Goldstein had put aside.

♠ CONNECTIVITY AND PHYSICS

Therefore, “Connectivity and Physics” is not a joke. I have to mention another thing, however, before we get to this lovely subject; it is again category of space, as I mentioned in the work No. 1 (Bloch who?):

- 1) Theorist appears to fond of mentioning physics in difficult appearances. T-JSSPs tell us solemnly that Generalized Phase Space is essentially different world form the real one. They make us feel as if we were carried to the different universe by Cannonical Transformation. However, all of the sudden, they come down from the heavenly high abstraction to the simplest Junior-Hischool playground, when they must speak something about physics. Besides, they make even mistakes and never aware of them. It appears, obviously, they are less able to play within the abstract space than mathematicians.

Behold, they are now playing in a Kindergarden of $n=1$. They cannot see the difference between the real space and their phase space. Sure, they scatter the flavor of abstraction when they are talking in X-P space. However, they lose their sense, when it comes to talk about the Trajectory of a point.

- 2) They easily mix'em up the x-y space (for calculus of variation) with x-t space. You can fix a point at $\{x(t), y(t)\}$ in x-y space, i. e., in the real space. But you cannot stand still in x-t space. This is the bitter experience for a girl who got an absent minded physics student for her Steady. You know, time runs, but she got to wait at the point (X_0, Y_0) ! Now she realized what is the Steady-State! It's too late, because time runs only irreversible fashion.

I'm afraid, I'm harping the same string. Some physicists, (remember, when a Japanese said Some, that means American's Great Many) are a sort of color blind about Hydrodynamics; nevertheless they know quite well about Electrodynamics. They never realize, that there are Two pictures for Stream line; Lagrangean and Eulerean. Because of this defect, they cannot distinct either we are talking of a trajectory of a particle in a Lagrangean x-t space, or it is a rolled-out map of 1-dimensional Eulerean map scheme. Since, both map has the same x-t coordinate in it. Well, I hope I would be back to this point, which is well known as HOMOTOPY for Topology people.

You cannot set (x, t) as a fixed point in this Topology (Homotopy) map. Time runs by itself. And, this concept (time, t) is easily confused very often by Variational people. At any rate, we have a good reason that the new mathematics must be invented in 20th century, and it appears we found a good thing to have.

♠♠ Connectivity Number (連結数) and how to deal
with it in Physics.

Let's start our study from the simplest and familiar case. That is the

Simply Connected Set (単連結集合). Readers may be familiar with the Function Analysis of Complex Variable (複素変数関数論). It starts usually by introducing the "Jordan curve theorem". i. e., "A Simple Closed Curve C within a plane defines the Two Domains by the closed curve C itself. One domain has bounded set of points, and called Inside. While, the other is called Outside, and the both domain has *the common boundary C*. etc"

Later, when the troublesome singular points came out, professors re-circle them so easily, and throw them out from the holy Simply Connected Domain. However, they scarcely tell us that a simply connected set/domain/space can be reduced continuously down to A Point. This is the new idea of Homology ; the most important character of connectivity associated with the Simply Connected Space. In this case, the connectivity number is 1, and the space is called Simply Connected Space. I will come back to this point later, to show you how to count the connectivity number of a given space.

As you know quite well, this idea of Jordan curve theorem is applied to Physics, firstly in the Particle Dynamics and later to the potential theory. Students are all happily forget about the awful Singular Point troubles forever ; because the kind professors had thrown them far out from the sight, and never let them come to their mind.

The Jordan Curve is demanded not to make a local loop, nor sub-ring, nor crossing. Therefore every student became to believe that nature is Smooth and the line of force or equi-potential line won't make crossing. Their belief came to such a stubborn state until they killed off Poincare's Chaotic flow-line.

However, we have to clear up the bill and think about the space problem from the beginning. Let's consult with the mathematics people, because the average physicists are very reluctant to approve that "We were wrong! Terribly wrong!"

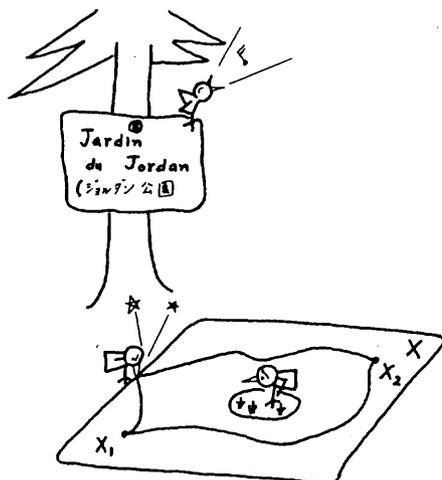
First of all, we have to define our domain of working area. We are going to work with the "Bounded Set of Points (有界集合)", and let's call it "X" for Domain or Space that contains all Real Number. (Complex Number is represented by using a combination of two Real Numbers).

Then the definition of "Simply Connected Set" is following;

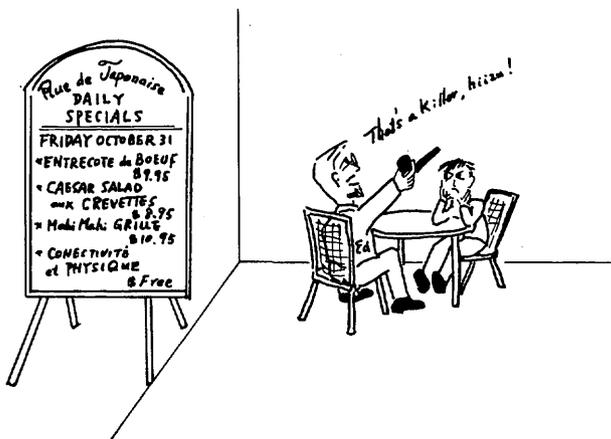
A Simply connected (2 dimensional) set/space within a plane can exist, when and only when, an arbitrary closed curve (arc) does not contain any point that belongs to the boundary. Therefore, it is obvious that the Game of Jordan closed curve, or the Game of (mechanical) Potential Theory, all breaks down when the Closed curve is in touch with the boundary; either on to the outer boundary or on to the inner boundary (island). (cf. the illustration of "Jardin du Jordun" : Jordun Park, ジョルダン公園).

You can enjoy the stories of holonomic or nonholonomic constraints for these cases. However, it appears that there have been not a single example of eye-opener with it. The author feels no grief at all to put lower priority for these arguments from the view point of space connectivity.

We've got an interesting litmus agent, which can tell us whether a problem at stake is a matter of particle physics or wave physics. Waves can go around the island, but particles cannot. The only way for a particle to go



around the island is by multiple collision, or scattering, or reflection. As I showed you in §5, waves can show Diffraction, but a particle cannot. I will come back this subject later in §12. All of this is obvious for the classical mechanics; everybody knows quite well that we can't enjoy baseball, once the dome got a pillar in it. No kidding! I will make a REMARK here, such as Prof. Muto did;



●REMARK No. 1

Double slit fringe game is absolutely Classical Physics phenomena.

§ 7 Justice of the Purse

“It was the local Court of Justice. Regularly, over the years, a city judge sat in the rear of the saloon and held court. The drinking customer got a break - every fourth drink on the house. The motorist accused of traffic violations were not as fortunate.”

One March afternoon, a stenographer was stopped inside the village limits by a uniformed police officer.

“You were doing 30 miles an hour in 20-mile-an-hour zone,” he told her.

“But officer,” she protested, “I didn’t see any sign.”

“Ignorance is no excuse,” he snapped. “You’re guilty.”

The information in this chapter comes from the American Bar Association, the AAA (American Auto Association), and other official sources. It should serve as an eye-opening for the 2,000,000 car owners who are arrested annually.

【“Highway Robbery”； Sam Crowther and Irwin Winehouse. STEIN AND DAY/Publisher/ NEW YORK, 1966】 【Ref. 63】

Now let’s take a look at, how it looks like inside. 【Fig. 15】 In 【Fig. 16】, I’ll show you the Topologically-Equal Structure of the Court. Hope readers see, how weird the structure is. It’s the second to the Labyrinth.

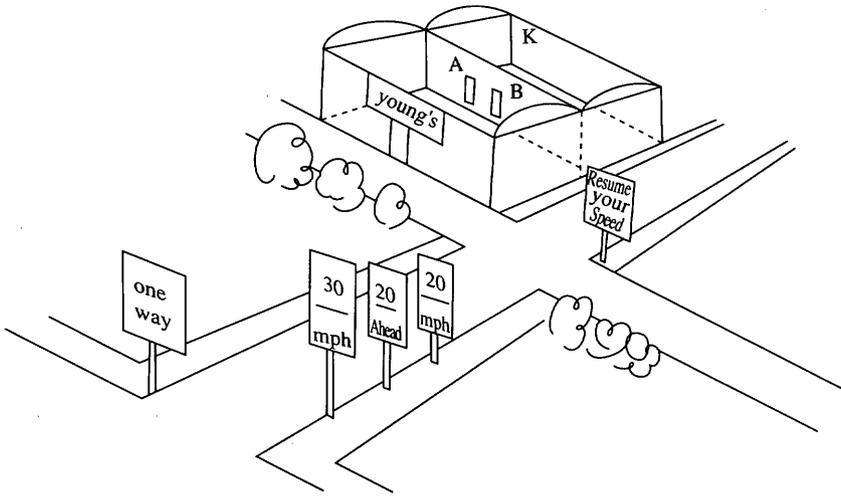


Fig. 15 The famous court-house at somewhere in the world.

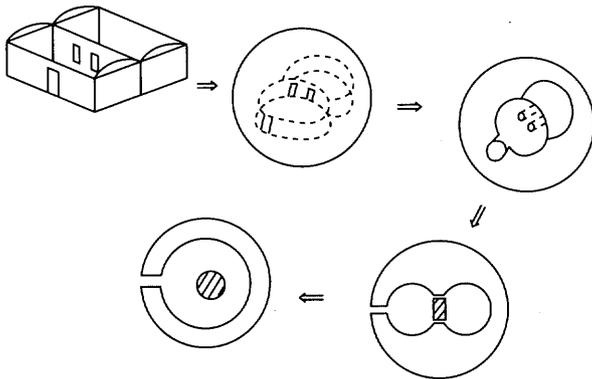


Fig. 16 The topologically equal Labyrinth for Fig. 15.

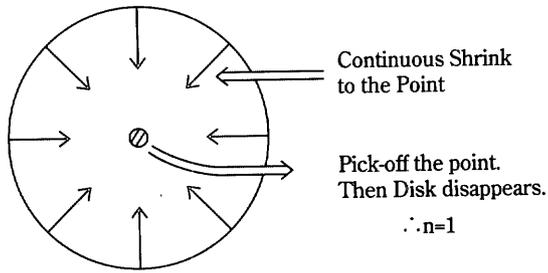


Fig. 17 The way to count-out the "Connectivity Number of Space". This example is for "2-dimensional Disk".

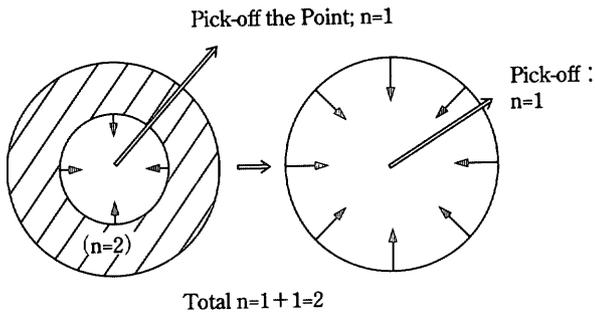


Fig. 18 Counting-out the connectivity number for The Space limited by the Two Concentric Circle".

Before we'd try to count up the connectivity number of this modern Labyrinth, we'd better to know some combat field rules. Grand rules of homology are just two. They are ;

- 1) Try to shrink a loop, within the domain (surface), down to a point, continuously. Here, the word "continuously" means, "continuous projection", mathematically. If you don't like the "neighbourhood game", you can employ your "common sense", for the present arguments. For the present, it means, "You can continue if your shrinking loop were NOT stopped by ISELAND and so forth at somewhere, until it becomes to a POINT".
- 2) Then, pick up the "point" and take it away from the domain/surface/set. Otherwise, the point will "pin-down the next shrinking closed curve". You have got "Count 1". Continue this process, until you are left with the empty space ("empty set"). Count up your total "Count Number you've got", when everything disappeared, then this is the Connectivity Number of your space.

Why don't we try examples ;

Example 1. Connectivity Number for a disc. [Fig. 17]

Example 2. Connectivity Number for a domain which is surrounded by concentric circles. [Fig. 18]

Example 3. Connectivity Number for the Labyrinth of the Local Court of Justice. (Readers are recommended to find it by himself. $[n=3]$) [Fig. 19]

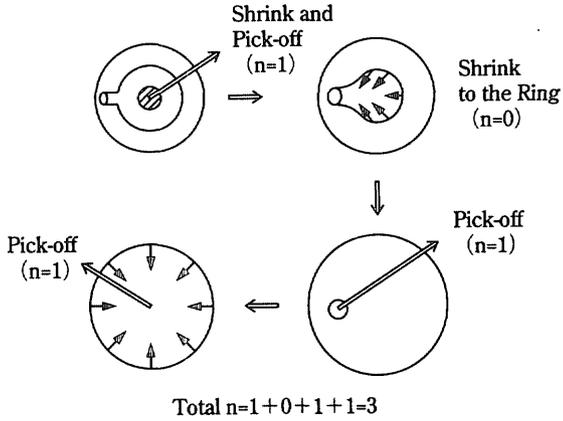


Fig. 19 The way of counting out for the Famous Labyrinth, or the Court-House.

●REMARK No. 2

As you would be able to see easily, the proposition for the VARIATIONAL CALCULATION METHOD will break down, if the space has higher connectivity number more than 1. I will come back this point in §12, more precisely.

★ Matter Wave

§ 8 I don't touch you. But I know you've got ball rolling !

In the previous sections from §2 through §7, I've shown you the kids' stuff of double slit storys with kid glove. In following sections from §8 through §11, I will show you our treaty which we exchanged with photo-electrons.

First of all, I must really tell you (Pure-Theorists), that we (Experimental-SSP) can recognize that (an) electron is coming up, before it will hit the detector surface ! This WAS really my greatest surprise, when I found the following sentence in the famous book ;

"It must be emphasized that the galovanometer will measure a current, even if no charge flows from the crystal to the electrode, i.e. if all the electrons are trapped in the crystal. It should not even be necessary for the electrodes to be in contact with the crystal" ["ELECTRONIC PROCESSES IN IONIC CRYSTALS"; N. F. Mott and R. W. Gurney. Oxford at the Clarendon Press, 2nd ed. p. 120, 1957] [Ref. 64] [Fig. 20]

I was just in a struggle with the ionization chamber, which was filled with liquid n-hexane. I was dreaming to measure the ionization current due to gamma ray irradiation (for my Ph. D work). You know, the people who were working with the gas ionization chamber, such as Geiger-counter for the extreme case, he could collect almost all of the ionized ions or electrons, rather freely, as if he was measuring metal conductivity.

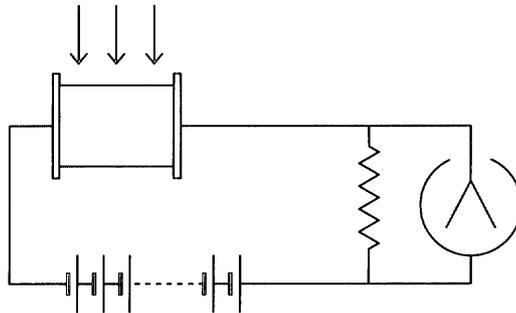


Fig.39 Experimental set-up for the measurement of primary photoelectric current

Fig. 20 The system layout for Photo-conductivity measurements. Emphasis should be put on the Fact, i.e., photoelectrons are not demanded to go through the crystal in order to touch to the electrode. Ref. 64.

But when it comes to a liquid filled ionization chamber, I found something wrong was sticking around me. Then I cooled down the temperature of n-hexane, hoping to reduce the scattering due to collisions with PHONONS, (after when I learned a little bit of SSP). The ionization current was decreased however, against my hope and finally got stopped, when n-hexane was frozen up.

Very fortunately, it was not so long before I met with the book above. That was quite a surprise and a help! Later, I found the wisdom stated in the book was "Just a Well-Known Trivial" for the Photo-Conductivity Peoples.

The book says also, "if the electron travels a distance x only, the charge measured will be,

$\epsilon x/l$, (1) **【Eq. number is due in the book】**

where l is the distance between electrodes" for a plane parallel capacitor type device. (cf.in **【Fig. 20】**).

When I got a job in ISSP afterward, someone in the seminar asked me to derive the equation (1) above, starting from a rigorous base of Electromagnetism. He insisted, "It sounds like a Junior-Hi Physics, if you start your argument from such a simple minded eq.(1)." So, I grabbed the "Reciprocal Principle", which is nothing but a linear response theory for a capacitor with arbitrary number and shape of electrodes. **【Ref. 65.】** The keen abstract equations work out very fine. I was succeeded in to escape through behind the smoke screen of abstractionism.

At any rate, Electrostatics is similar to Thermodynamics. It is similar in the sense that it just compares between two states ; before and after the action. The Time Factor $[t]$ is NOT considered as a variable within the framework.

Soon I realized there are two school of people in Photo-Conductivity Society ;

- 1) One group is measuring the total charge Q , which is the integrated value of eq.(1), whole through the crystal. They measure the total charge Q , which are generated by every single light pulse exposure. Technically, they employ a camera shutter and the Carry Vibrating Reed Electrometer.

- 2) The other group is measuring the Photo-Current, which corresponds to the time derivative of eq.(1), they said. The aim of their measurements are to obtain the microscopic informations in photo-electron dynamics ; such as mobility etc.

The point of physics behind them for the group-2) people is to assume that photo-electrons are able to get the final (or maybe temporal) equilibrium distributions before they will be trapped and became unable to move along. Technically, they employ the shortest light pulse and Hi-speed electronics.

The consensus within these two group peoples are, however, that eq.(1) holds true. No people, including myself, has no doubt about it at all. This is because, in our case, mylar sheets or quartz films were cramped between the two electrodes and the crystal, so that no electron can get In-N-Out across the crystal surface. They called this trick as "The Blocking Electrode Technique". According to my terminology, the photo-electrons are absolutely contained within the crystal, i.e. "Within the Local World".

The physics behind this trick is Electrostatics, as you can see well. Suppose you put an electron within the space between plane-parallel capacitor. Then the electron would begin to drift toward the (+) electrode, if it's available to move. You would easily agree, then the potential on the electrode should drop some extent ; because the work was done to pull the electron toward the (+) electrode. Of course, two electrodes did the work. However much the drop can be little, it is the technical problem, whether we can observe the drop of voltage on the electrode.

Question is, how we can calculate this phenomena taking the Time (t) into considerations? Remember, the statement above came from Electrostatics. It compares the difference between before and after the Action.

Laplace Transformation or the Heaviside Transformation is invented for such a purpose. Readers are able to look at the small calculation in [Appendix II].

The reason why I introduce you the story of photo-conductivity measurement is that electron is always associated with the electric field. We can always tell you that (an) electron is coming up BEFORE we may catch it. Another words, the poor electrons never cannot escape from our detection system, once it moved, however slow it may be! Remember, the applied voltage across the electrodes is only a few volts. Actually, this is the "Single Channel Charge-Coupled-Device".

If you say, there is a photo-plate or sophisticated electronics which recorded the interference fringe pattern, it is due to the electric field measurements. The detecting system did Not measure the Material Wave itself. It did not measure the mass of electron, either. When people speak about spin of an electron they measured magnetic field strength. Remember, electric field (and magnetic field) always comes before the center of the mass of the electron. Never forget the Blocking Electrode Treaty!

What do I want to say? I don't care at all, whether the center of the MASS of AN electron got past through which one of the double slit! The fringe pattern is the same for either case, because it is detected before the Center of the Particle would got to the detector plate.

What's more, there are terrible messy confusions about the Dimension of the Detecting System, as you saw about the OPTICAL SLIT. It appears that all the Japanese Professors Men don't have the modern knowledge of CCD (Charge Coupled Device), I might go down to their platform, since they talk very frequently about the photo-plate. Still, it is obvious they never know about How the Photographic Latent Images will be obtained. Hope that they would try to Open any book, that states the latent image formations. [Ref. 66]

I believe there are many big progress have been done on this topics in these 50 years. However, the following two points must be well established, I hope :

- 1) A mobile electron is released from Silver Halide Atom due to the absorption of Electric Field Energy. If you are suspicious, why don't you look into Dr. FERMI's Lecture Note. [Ref. 61]

Dr. Fermi said, "A charged particle moving through matter loses energy by electromagnetic interactions which raise electrons of the matter to excited energy states. If an excited level is in the continue of states the electron is ionized ; if not, the electron is in an excited bound state. In either case the increment of energy is taken from the kinetic energy of the incident particle". (Needless to say, for our case, the Conduction Band is regarded "Continue" somehow!).

- 2) The released electron moves around some distances before it settles at the Latent Image Formation Place.

Therefore, there are double confusions ;

- 1) We are Not observing the fringe of the Matter Wave.
- 2) It is Not the original Spot where electron hit the photo-plate (detector).

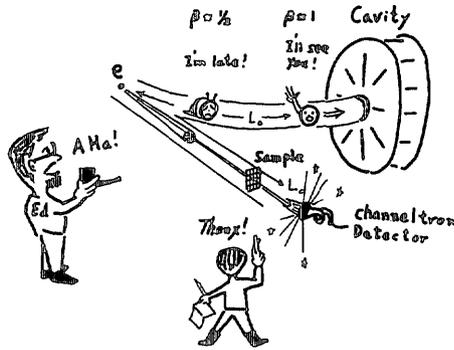
Then, what we should do ? Within the domain of my imagination, it appears there's no way but we get to *Neutral Atom Beam Experiments* [Ref. 4, 5];

"Please, please, don't let us hear such a Good Night Story any more ; Once we had two identical boxes and an electron. Someone put The electron into one box. Another someone took one of the two boxes, knowing nothing which one got the electron. He was ordered to carry it to Ch. de Gaulle Air Port, Paris. A Friend of Dr. Wigner was somehow waiting at the arrival terminal du long-temps !

He opened it. BUT (!), he was so Unkind to Dr. Wigner that he didn't let Dr. Wigner know the result! Therefore, Dr. Wigner's wave-function couldn't get to any Eigen State, et cetera et cetera !" uh-uh.

§ 9 I'll see you !—Sorry, I'm late !

As you've read in the previous section, electron is always associated with the electric field. You know, electron emits the Electro-Magnetic wave, or light, when it's suffered acceleration (deceleration), what ever the forces may be. This mechanism is completely different from that of the light emission due to the internal energy transition of atom and/or molecule.



Tell you what ; it's very nice to stop off at SRC (Synchrotron Radiation Center), Stoughton, Wisconsin. There is a good demonstration device to understand the Special Relativity. You learn Relativity much easier than by any lectures. Forget the drowsy light emitting game on the running train, and beat it out of their head about on boarding the light velocity space rocket.

As shown in the illustration, the speed of light is independent to the speed of circulating electron. Once the light was emitted in the bending section for magnet, it will hit your sample and the detector after the same retardation time.

Some Theoretical Japanese Physicist often write such a story as follows ; "When Dr. Einstein was six (or about that) years of his age, he began to wander, what shape of light he may see if he ran, side by side to the light, with the same speed to light ?"

They cherish this story very much. They printed it on a best seller series to introduce Dr. Einstein's Life to public. As the result, we are

annoyed by FAQ (Frequently Asked Question). I dug up the Root of the story. Finally, there's only one left, i.e. A Translation of "Einstein's Autobiography" which is very hard to find, like Dr. Neumann's case.

This story is very weird. Firstly, Light is never to be seen from the side. You had a country folk around '70, singing "I've never seen, light turned back to me!" Secondly, they are saying "Suppose we switched on a pulse laser on the space craft of light speed" etc. They've forgot about that it takes TIME to build up the pulse-laser. What's more, it takes TIME even for an electron to jump up to the higher level.

Maybe you've noticed that One of the Main Purpose of this work No.3 is to talk and discuss about Time-axis. It is in a sense to follow Dr. Einstein's SPACE-TIME coordinate; this is not Space-and-Time coordinates. [Ref. 67]

With this regard, I wish to send some "REMARKS and QUESTIONS" to A Theoretician. It appears to me that everything is related with The Boundary Problem, from the modern math point of view, such as SET, TOPOLOGY, and HOMOTOPY. By the word of "Boundary Problem", I don't mean the customary Boundary Value Problem nor Initial Condition Problem. This is "The Novel Boundary Quality Problem" on the Space-Time world. I would like to beg the reader's patience, not to throw away this copy at this point. It may sound like a headachy monologue, but I have never seen nor heard any one to speak about this point. I do not want to persuade you; I need not to do such a thing. All I wish is, I want to hear you and wish to know where and how it is wrong, if there is a mistake in the story.

§10 Double Slit Experiment by using Dropping Atoms

As I've said in §8, I wrote two reports on The Bulletin of Chuo-Gakuin-University (CGU) in 1993. [Ref. 4, 5] I sent more than 40 copies to Japanese Physicists. However, I got absolutely ZERO reply. The only one came in, to my surprize, was from Strasbourg, France. The friend over there sent me back with the whole translated text into French. However, that was the all. No response came in. (p.s. He came in on 4/10/98. We intended to see Dr. Shimizu, but he got more urgent job to go back.)

I raised many questions in the reports, and waited for comments and/or objections. Finally, I realized there were no people at all who were interested in such an ancient subject. The world was busy enough even in 1993. People appeared dislike to take Time such a subjects that they have not heard. Taking this oportunity, I would pick up the same trumpet, and I would like to ring up the curtain of the prelude for §11.

●REMARK AND QUESTION, NO. 3.

Once, there was a double-slit experiment, done by employing the free falling Neon atoms. Atoms were hold in a narrow space, by the laser-cooling technique. By opening the cooler-trap, atoms began to fall, they said. Now, the falling velocity was so slow, and the Neon atom mass was not so light, that de Broglie wavelength were supposed to be fairly long. They put a mechanical double-slit screen where the free falling Ne atoms were supposed to pass, hoping to obtain "the interference fringe due to the Atom de Broglie Wave". Indeed, they obtained the fringe patterns, and somehow or other, their results were published on widely accepted journals [Ref. 68]

They employed TV electronics technique to take data, and there were some discussions and trials for data analysis.

However, the way of their analysis appeared rather unsatisfactory from the Optics point of view. I got an appointment to see one of the author of the work, and asked to approve for me do other way of analysis, on their published data. It was nice up to this point. However, soon I noticed they lack the fundamental knowledges that people can find in the book of Drs. Born and Wolf. What's more, I found they were looking for the other way to go. It appeared me they were speaking of too sophisticated Physics, with too primitive knowledges.

Again, I asked their approval to submit my analysis to this bulletin, and they were kind enough. At any rate, my conclusions were rather eccentric and I got just complete silence, all over the Japan island, as I said before.

The eccentric conclusions were as followings :

- 1) The width of their double slit is $2\mu\text{m}$, and the wavelength of de Broglie wave for the dropping atoms is, typically, 200 Å. Therefore the ratio of the two dimensions end up with a figure about 100. As I said 1000 times in §2, and this is not an optical slit, but an Opening. We should employ the Fraunhofer analysis for diffraction. I noticed, however, the university professors, including the authors of the original work, were figuring the results by the simple Junior-Hi method which appeared in Fig. 7.3, in "Born·Wolf, §7. 3. 1.". This is, again, due to the awful contamination of education that is very common in Japan.

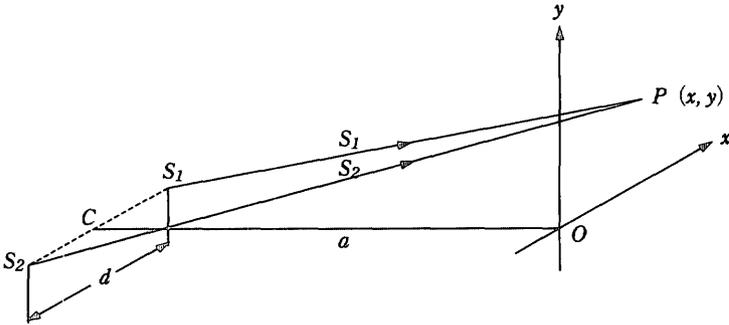


Fig.7.3 Illustrating interference with two point sources

Fig. 21 The most Primitive way to explain the diffraction and interference effect of light.

2) The experimental data revealed that the dropping speed of atom has a distribution. I figured, this is because the trapped atoms by the laser cooling technique still has some initial velocity. Therefore, an atom that has higher velocity component to downward reaches faster than the others to the detector. Another words, “within the same given time, the Free falling Particle that has the shorter de Broglie wavelegth can go further distance.” This concept completely in accord with Dr. Feynman’s saying for the simple example, in Chapter 3, on Fig. 3-1, in his text book ; “QUANTUM MECHANICS AND PATH INTEGRALS” [Ref. 56]. However, I know those uncountable number of T-JSSP, who insists that the velocity of the Wave is as high as the light velocity, or even higher so that they spread instantaneously. I really don’t know !

3) Now, we can derive Two Wavelengths by Two Independent experimental data ;

(a) The Optical-Wavelength, which is derived via the Fraunhofer formu-

la.

- (b) The Semiclassical-Wavelength, which is derived by inserting the Classical Falling Velocity of Atom into the de Broglie formula.

The ratio of the Two Velocities showed a very systematic discrepancy about factor of 1.8 (~ 2). This is the expected ratio, if we assume that The Optical-Wave for case (a) is associated with PHASE VELOCITY, since it is Phase that concerned with the Fraunhofer Interference. On the other hand, for case (b), The Semiclassical-Wave should be related with GROUP VELOCITY, since this is directly related with the motion of the center of Atomic mass.

It appears that the Optical-Wavelength, which is associated with the Phase Velocity, should go to Dr. de Broglie's Wave. I learned Dr. de Broglie reached the same belief in his later stage [Ref. 69] Why don't you ask French Physicist about this story ; they must know better !

4) After some careful manipulation, so that we should not mix up the two velocities, Phase and Group Velocity, we could get to the "Dispersion Relation" of the Material Wave of Ne-atom. To my surprise, there appeared the Dispersion Relation in the ω vs k diagram.

- 5) The dispersion relation is represented by the following equation ;

$$\omega = Ak + Bk^2.$$

As you know, this is a Super-Linear function. This is NOT a theory, but a result which is derived from the experimental data. The story is simple.

It'll be stated very roughly, and a bit more convincing statement will be presented in the following ●REMARK AND QUESTION, No. 4. If you would not lose your interest nevertheless, you could find more in [Appendix III].

《The Roughest Story》

Since, $h/p = \lambda$ is the de Broglie relation which connects the particle momentum p and the de Broglie wavelength λ , I put the following experimental data into the equation, $h/p = \lambda$;

p : Ne atom's momentum, which were derived by the atom's falling velocity.

λ : Ne atom's optical (de Broglie) wavelength, which were derived by the analysis of Fraunhofer diffraction Theory. (This is NOT the popular Junior-Hi oriented calculations.)

The point is, these data were obtained by the same experiment at the same time. Could you, any one, tell me if I made a mistake so far? If YES, and if I could agree with you, I won't hesitate to withdraw at once!

You know, for the *light wave*, we have

$\omega = ck$, and we get,

$v(\text{phase}) = \omega/k = c$, and $v(\text{group}) = d\omega/dk = c$.

Therefore, Phase Velocity is equal to Group Velocity, since the ω - k relation is Linear. However, for the present case, it is Super-Linear i.e.,

$\omega = Ak + Bk^2$. Then we have;

$$v(\text{phase}) = \omega/k = A + Bk, \text{ and } v(\text{group}) = d\omega/dk = A + 2Bk,$$

which is exactly the data is showing us. Now we’ve got a very weird result ;

The phase velocity is different from the group velocity, which is not strange at all by itself. But, the group velocity is higher than the phase velocity ! What’s more, the k -dependence for the two velocities is the same ! I’d ask again, could you be so kind enough to point out what was wrong with the story ? It was only Dr. Imai who gave me a reply when I distributed the reprint of the article to my Japanese friends. He mentioned only briefly, however, “It is disastrous if we have the k^2 term (大変だ)”. However, he didn’t explain any further how it is disastrous. Rest of the University Friends, whom I sent the copy to, all kept complete silence like a Sub on the botom of the Pacific.

If, and only if, you would accept the Experimental Data and the Analysis of the Classical Wave Optics, then believe it or not, this is the place where you’ve got arrived.

Actually, such a thing like this is not at all strange phenomena these days. Why don’t you look at the [Fig. 22]. Any Super-Jet has the higher particle velocity than the phase velocity of sound. Maybe even ducks know better about the propagation of waves than the university professors. Of course, the question is the Free Falling Atom is actually accelerated by the gravity ! So, this is a Gravitational Linear-Accelerator! When the gravity breaks in, I am not yet well equipped with to fight. I might stop here to role out the strange carpet.

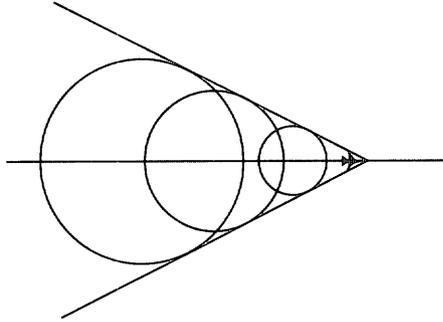


Fig. 22 An example of “Particle velocity is faster than the Phase velocity”. In The Fig. 22, group velocity is replaced by the particle velocity. This is the point of argument, and you can amuse away for all of your life.

● REMARK AND QUESTION, No. 4

In the book “QUANTUM MECHANICS”, Dr. Albert Messiah wrote in the foot note at p. 13, Chapt. 1, §5 The Compton Effect, as following [Ref. 70];

foot note 2); According to the principle of relativity, the (rest) mass m , the energy ϵ and the momentum p of a particle are connected by the relation : $\epsilon^2 - p^2 c^2 = m^2 c^4$; its velocity $v = \partial\epsilon/\partial p = pc^2/\epsilon$. If $v=c$, [then] $\epsilon=pc$ and $m=0$. (Dr. Messiah wanted to say “directly from Einstein’s hypothesis, since they possess the velocity c , photons are particles of zero mass”).

In another section, p. 52, Chapt. 2, §3 Free Wave Packet, Phase Velocity and Group Velocity, he wrote ;

“It is this velocity $v(g)$, and not the phase velocity $v(\phi)$ which, in the classical approximation where one consider the extension of the wave packet to be negligible, must be identical with the particle velocity,

$$v = dE/dp \quad (\doteq p/m \text{ in non-relativistic approximation}).$$

From the condition $v = v(g)$ and from relation $E = h\omega/2\pi$ one obtains the de Broglie relation :

$$p = hk/2\pi = h/\lambda.$$

However, to my opinion, these are the Sufficient Condition for Existence of de Broglie Wave. Dr. Einstein and Dr. de Broglie didn't verify everything that is Necessary for Existence of de Broglie Wave. I, as an experimentalist, still think, that I need some experimental Facts before I would convince in any theory. This is why I showed you the "Double Slit Experiment by employing Free Falling Ne Atoms"; it may not be spectacular nor confident enough. But fact is a fact.

«a bit more convincing story»

As I said earlier, I have my stuff back in [Appendix III] to show you, if it may become your interests to look into the gear box. However, let me start from the conclusion of the Appendix III;

After a little manipulation, starting from the same Dr. Einstein's principle, i.e., $\{\epsilon^2 - p^2 c^2 = m_0^2 c^4\}$, I've got to the following equation for de Broglie Wavelength, $\lambda(d)$;

$$\lambda(d) = \{v(g,d)/v(p,d)\} \cdot \{v(p,d)/c\}^2 \cdot (h/m_0 c) \cdot 1/(v_m/c) \cdot \{1 - (v_m/c)^2\}^{1/2} \cdot (1)$$

where ; $v(g,d)$ is Group velocity of de Broglie Wave. g stands for Group and d stands for de-Broglie.

$v(p,d)$ is Phase velocity of de Broglie Wave. p stands for Phase.

v_m is particle velocity. m stands for mass, since suffix “p” for “particle” cannot be used to avoid confusion with “Phase”.

c and h are velocity of light and Plank constant, respectively.

There are 4 cases that we can amuse, and we will see what sort of the approximations are hidden behind the curtain :

Case (1). The most simple minded calculation.

Let's neglect all the difference among, $v(g,d)$, $V(g,p)$, and v_m , and just say they are represented by the single velocity v . Another words, let all the velocity, $v(g,d)=v(g,p)=v_m=v$, whatever heck the meaning of v maybe. Then you get the most familiar result from eq(1) as follows ;

$$\lambda(d)=1 \cdot 1^2 \cdot (h/m_o c) \cdot 1/(v/c) \cdot \{1-(v/c)^2\}^{1/2} \dots(2)$$

$$=(h/m_o v) \cdot \{1-(v/c)^2\}^{1/2}=h/p. \quad \dots(3)$$

This is the most popular result, and you will be able to find it in almost all the text book of Quantum Mechanics. The curve of eq.(2) is shown on [Fig. 23] in the unit of $(h/m_o c)$, the Compton wavelength for an electron, i.e., $(2.426 \times 10^{-10} \text{ cm} : \text{AIP handbook 3rd ed.})$;

$$\lambda(d)=(h/m_o c) \cdot 1/\beta \cdot \{1-\beta^2\}^{1/2} \dots(2)$$

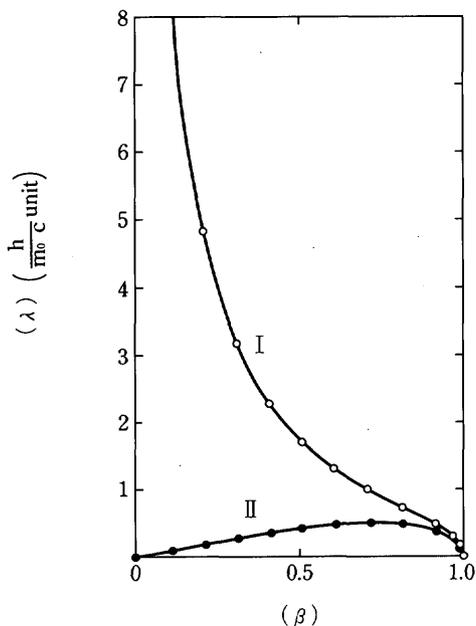


Fig. 23 This figure is a reprint from the old work. Ref. 5.

This is actually the same curve as shown in [Ref. 5, Part II, Fig. 1]. T-JSSPs never forget to grab the chance to make a comment here ;

“The curve goes up to infinity (∞) when we go down to $v=0$. This is the ANOTHER evidence to demonstrate that UNCERTAINTY exists CERTAINLY. You see, if we get at $v=0$, that means $\Delta v=0$. Another words, we are sure to know the value of velocity, exactly precisely equal to zero ! THEREFORE, Δx must go up to ∞ . Since Uncertainty requests the product $\Delta v \cdot \Delta x$ must be less than the definite value. Look, Δx goes up to ∞ means the Matter Wave’s Wavelength (they don’t call it de Broglie Wave somehow) λ must be ∞ !” (I don’t know how a professor abroad talks at this point in his class.)

Incidentally, let me make a comment on [Fig. 23]. The function has the definite value $\lambda(d)=0$ at $\beta=1$; which is emphasized by putting a black dot on the axis. I beg readers' strong attention at this point, where $\beta=1$; this is the «Closed point on the β axis», or the set of the velocity. *The light or photon has zero-mass and zero de Broglie Wavelength, but it can take any wavelength, as the electro-magnetic wave, at $\beta=1$.* I put a stress on this point in the [Appendix IV] by the way.

Case (2). A little bit more careful calculation than Case (1).

Let's take $v(g.d)=v(p.d)=v_m \neq c$ at the beginning, and keep go on. Then let the variables drive to "c", the light velocity, afterwards. We will find what we have done in Case (1). The point that I want to argue here is that the particle velocity " v_m " can never be able to get to the light velocity "c". Then we will realize how we were simple minded and careless in Case (1).

You would imagine that we will get to the identical result as Case (1), at the final stage of this argument, Case (2). However, it is not the true. We will find that we have to be more careful than we thought about the discrepancy among the three velocities; $v(g.d)$ {Group Velocity of de Broglie Wave}, $v(p.d)$ {Phase Velocity of de Broglie Wave}, and v_m {The Particle Velocity}. I hope you will follow me to my surprise. Let's start from eq.(1), with the condition that, $v(g.d)=v(p.d)=v_m$, then we have;

$$\lambda(d) = 1 \cdot (\beta_p)^2 \cdot (h/m_0 c) \cdot (1/\beta_m) \cdot \{1 - \beta_m^2\}^{1/2}, \dots (4)$$

$$\Rightarrow (h/m_0 c) \cdot \beta \cdot \{1 - \beta^2\}^{1/2}, \dots (4)'$$

where, we put $(\beta_p, \beta_m) = \beta$, since we assumed $v(g.d) = v(p.d) = v_m$.

Now you see how weird it is! The eq.(4) or (4)' is completely different from the former eq.(2); the β -dependence is completely different from case (2), i.e.;

$$\lambda(d) = (h/m_0 c) \cdot (1/\beta) \cdot \{1 - \beta^2\}^{1/2}, \dots (2)$$

The eq.(2) and (4)' are shown on [Fig. 23], as the curve I, and curve II, respectively. The reason why we've got such a difference is, we took the possible tiny difference between $v(p.d)$ and v_m (particle velocity) until the last moment.

Dr. Messiah demands repeatedly that we have to put the group velocity of de Broglie wave for $d\varepsilon/dp$. I guess I know the reason why, and I did so. Still, we've got arrived at such a weird result. However, if you would raise a question that it is unlikely for the phase velocity could be equal to the particle velocity v_m , then why don't you look at the following Case (3).

Case (3). A more realistic calculation than Case (2).

In this case, I can show you a realistic calculation. By the word "realistic" I mean this is our limit to solve the equation analytically. As you know, there are three unknown factors, $v(g.d)$ {group velocity of de Broglie wave}, $v(p.d)$ {phase velocity of de Broglie wave}, and v_m {particle velocity of mass "m"}. We have, in our hand, only two parameters that experimentally measurable; the falling speed and the spreading angle due to Fraunhofer diffraction.

Let's assume, $v(p.d) \neq v(g.d) = v_m$. We get to the result straightly ;

$$\lambda(d) = \{v(g.d)/v(p.d)\} \cdot \{v(p.d)/c\}^2 \cdot (h/m_o c) \cdot \{1/(v_m/c)\} \cdot \{1 - (v_m/c)^2\}^{1/2}.$$

$$\Rightarrow \{v(g.d)/v(p.d)\} \cdot \{v(p.d)v(g.d)/v(g.d)c\}^2 \cdot (h/m_o c) \cdot \{1/(v_m/c)\} \cdot \{1 - (v_m/c)^2\}^{1/2} \dots (5)$$

$$= \{v(p.d)/v(g.d)\} \cdot \{v(g.d)/c\}^2 \cdot (h/m_o c) \cdot \{1/(v_m/c)\} \cdot \{1 - (v_m/c)^2\}^{1/2}.$$

$$\Rightarrow \{v(p.d)/v(g.d)\} \cdot \beta \cdot (h/m_o c) \cdot \{1 - \beta^2\}^{1/2} \dots (6)$$

Now we've arrived at the point we can put the experimental data.

$$v(\text{phase. de B})/v(\text{group. de B}) = \lambda(\text{optical})/\lambda(\text{gravity}) = 2 \dots (7)$$

where, we put $\beta = v(g.d)/c = v_m/c$.

The result is as shown in [Fig. 23], the Jet-Liner takes place. My QUESTION is, as the calculation is so simple algebra, if something wrong with it, then it must be in my CONCEPT. I was very much anxious to know where I lost my way. No body told me, however, where I've got on to Wrong-way. As I told before, my old friend Dr. Grosmann was so kind enough to translate the articles into French and distributed them to his students at Univ. Strasbourg. However, I didn't get any information further. I learned Dr. de Broglie was "respected but not necessarily loved by even French" [Ref. 69] Maybe this was the reason ; I don't know.

To my feeling, it would be more acceptable to have $\lambda = 0$ than $\lambda = \infty$ when

$v = 0$. It appears very hard to swallow that when we were trying to slow down the velocity of ATOM, we gradually become hard to know its WHEREABOUT, and finally it DISAPPEARS from our sight! As I said Electron is too light and it has charge. These are the origins of every troubles. However, when it comes to the neutral atom, I think, that must be our partner to play the game.

What's more, the curves I and II in the **[Fig. 23]** have almost identical value when β is close to 1. This could be the reason why no serious arguments were raised when they estimated the wavelength of Matter Wave. However, when the particle velocity really got slow, then we have to re-think about the validity of the meaning more seriously, I'd imagine.

★The Apples of Wrath

For years and years, I was wondering how to straighten up my scattered knowledges on physics. Those were accumulated, due to sedimentation while I was moving hither and thither, like a rolling stone. Surely, rolling stone gathers no moss. However, it gathers MESS. It piles up very rapidly, like the ugly soil layer on the Kanto-Plane, on which Tokyo is located.

When I got Ed Rowe's Xmas card of 12-16-84, I felt a sort of sorrow, as if I was hearing he said 《An Era is getting over, hiizu!》. He wrote, as you know well, as follows ;

“I stayed on at the request of the University Chancellor, tho I probably would have any way - a man should finish what he starts, if he can”. [Ref. 47] 《The Storage Ring Experiments in the United States (Part III), p. 170》

Scarcely, at the time, I had succeeded in to call forth my Battalion which were smashed into pieces by the “Annihilation-Operators” who operated upon RCA Res. Lab., Tokyo, in 1982. I had started composing a series of short writing, title of which was, “A History of (basic) Semiconductor Research in Our Country (in Japanese)”. One of the purpose for the work was to show people the trace of the defeat, i. e., 《How the Endeavors to do the Fundamental Research of Semiconductor Physics were crushed and extinguished in This Country》. I didn't intend to speak out my opinion, but I tried to “Let the facts cry out”.

Soon I realized that there came the conflict to recognize ... “What is FACT ?” Fortunately, I had a friend of Professor in CGU, who was special-

ized in "Ancient History of Orient (around 5000 BC)". We dropped in a German Restaurant on our way back from CGU, every Monday evening, and I learned quite a lot from him about "What is History ?". The rendez-vous continued 5 years, until he moved to another university for the new job.

I started to collect interview records, April 11, 1986, from Old-Semiconductor-Scientists of This Country. The purpose for it was to collect the old "Facts" on Semiconductor Research in This Country.

Surely, there were fairly good amount of official and/or private documents about the history of engineering for transistor manufacturing. However, there was almost none about the History of Basic Research for Semiconductor Physics.

Coming to the conclusion of the interview activity, I have collected 16 cases in all. They are the retired professors and/or research staff in factories, such as Toshiba, Hitachi, and Matsushita. These records were published by putting together in two volumes from the CGU. The interview activity took 5 years ; from April 11, 1986 through June 29, 1991.

However, I realized it happened to open Two-Front Confrontations by these activities :

[1] To the establishments in The History of Physics Society. They don't take credit on Interview at all. They said it was The 2nd Grade Data. The reason is laughable ! ; "Human being tells a lie"!

They don't believe in the ears. They believe in "The Written documents" only presented by the well authorized historical personnel. This is the mat-

ter of Recognition, or more philosophically speaking, the subject of Epistemology! 《To be honest, they didn't have even a bit of knowledge for Semiconductor Physics. They are simply The Old Fools. That's all !》

[2] Another enemy was living in my mind itself. I realized, 《How stupid was I! We were (I was) just working to leave the numerical data table for such and such theoretical parameters! That was all for us (me) Experimentalist had done. Our Era was nothing but The Era of Description. We (I) didn't get any eyeopening discovery. Alas! This was the full meaning of The “State of the Arts”》.

However, with the progress of the interview, I found another one in my mind ;

They were The Japanese Theorists of Solid State Physics ; what I call “Busseiron-no-Riron-Ya (物性論の理論屋ども)”! The interview records revealed that Engineers were busy enough to chase after, and sometimes to compete with the US progress. Their records sound like the monument at Thermopylae, Greece.

However, The Theorists of Solid State Physics, to my opinion, kept themselves busy just to Explain the Experimental Results. They employed themselves, to my opinion, to be the Back-Seat -Theorist, or Buggy-Theorist like a Buggy-Home-Doctor. It was the end of my perseverance when I heard one of them high-hatted, “It's enough, if only for us to be able to calculate the Quantum Mechanical Problem in SSP! (計算さえ出来れば好い!)”.

I felt tired and exhausted to talk with those know-it-all. I began to write "The Memoire of The Storage Ring Experiments in US(in Japanese)". The reason for the writing was half to straighten up the old memories, and the other half was, of course, to console myself by fleeing into the old illusion.

The result got much worse ; people around the New Light Source were all looked like the cat that ate the canary to read the Note. Since, while PSL was desperately struggling for the single capture, they made much Wiser Decision to pick up a LINAC and multiple injection from the beginning.

Then I decided to move to the supposedly No-man's-land to amuse myself. It was The 7th-Century's Poetry ; "Man-Yoh-Shuh (万葉集), Ten-Thousand-Leave". This is one of the most famous poetry in Japan, and there are wide spectrum from right-wing scholars to the soft-wing romantists who have the strongest affection to this Nationally loved Poetry. However, it is very scarce who dug up the original characters, so that he may find a scientific way of understanding, for example meteorologically, against the orthodoxed fashion. I kept this for my hiding hobby.

Nevertheless, some physicist kept pursuing with poor knowledges and raised nasty arguments. At the time, I noticed Ed Rowe didn't give me his Xmas card. I sent him a message by translating one poem out of 4515 :

《宇良宇良尔 照流春日尔 比婆理安我里 情悲毛 比登里志於母倍婆》
ウラウラニ テレルハルヒニ ヒバリアガリ ココロカナシモ ヒトリ
シオモエバ

“A skylark is flying up and up,
 In this calm sunny spring field.
 But, . . . my heart and soul get aches,
 Since, . . . I am thinking alone.”

【Man-Yoh-Shuh, (Ten-Thousand-Leave, vol. 19, No. 4292, by Yakamochi Ohtomo (Tr. HF)】

“So, don’t think alone” said I. “That makes sense” Ed Rowe replied. This is why, Ed wrote at the end of his card about the poetry, [Ref. 47 p. 172]

In this sort of chaotic circumstances, Ed Rowe, Charlie and Edna visited Japan, to join “The Third International Conference on Synchrotron Radiation Instrumentation” held in Tsukuda, in September 3, 1988. I knew Ed was going around many places, even to China, for consultation business for a machine. We had got together at a small dining table at Restaurant Tsukubane, in Tsukuba Daiichi Hotel, after 8 to 10 years of blank.

Ed Rowe asked my What’s Ups, and I’d got stuck for a few second. You know, I was in the midst of 4-way battle against all the NUTS !;

【1】 For PSL Memoire ; some small nuts were shooting at me, shouting, “It can’t be an ARTICLE !”. I didn’t say it was an article. I called it just a [Note]. But, Nuts had Wooden Heads, and they won’t stop shooting until I shifted the place to submit.

【2】 For Semiconductor Research History ; the establishments that got dwelling in the Web of the History of Physics Sub-Committee in Physical Society of Japan refused to discuss the Recognition Problem of the Fact.

They refused anything once they got a smell of Philosophy. Their philosophy was “Je suis, donc je suis ! (I exist, therefore I exist !) But, you don't exist, since I think so !”

What's more, The Editorial Committee of Journal of Physical Society of Japan rejected my English article for this subject ; by the reason that they had no precedent for such a sort of article. They have no logic at all : As a member of the physical Society of Japan, you can present your result-of-research at the History of Physics Section as a speaker. However, you cannot publish it on the society journal because there is no precedent.

To polish up the high-hat, The Sub-Committee asked to write an invited paper to the Japanese Journal, on my opinion and experiences for the interview. BUT(!), they turned down the invited paper when I submitted to the committee. They put hell of the reasons upon the article, but I knew the true reason. They don't know anything about the modern (French) epistemology. We got to find some REALITY out of the MESS. They lived with Old Hegel, or Kant, at its best. They could not say “I don't know”.

[3] For Ten Thousand Leave ; battle field shifted gradually “How much I know about it”. Finally, I tried to shake them off, by translating my own way, the famous poem “Chanson d' automne” by Paul Verlaine. None of them even read French. BUT(!), bullets came back ; “Don't you know Verlaine was a homosexual ?” Now I understood everything. He was just jealous about the others' talent, or ability ; just like Verlaine was to Arthur Rimbaud's talent on poem.

Conclusion ; I fled before the real bullets might hit at my hand.

[4] For the Interview ; three big waves were over me :

(1) A guest was so eager to speak out Everything, that the time was too short. He called me number of times, by the long distance. Finally I went up to a business hotel about 10 a. m. to see him again. However, he took too much can o'beer already, and he couldn't arrange his story at all.

The results : I was as if taking a tape from his endless tape. What's more, the story was very much private, and hard to be opened. We parted with his very tight shakehand and I left him with deep satisfaction. I realized however, "To listen is happier than to speak !".

(2) A guest may not well be informed that his talk would be on tape, or highly possibly, he didn't understand anything what would be going on. At any rate, when I finished up his "lecture" in draft and mailed it to him, my trouble started. He kept complete silence about half a year. Finally, after many tricks, I got his final draft, but the content was completely on different subject !

I lamented : What for the "lost my time ?" ; six hours on the bullet train, one lodging before the day, morning meal time, 《lecture》, evening dinning time surrounded by his disciples with raw fish and Sake, divided bill to share his cost, and another night lodging, PLUS weeks of time-consuming tape-to-draft job ! It must be also nothing for him, because I am not EX-ISTING !

(3) For a hi-prestaged physicist's interview : We interviewers came by three, because I needed to step up the stairs to get to him. The results ; two other interviewers were, maybe, so delighted to be on the same tape with the world famous professor, and they lost self-control, I am afraid.

However, when the draft was handed to them, both of them just revised it

by simply crossing out all the kid's statements of their part. Again, where was gone my lost *precious* time ?!

Such was such, I had no choice but to answer Ed's question that “I'm writing a memoire of PSL”. I felt a very slight and short pulse came from by Ed's shaking his head. I felt his message : “It's not your job to write the memoire of PSL”. Or maybe he was intended to say, “It's not a job for your age”. I don't know which.

Finally, I parted Ed in front of his lodging place. Ed showed a big water mill in front of us, the diameter of which was about 10 meters. It was just to attract passenger's attentions, but the water buckets were all broken except one. Water was running wasted, but Ed said ;

“Wait for a moment hiizu. It turns only once, after some minuts, BOOM !”

Yes it did. I don't know why, but when the only one bucket became full, it rounded 360 degrees around, with good momentum ! Then we parted, as always, watching his closed eyelids. Later, I wrote about the “One turn water mill”, which he called as “The mills of the Gods grind slow”. [Ref. 47 p. 127]

I felt strongly, that I have to find my subject for my Life Work somehow. I felt Ed was going to close his job at the lonely hill, eventually. I didn't meet with chaos yet.

On September 8, 1991, Dr. Robert Bachrach appeared Tokyo, after 20 years of blank. I was in the final phase of exhaustion to struggle with those

nuts all around me. The series of PSL memoire was over in 1990. A History of Semiconductor in This Country was coming to end, and the end of Interview was in sight. However, I felt as if I was a fly that dropped into a honey bottle. I was high and dry and would die of hunger all surrounded by Sticky honey, without being able to lift even a leg. Since, by and by, and more and more, I was feeling those establishments of Quntum Mechanics in Japan are different feathers.

When Bob asked to a university professor, "Do you think Chaos is Physics?" I thought "That's a Good Question! Yeah, Chaos can be Physics! I've never thought of such possibility before!" The Professor couldn't answer at all. He just puffed out smoke screen, and hid himself behind it with yak-yak statements. As for me, I thought Chaos was just a game of designing or decolation until that moment. I began to study chaos, from the different point of view with high gear. I imagined, "This may be good place for me to escape from those Fish".

Soon I realized that, "This is a Too Good Place to have a narrow Escape". It appeared that my small Mess on Non-linear Equations that I gathered from such as Dr. Struble's book [Ref. 71], and/or Soliton Physics [Ref. 72], were all just a Winchester rifle to Carbine. (May I remind you that Dr. R. Hirota, who is known by Hirota Soliton these days, was in RCA Tokyo Lab. We worked together for about 10 years, including The latex System). In about 1993, before Ed Rowe's "Nomination" letter came in, I was almost decided to study everything form the beginning.

Then the big impact came when I found an article of Dr. Prigogine's article on a Japanese Scientific Magazine. I decided definitely to roll over the

stone once again :

Dr. Ilya Prigogine's specially invited article to Japanese readers was appeared on "Parity", in January and February Issue in 1995; the title of which is "Time, chaos and the laws of nature". [Ref. 73] The "Parity" is a sort of funny journal. First of all, it is a commercial journal, but not for the original articles. It has the contract with APS and half of the space is covered by the translated articles and news from PHYSICS TODAY.

The rest of the space is covered by another news and articles, which were selected by editorists. Dr. Prigogine's translated article was appeared on this space of the journal, and I noticed the day break was really coming. Then came in the Ed Rowe's historical announcing letter that Tantalus was accepted by the Smithsonian Institution. [Ref. 47]

In the letter of congratulations to Ed, I spelled out my "private future project of my work", for the first time "To the Outer World from my Brain". This is the way of expression that Dr. Toshio Matsumoto told me. He warns always, "You got to be very-very careful, when you put your idea, thoughts or anything that sits in your brain to put the outer world from the head. Since, once it was out, peoples (Japanese) won't hesitate to take it in". Yeah, I know. They won't hesitate to "take-in", until it can be fit to their small brain!

Actually, it was a sort of my silent "*Declaration of War to T-JSSP*". I *crossed out the lines*, when I put the letter on [Ref. 47] "The Storage Ring Experiments in the United States (Part III)" pp. 128-129. I disclose it here to my friends and foes, so that they may sharpen their Hospitality or Hostil-

ity towards me. The disclosed part is indicated by curly brackets { }:

March 1, 1995

Dear Ed;

Congratulations! I thank you very much for your letter of Feb. 14, and 21, 1995. You have done the very decent and fine job from the very start to the finish up of the Tantalus I! Smithsonian must be the place for the Tantalus to find his rest. It will sit there, and "shall not perish from the earth".

I remember still, clearly, the morning that I met you first at the Madison Air Port, on April 16, 1967. You, too, mentioned in your letter of July 8, 1988;

"I am amazed to realize that it has been 21 years since I picked you and Fred Brown up at the air port that misty morning and that we are in our 20th year of operation".

I remember also, when you guided us to the "dingy, uncomfortable hole in the ground", to show us the Tantalus I. There were only "Bending Magnets" and the "Central Pilar"! No doughnut ring. You mentioned, the ring is under vacuum testing down in the Lab.; might be. At any rate, the doughnut was not in the position. I got a strong impression by the scene. I thought I was looking at Stonehenge of 20th Century's! That was the beginning. It was quite a day!

It's very nice and delicate of you to recall the hardships that us "Users must be suffered. However, at the same time I believe, you people, Ed, Charlie, Roger Otte, Richard Fasking, John Budden, Darrll Klinke, all

should proud of their endurance and perseverances of the days. These were, also, "the real heroes of the era". We were all on the "tiny ship". I have never had even a moment to wonder who were the heroes and who were not. I quite enjoyed the sense of unity, in the green shabby operation room on top of the "Lonely Hill".

{I am drawing two oil paintings on the experiments in Stoughton, from time to time. If it would be finished before the coming Xmas, I will send you a pictures. You will be able to look into my mental scenery.

I am quite impressed by the Dr. Prigogine's article, sent to the Japanese readers of a Japanese Journal named "Parity" (in Japanese). It states the new quantum mechanics is rising on the horizon, and wiping out the "Fog of Copenhagen" which prevailed over the world more than 70 years. On the other hand, a French, Mr. Morin, is turning over the stone, set by Decarte and Newton, about 300 years ago. It is said, altogether, that we are now in a very important era of rolling up of the paradigm, which maybe or may not occur once for 100 years. I wish I could join this change, and make some small contributions to the subject of mathematical physics, which is now under way by the "Brussel-Texas school".

In the meantime, I have a 7 year contract in a small Private University as a full time staff. I need not take care of experiment at all ; just for lectures. On the other hand, I have another 2 year contract as a half-time staff in a National University, which is located so close as 15 minuts riding by bicycle. This job is also just for lectures.} —So, now I can live without worrying about the bread of this day.

I wish I should be able to enjoy these cold but calm-blue-sky days, just like the winter in Tokyo, {and wish to enjoy to *stray into the Hilbert Shace*.} You should bless me for my finding out of my final subject.

Finally, congratulations again for you endeavours on Tantalus I from its

START to END. I should be sure to be happy to face the machine, if I would happen to visit the Smithsonian in the future. Thank you very much for your considerations. I wish you should find the joy in a long heavy job to disassemble and to pack up the Tantalus I.

Best regards,
Hiizu

In April 1996, a friend of mine, since we were the Junior Hi-School boys had retired from a university and came back to Tokyo. I asked him to get together to have a rush colloquium, just with two persons on Chaos Mathematics. He is an applied mathematician.

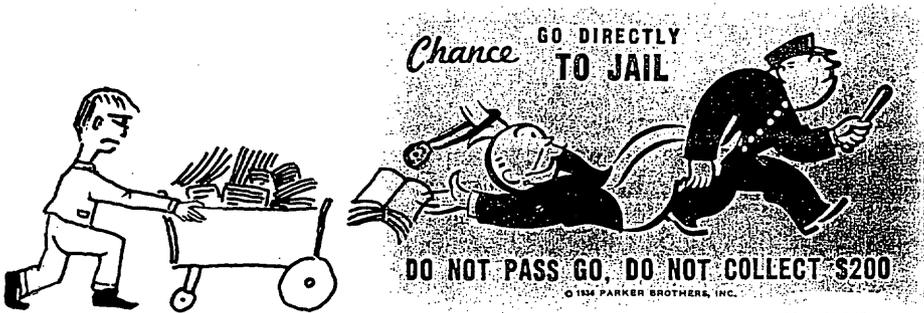
He picked up Dr. Reichl's book for the text. [Ref. 23] It was the first experience in my life, that I was asked to run fast. We got together on every sunday afternoon, at The Union (学士会館), and we read through the Classical System, Chapt. 2 and 3, in a month. The seminar was as if I hitched a supersonic jet. It turned out quite a Bazooka-seminar for me.

It started by such a quivering Historical Overview, Chapter 1, §1.2 as following, (I thought this is quite well known to the Western peoples, but I'm getting rather uncertain these days. So, let me repeat it here for our ground understandings):

“The belief in the deterministic nature of Newtonian mechanics was formally laid to rest by Sir James Lighthill [Lighthill 1986] in a lecture to the Royal Society on the three hundredth anniversary of Newton's Principia. In



Who, you mean?
Rioter, or Liar?



his lecture Lighthill says”;

“ . . . I speak . . . once again on behalf of the broad global fraternity of practitioners of mechanics. We are all deeply conscious today that the enthusiasm of our forebears for the marvellous achievements of Newtonian mechanics led them to make generalizations in this area of predictability which, indeed, we may have generally tended to believe before 1960, but which we now recognize were *fales*. We collectively wish to apologize for

having misled the general educated public by spreading ideas about the determinism of systems satisfying Newton's law of motion that, after 1960, were to be proved incorrect".

A HA! That was the Three Hundredth Anniversary! What the representatives of Japanese Physicists carried back to home? Someone kindly gave me a sheet of Apple Post Stamps, but they couldn't pick up even an Apple Seed. Or, they are hiding "The FACTS" behind their broad backs, just as they did during the Pacific War :

They are just worrying about to raise the devil!

《Go fetch fire. Pluck down benches.—Julius Caesar, Act III, Scene II》

★To A Theoretician

In this part, from §11 through §16, I would like to make a "Show and Tell" on my struggles of these about 4 years. If you would be kind enough, why don't you tell me straightly where I am wrong, or nonsense. I have walked out from The Physics Society of Japan, and I am not interested in too much about whether it is right or wrong from the Physics point of view. However, I want to straighten up the winding and darkish trail through the MESS that I gathered.

The mathematical tool to bring this time is HOMOTOPY. I want to add something NEW by the full use of this tool. If you would allow me to say analogically, I want to show you another Variation Route that may lead us to the higher ridge of the cliff.

In §11, The Classical Calculus of Variation is stated with some new aspect, I hope. In §12, The Idea of The Feynman Path Integral is re-studied from the more Visual way than before, by the full use of Homotopy. In §13, some trial will be shown to couple the Path Integral to The Minkowsky Spase via Homotopy.

You may realize, that the way of employing full use of Geometry, the Visual Method, or Homotopy is much easier than the old fashioned Analytical method, or modern way but just speaking "Words, words, words" (Hamlet — Act II, Scene II). Homotopy is the one out of six important Parts of Topology. Therefore it is vividly related to Space-and-Time.

Once the image was swallowed, it is a matter of your stomach conditions,

how it will be digested. As a matter of fact, my friends of mathematics are always complaining that it is very hard to understand other people's article. Because they could not see the IMAGES behind the description. This is the REALITY even for mathematicians. Why we will be able to understand without visual images ?

Nobody tries to build a house by solving Equation. Peoples open The House Kit Catalogue, and look into the Figures of the Parts. By Catalogue Number, they make orders, BECAUSE they've got the Visual IMAGE of the whole Structure, and they convince that they can build a house.

§11 Calculus of Variation (変分法)

Somehow or other, T-JSSPs very fond of "Calculus of Variation". It is a good idea that we start from this point. We can get to their toy-box with the mostly Least-Action. You know, once a kid got a Match-Box Suitcase, it will be full very quickly with their gear. In this Small Country, Japan, peoples believe in that "God dwells-in SMALL DETAILS" (神は細部に宿り給う). This is because, I believe, the Island was too narrow to construct Pyramids from the prehistoric ages. After 3,000 or 100,000 years of severe experiences, Japanese reached this religion at last. (I don't know, actually !)

At any rate, the more they fill up their suitcase with small pieces, the higher they are respected. What's more, the longer they play with the same toy, adding small modifications upon it, the more they are admired. The point is not whether he is the first or the second. The most important point is, "How Long he has been working with it ?" Eventually, they can proud of

themselves by saying, "I have got worked with this subject, more than 30 years!" (この道一筋 30 年).

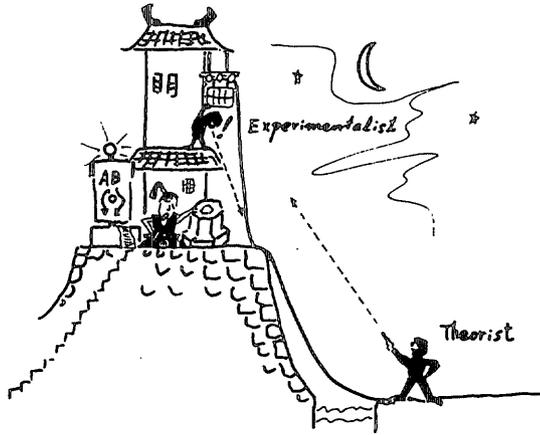
You people call it, "That is the Japanese Minor Modification". Surely you can claim that way. I must add, the Japanese of these days are getting to understand what you mean. However, to see and to understand is different. It is still not the matter of Priority, nor Creativity, nor Uniqueness that they are mostly concerned. I sincerely hope that you do understand this point. Yes. They (we) lack the keen sense to recognize the distinction between "A Craftsman and an Artist". The same story goes with Physicists.

You may think that I am speaking bad at Japanese Culture. No, it is not. I have got started to talk about SPACE-and-TIME already. You know, "Small island and Detail loving native god is the matter of SPACE, and 30 years of Craft-Physics Experience is the matter of TIME!"

On top of the gadgets in their suitcase, we find "Constraints". I'd suggest to kick it; it is just "words, wrods, wors". Mathematically, "Constraints or Constraining force (束縛力)" can be stated by just two lines :

- (1) A Force that hinders the Newton's First Law of Motion.
- (2) A Force that works at right angle to the motion of a point-mass.

The longeur storys for the constraints always end up with the Un-Happy-End. If you look back again at the illustration for "The Jordin Loop" in §6, you may agree that it shows "The necessary and sufficient condition for the classical calculus of variation" (古典変分学). By the word "classical", they mean the "Calculus of Variation by The Definit Integral (Riemann In-



Midsummer Night Dream

tegral)". Riemann Integral demands a differentiable and continuous function almost every where (a. e.), i. e., C^2 function or higher grade.

We can say briefly that the Calculus of Variation is "A Projection from Function Space to Number Space". [Ref. 74] I will show you soon later of this statement more visually. However, we got to remember here that if the integral is not the definit integral, then it becomes very hard problem to find a functional (汎関数). It becomes so hard until there is no solution at all for some cases, they say.

The [Fig. 24] is a typical figure for the Hamilton's principle. [Ref. 62] Let me call your attention here, by the way, that the mathematicians who invented the calculus of variations were terribly old peoples; Lagrange and Euler lived in 18th century. Therefore, it is natural that they lacked the strict sense to distinct the Time cordinate from the Space. So they took the Time just as an Implicit Parameter or Variable. For their concepts on Space, we will find another problems later.

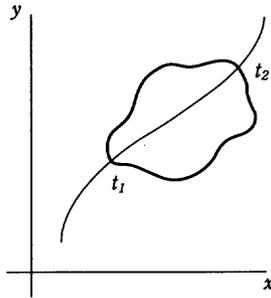


Fig.2.1 Path of the system point in configuration space

Fig. 24 The most fundamental figure for the “Classical Mechanics”; the Hamilton’s Principle is the corner stone for building the mechanics.

Let’s skip the old and standard arguments on **[Fig. 24]**. I would suppose that readers are quite good at it. However, I realized it is very hard to find a text book of Classical Mechanics, which shows explicitly the Time axis in the section for Classical Calculus of Variation.

There is no such a figure in Dr. Goldstein’s book **[Ref. 62]**, for example. His all argument is performed in the “Configuration Space (q-only space)”, until we face the Hamilton Yacobi Theory.

Here is the darkish little JCT where we lost Dr. Poincare : It is darkish in Mechanics, however, it is bright and clear in Mathematics. I found such a figure scarecely in Dr. Okazaki’s booklet, titled “Handy Priciple of Variation, (べんりな変分原理)”, as shown in **[Fig. 25]** **[Ref. 75]**. “Handy” is a word. That shows he is honest. However, he could not put the vertical axis, since it was 3-dimensional.

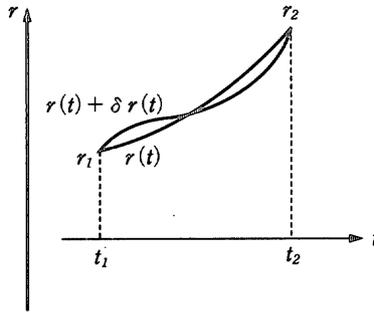
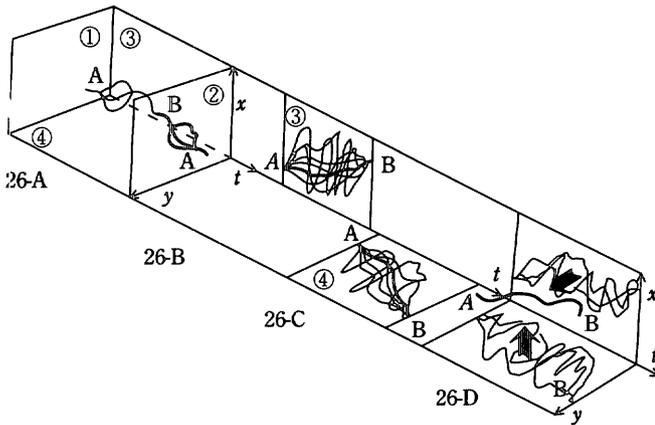


Fig. 25 Dr. Makoto OKAZAKI's diagram in order to apply the principle of the "Calculus of Variations" for the mechanics.



"Look, my lord, it comes !"
 (Hamlet: Act I, scene IV)

Fig. 26-A, 26-B, 26-C, 26-D

Starting sector for this Article No. 3, "Who affraids of Born-Wolf?" We start from the "Space", where old mechanics are prevailing. Point is the old peoples didn't know topology. Therefor they thought it was good enough to change the real parameter number in order to calculate the degree of neighbourfood between the functions; which maybe very un-satisfactory.

It is also true for a mathematical text book. [Ref. 74] Very often, they solve the Cycloid problem, showing parameter t explicitly such as $dy/dx = \cot t$. But they do not explain its important meaning.

The way I am going to show you is like how to build a 2 x 4 panel house. As I said before, in ((No. 1) p. 130), the "configuration space" reduces down to a "real space" when we have only One Particle. All right. Why don't you look at the [Fig. 26-A, -B, -C, -D]. Let these figures cut off the entangled, mysterious Words which hang together with the "Classical Calculus of Variation". You would find how it is more sophisticated beauty than we have ever thought before.

In [Fig. 26-A], you may find a "Trajectory A-B", which starts from the point A on panel ①, and ending at the point B on panel ②. A projection of the Trajectory A-B onto panel ② (x-y plane) is identical with [Fig. 24]; sorry about 90 rotation.

However, our situation is not that quite simple as it appears. Since, Topology says an awfull thing [Ref. 74] : When you claim to change the function $Y^*(t)$ to $Y(t, \alpha)$ within the SET of Function (Vector) Space, it does not mean anything to claim "little difference", unless you define the "neighbourship" (or Topology, or Distance) within the Functional Space. (I hope I said something make sense). Another words, you have no standard to say which function is closer to another, unless you know the way to measure the "distance, or norm, or something" between functions.

You all know the "definition of vector" in Euclidean (number) space. That is the "Linear Algebra". The same definition is extended and applied to

functions. Then we reach at Function Space.

"Topology" is standing on much more sophisticated, abstract fashion, i. e., by the THREE AXIOMS (公理 : 自明の理). This is not necessarily limited to "Linear Mathematics".

The essential point of the Axioms is, as far as I understood, how to recognize the Continuity of Space. This is, in turn, strongly related to the definition of Neighborhood in Space. Incidentally, the old fashioned way to study the Neighbourhood in mathematics starts from the notorious " ε - δ " game.

Topology is much more smart ; it employs the SET Theory. Among the Set Theory, it is especially important to understand the sense of "Open Set". I will show you later, how many things which are taken for granted can be jolt-able. 《At the same time, you will soon agree that what a grievous mistake the Japanese made when they decided to abandon SET Theory (集合論) from curriculum : they abandoned all the future of Modern Science.》

In order to show around the panel house to you, I will stop at, firstly in front of the Panel ③, [Fig. 26-B], and let you stand upon the Panel ④, [Fig. 26-C].

Here is the awfull painting. We got to pick up all the combination out of this MESS, and got to evaluate somehow, which Trajectory could be the Least Expensive. Actually, the paintings on the Panel ③ and ④, are the Function Space of Dimension 1, standing upon the real number [t].

Now wait for a while, until a Ghost may come out when you finished the Projection from Function Vector Space to Number Space, as shown in [Fig. 26-D]. Now, we are eligible for chasing Dr. Poincaré. We found the lost JCT to Chaos; I would imagine.

Readers may rush to raise hand and cry, "What's wrong with Dr. Euler-Lagrange?" Surely, they lived too early! This is one thing. Therefore, they didn't learn Topology. However, we should learn of it, and should take-it-in our territory.

Still you may say;

"Is this the JCT where we lost M. Poincaré? You think we are on the Wrong Way?"

"No, not at all. You solved beautifully all the problems that you can solve. However, you did not solve the problems that you cannot solve!"

I am not saying it was good or bad. But I will show you how Dr. Euler shuffled the cards. He was older than Poincaré, and he had to invent something. Everybody swallowed well for employing the parameter $[\alpha]$, in such a way as follows;

$$Y(x, \alpha) = y^*(x) + \alpha \eta(x) \dots \text{ [Ref. 74]}$$

Why don't you enjoy yourself, following the down stream of the Rigorous Logic. However, you should realize that Dr. Euler changed his card from the \langle Function Set \rangle to the \langle Real Number Set : (α) \rangle . It is said well known today, that the "Density of Function Set" is HIGHER than the Real Number

Set. Don't you think you put many things into discard here ?

In retrospect, I met with a friend when I was working as a half-time staff in a university. He was a theoretical physicist. He confessed one day that, when he was an under graduate, he could not swallow at all "What does it mean to take derivative by a CONSTANT α ?" Well, I did not say even a word about the "Parametric derivative", which would be supposed to learn at Senior High School. However, he may had better reasons than his professors.

You would ask now, "What's good for taking such an Half-lunatic Ghost into Physics?" Well, as I said before, we can make it straight, for example, to Dr. Feynman's Path Integrals and maybe so on. How is that ?

§12 Dr. Feynman's Path Integrals

1 Introductory Remark

[Fig. 27] invites you to the world famous Dr. Feynman's Path Integrals room. You have decided to leave the haunted space. Remember, Ghost can stay forever, but you cannot play with it forever. Go ahead !

There is again the panel ③, so that you might recall the reality of the world is "like this". Dr. Feynman also realized that the real world is close to this painting on the panel ③. However, he was the real pioneer. He did not know how to describe it by WORDS. I should say the almost anyone can find shortcomings or faults in the pioneer's work. This is because you are looking his work from his back. I appreciate it very much that American

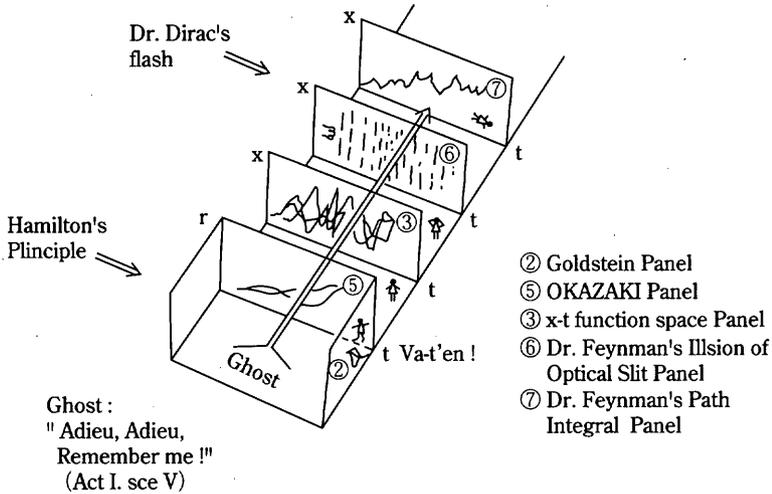


Fig. 27 One of the way to explain the "Feynman's Path-integral method"; how he got to the Idea.

People know this fact quite well.

I guess it is because they play American Football. A Fullback can decide, at which spot he should launch eye-opening Forward Pass, simply because he is standing behind the line (dots). What a dull or awful game it will be, if the Rules were changed, so that only dots can throw the Forward Pass! I am now convinced ; The reason why Japanese never appreciate the poineer's work is they don't play, nor understand, Football.

I don't know when Dr. Dirac's white flash shined upon Dr. Feynman, either he was in front of the panel ③, or he was getting through the panel ③. [Ref. 58, (Dirac); Ref. 57, (Feynman)] I realized the personal history of Dr. Feynman was getting foggy already. [Ref. 76] It is very natural that if a man (or a woman) got high position, it becomes hard to reach him (her).

However, it should be kept in mind that the more you get higher position, the more the possibility goes up for you to find a bad friend, who sneaked into your circle. I am talking about the Illusion panel ⑥.

As I told you before, optical slit has nothing to do with the arguments here. You know, even non-diffracting light beam (Bessel beam) is getting popular these days. [Ref. 77] So I should say just one thing ; Dr. Feynman must had a bad friend of optical experimentalist in his circle, unfortunately.

Dr. Feynman only needed "Gaussian Distribution", or so called "Error-function" for him to invent the new way of Quantum Mechanics. [Ref. 56] Probably, the rest of the world was not so generous enough at the moment to accept the young man's new idea so easily. [Ref. 76] So he might thought he needed something to support from experimental point of view. However, his idea is well established today, and the panel ⑥ should be referred as the historically monumental wall painting. I don't have even a word for the copy cats of T-JSSP.

When you have got through the illusion panel ⑥, you will suddenly find the beautiful Panel ⑦. This is the famous Dr. Feynman's Path Integral's painting : The Sum of the Line Integrals along the Pathes.

I cannot be so optimistic that the Sum of the path integrals converges always well. On the contrary, Dr. Feynman said in his book that he had difficulties almost every cases except for free electron : Mathematically speaking, except when he did it by the Gaussian Function, Gaussian Distribution Function, or Gaussian Error Function. [Ref. 56]

《LITTLE BREAK》

The reasons why I call it Pseudo-Math : [cf. between Panel ⑥ and ⑦]

(1) Gaussian-Error-Function (ガウスの誤差関数) ;

I always recall Professor Chewji Tsuboy's (坪井忠二) lecture on "Classical Statistics", whenever I heard argument related to this function. Remember, this is the Classical subject.

There were only 12 under-graduates in Geophysics Section, Department of Physics. Professor Tsubo-Chew (his Nickname : 坪忠) was such an old fashioned professor as to show up his class putting on black suits and a bow tie : It was in 1950's. He told us one day :

"Gaussian Distribution, i.e., the Error Function is a really weird function. Do you think that you will make such a BIG Mistake, when you measure the length of this desk, say 2 meters long, for example, as to report, 《This table is 10 meters long, or 100 meters, or infinity long!》?" Everybody giggled, but I couldn't. "That's correct. Something must be wrong with Mr. Gauss!", I thought.

《The same question is sticking around to Qunatum Mechanics》.

Why do you need your boundary condition at infinity (∞), in order to determine the radial function for an electron in Hydrogen Atom, which has such a tiny radius, say 0.6A? "That's because of The Coulomb Force" : Are you serious ?

(2) Probability (確率);

A teacher said in a Middle School (Junior High School) class ;

“Every night your probability to be bombed is accumulating higher and higher. When it reached up to 1, then you will be really got hit!” “That’s not correct”, I thought. Since, unless we got the total figure of the fire-bombs that B-29s may deliver until the end of bombing Tokyo, we cannot calculate the PROBABILITY. (We need a denominator beforehand, don’t we?)

《The same question is sticking around to Quantum Mechanics》.

How come did you know every term’s probability beforehand, both theoretically and/or experimentally, so that you would be able to renormalize each term to 1? You didn’t say PROBABILITY? You said Expectation Value? (確率なんて言っていない。期待値と言ってる!) However, Dr. Messiah, Dr. Dirac and maybe many others are saying PROBABILITY, I would imagine.

I didn’t raise serious argument in “§11 Calculus of Variation”. However, I am anxious to say “You solved the problem before you solve it”! Therefore, peoples would change your jargons, such as “Transition Probability” into “Transition Stochasticity (推計値)”, for example. I won’t join you too much. You will see the point of my argument when we get to “§14 Homotopy”, I hope.

2 Equations

The starting point of Dr. Feynman’s Theory is Hamilton’s Principle. It is described in Dr. Goldstein’s book, “Classical Mechanics” ; Chapter 2, p. 35,

2nd ed :

"The integral Hamilton's Principle describes the motion of those mechanical systems for which all forces (except the force of constrain) are derived from a generalized scalar potential that may be a function of coordinates, velocities, and time. Borrowing from the terminology devised by C. Lanczos (ランチョス), such systems will be denoted as monogenic. Where the potential is an explicit function of position coordinate only, then a monogenic system is also conservative. For monogenic systems, Hamilton's principle can be stated as The motion of the system from time t_1 to t_2 is such that the line integral

$$I = \int_{t_1}^{t_2} L dt, \quad (2-1)$$

where $L = T - V$, has a stationary value for the correct path of the motion*."

* foot note. The quantity I is refered as the action or action integral.

Sounds great. As if a formidable castle is standing in front of us. However, there are many points that I would like to remark ;

● REMARK 12-1 : Hamilton's Principle

The Principle (原理) is not The Theorem (定理). Theorem is standing on assumption and verification. However, Principle need not, or cannot, be verified. Principle can survive, provided that "Majority of the people of the era were acknowledged it is True. What's more, no counter evidence can be

presented that tells it is false”. Therefore, you can replace any-principle, if you can present another. There is someone who is saying that Hamilton’s Principle can be derived from D’Alembert’s PRINCIPLE. Hope you see this statement doesn’t make sense at all.

Jean Le Rond D’Alembert was a French mathematician, philosopher, physicist, and encyclopédiste (contributor of the encyclopedia), 1717-1783.(!) I don’t want to go back that far. However, if I would happen to visit and live in France, and decided to study the Origin of D’Alembert’s Principle for my life, then it will be ended up to find myself drowning in “du vin”, and writing “The Grapes of Wrath”, indeed!

● REMARK 12-2 : Scalar potential and Conservative system

As I said before, we can go forward just by saying, “We will take care of the connectivity of Space, later”. Why don’t we play in the sunny “Jardin du Jordin” (ジョルダン公園), instead of thinking about the gloomy M. D’Alembert’s Principle? I am not familiar with AB-effect too much yet, but I feel many hanky business about it. I know Dr. Feynman circumvented the Connectivity of Space by his own way. I hope I can make some comment on this subject in the near future.

2’ Back to Equations

Once you’ve got a good get-set on The Hamilton’s Principle, you can start from the same Action Integrals as,

$$S(b, a) = \int_{t_a}^{t_b} dt. L(x, \dot{x}, t),$$

however, the Character [I] is changed into [S]. Also, the explicit Variables for L, Lagrangean Density, is limited up to only \dot{x} [=dx/dt]. Next step is to step-up this Action Integral to Dr. Feynman's Path Integrals formalism $K(b,a)$, i.e., ;

$$K(b, a) = \int_a^b Dx(t).e^{i/\hbar. S(b,a)}$$

where $Dx(t)$ means to integrate along a line and to sum-up all the possible pathes.

This is mathematically the most mysterious idea (word, statement). He wrote in the interesting semi-autobiology book [Ref. 78] that "we got to bounce around all the Space through the infinite number of the virtual slits". However, the true mystery is that the line integrals which are not True trajectory should quickly cancel each other because the Phase Difference of the complex function occurs so sensitive for the shift in Space.

I am not opposing Dr. Feynman at all. On the contrary, this is the real ingenious idea. The result is perfectly correct, but the word is perfectly hard to be understood.

I am really happy to encounter Dr. Feynman's Path Integrals Method ONLY AFTER I learned some Topology. I will bet 100 bucks that Dr. Feynman didn't learn too much about Topology, Lebesgue Integral, and French. However, without "Knowledge for The Space", Topology, he flew all around the space with perfectly correct way. He was the pilot without liscence. That is the way for a genius flies !

As I said before, the Panel ⑥ is the genius's illusion. It appears the more smart Halfbacks invented to Reverse or Double-reverse plays afterwards. I won't say too much of their smart plays but just point out one thing. The smarter the way was invented, the narrower and shorter the field to reach the ball. This is simply because, halfbacks have no such strength to throw the long forward pass as fullback has.

What I am going to introduce you is not such a beautiful way but sure to lead to a touch-down ; the combination of Screen-pass and Center-plunge. However, later we will all find out that the field length was not the limited one, as 100 yard ! It appears to me an 《Open》 field ! Whether it is sad or joyful, is up to people.

However, before to watch the local university games, such as U of I, U of Indiana, and U of W, I might point out another one thing. We have, what I secretly call, a social climber physicist in J-TSSP. He wrote in his book, he had an honored occasion to watch the "Famous Feynman Bombardment" in front of his eyes. I don't know whether he was a good bomber or not, but if so that is the evidence how strongly he was frustrated by the rest of the peoples. I will show you the traces of genius's frustrations in [Fig. 28], in the following section, §13 POSTER PANELS.

● REMARK 12-3 : Interchangeable Integration Order

Dr. Feynman stated repeatedly, the feasibility to interchange the integration order between $[x$ and $t]$ by Words. It is again hard to understand, for me, what he was saying. In §13, you will clearly see, that there is no problem at all to interchange the order of variables for integration. However,

some good meaning can be found by someone if he studies full meaning of care of Homotopy. I won't insist at all. So far, I don't understand what made him worry so much. Maybe he thought "Principle First", i.e., the integration for time [t] must be calculated before space coordinate [x]. Then, the "Action Integral" must be Hamilton's Great Spellbound.

As Dr. Feynman stated, the combination of the equations of [S(b,a)] and [I] gives us ;

$$K(b, a) = \int_a^b Dx(t). \exp \left[\frac{i}{\hbar} \int_{t_a}^{t_b} dt. L(x, \dot{x}, t) \right],$$

and he wanted to interchange the order of integration in later Application such as [Ref. 56, Chap. 6, 6-1, p. 121, "Evaluation of the Terms"] ;

"We wish to interchange the order of integration over the variable x (this is erratum : x should be s) and the path x(t)."

Dr. Feynman didn't show the justification for above, but as I am repeatedly saying, you would say in §14 "Please, please go ahead, without hesitation!"

● REMARK 12-4 : Schrödinger's Wavefunction

As the Schrödinger's Wavefunction is a Complex Function, we got to examine if we are Safe or Out. [Ref. 79, 80] Since all the variables are "Real Number" [We are not playing on the Complex Plane. That's interesting!] someone may be uneasy. However, when the following expansion does have meaning, it's OKed. [Otherwise ? I don't know!] ;

$$\exp \{ (i/h) S(b,a) \} = 1 + (i/h) S(b,a) + 1/2 \{ (i/h) S(b,a) \}^2 + \dots$$

This means, we found ourselves left at the simple spot named “Sin-Cos world” for the action integral, after the long long trip! 《um-huh. Happy? I guess so. However, Remember! Dr. Feynman is a Pioneer!》

● REMARK 12-5 : Connectivity of Space

I've realized Dr. Feynman treated with connectivity of space. [Ref. 81] I'm learning in a hurry, how they are going to circumvent the rocks and pillars. However, I know there are more awful thing at the Boundary of Space (or Map), on which they don't appear to be realized. Let me just tell you how awful it will be in §14. However, I have an introductory story here :

It happened on November 6, 1996, at 6 : 30 p.m. Pacific Time, at Dr. Robert Bachrach's house, San Jose, California. He was looking into two big maps to find the spot where he is working for. At the same time, he was calling up to Dr. Fred Brown in Seattle, Washington. Bob was grabbing a powful combat style code-less telephone. As I told you, he is a busiest Manager. He always manages two things at the same time by his time-sharing system. His trouble of that time was, however, the location of the Reseach Center of the Company was hard to be found on either two Maps. Soon, Bob got the line to Fred ;

“Hello, Fred? Hiizu is here!”, he handed me the weapon, TELLING ;

“The Big Operation always occurs at the BOUNDARY OF THE BIG MAP!”

"Hi Fred?" I called him, giggling 50% for Fred, and another 50% for the marvelous sentence which has The Complete Mathematical Meaning at the same time! Why don't you wait until §14!

§13 Poster Panels

[Fig. 28] shows how Dr. Feynman struggled against the Panel ③, i.e. The Reality of the world (nature). Meanwhile, the unkindest voice of the Ghost was always behind him ; "Remember mee!" What's more, the weapon he got was half-out-of-dated Pseudo-math.

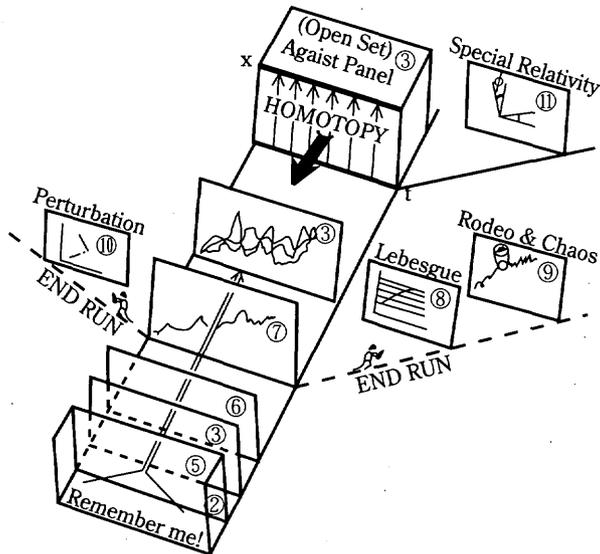


Fig. 28 One of the way to explain "How Dr.Feynman got fought against the Reality". This sector is the Show-down of this work No. 3; which may let us know the way how we can go ahead with the help of Dr. Feynman's method.

To my opinion, he tried hundreds of End Runs. Since there were no receiver at all for his forward pass. He could not try center plunge either. Obviously, he did not have enough members to crush the front. I'm not saying by the [Fig. 28], that he crossed the side-line. As for the lines, Dr. Feynman showed us, how the Field was wider than we thought previously. Let's look at the Panels he showed :

● Panel ⑧ : Lebesgue Integral

On this Panel ⑧, we see exactly the same idea for The Lebesgue Integral. The readers of this tiny article won't against my comment any more ; I hope you've payed a look at a textbook of math, in these 6 months. In fact, he mentioned about the Lebesgue Integral as following ; [Ref. 56, Chapt. 2, pp. 33-34, and Fig. 2-3]

"There may be other cases where no such substitution is available or adequate, and the present definition of a sum over all paths is just too awkward to use. Such situation arises in ordinary integration in which the Riemann definition, as in Eq. (2-18), is not adequate and recourse must be had to some other definition, such as of the *Lebesgue*.

The necessity to redefine the method of integration *dose not destroy* the concept of integration. So we feel that the possible awkwardness of the special definition of the sum over all paths [as given in Eq. (2-22)] may eventually require *new definitions* to be formulated."

Bravo! Where is such a New Definitioner from coast to coast? I happened to meet with Dr. Schulman's book an January 30, 1998, at Tokyo Yaesu Book Center. [Ref. 81] I felt a sort of sadness that I was not the

first, but soon I felt a sort of joy ; "Maybe I have better knowledge on Homotopy than those peoples."

You know, Topology is the Math for Space. The Space is much more well understood by Figures (geometry) than Equations. I don't like to read even a line of these headachy words. Dr. Schulman says in his Preface to Japanese readers :

"Perhaps someday I will be able to comment on the quality of the translation !"

I want to tell you, the readers of this "Note" in SRC, Stoughton, Wisconsin ;

"Within a week, I will be able to comment on the quality of the translation. Since, I've ordered the original book via the bookstore Maruzen. If it is out of print, I will go to the Library of Tokyo University. I will see, whether there is another Feynman collector in the Department of Physics."
(p.s. ; I've got one.)

I sincerely recommend you one thing, Dear Colleagues in SRC ;

"Never try to learn Mathematics through Physicists, whoever he may be. Because, he chops off things which he can not understand. Probably, vice versa !"

● Panel ⑨ : C° function, or Rodeo function, and/or Chaos

On this Panel ⑨, we see an example of C^0 function. [“Wannier who?” (No. 2) p. 418] What’s more, Dr. Feynman showed us what an awful thing is coming; Chaos. [Ref. 56, Chapt. 7, p. 176, Fig. 7-1] Dr. Richard Feynman past away on 15, February 1988. [Ref. 76] The famous book “CHAOS” by James Gleick, was published on 1987! It will be one of the most interesting subject for the History of Science;

“How much Dr. Feynman was concerned with Chaos?”

I would like to point out one thing on this Panel ⑨;

We got to realize, how awful thing it will be, The Quantum Mechanics! Also we got to know that Dr. Feynman was ringing up the curtain by the word, “Transition *Elements*”. Now you may feel nostalgia, if you recall Dr. Neumann’s Gothic and sleepy “Hilbert Space Theory”?

● Panel ⑩. The Perturbation Expansion

The Panel ⑩ is the most popular Parts for the famous Feynman Diagram. [Ref. 56. Chapt. 6, p. 122. Fig. 6-1] I heard once, a rather famous young T-JSSP was saying, “The mysterious vertical axis of Feynman Diagram”. Maybe he put an irony into his comment. The other NOT-SO-FAMOUS young theorist was saying, “It is enough for us to be able to calculate...”, (計算さえ出来れば良い) as I told you before. However, I think I must say a little bit about the Vertical Axis in §14. 《Remember, when a Japanese said “a little bit”, it means American’s Big, or Great Many!》

Maybe it’s premature, but I would like to point up one thing. That is ab-

out "The Point [c], which appeared at time [s] in the **[Fig. 6-1]** on Panel ⑩. In the figure caption, Dr. Feynman says as following ;

"A particle starts from a and moves as a free particle to c. Here it is acted upon, or scattered, by the potential $V [x(s),s] = V_c$. Thereafter it moves as a free particle to b. The amplitude for such a motion is given in Eq. (6-10). If this amplitude is integrated over all possible positions of the point c, the result is the first-order term in the perturbation expansion."

I would like to strongly point up here ;

"The Particle did not change its direction by itself. There was definitely some reasons to change its way to march at the point [c]. 《No result without reason》 What was the reasons, then? The encounter with the potential. Then, how come the potential suddenly appeared? It is surely shown by the Equation; $V [x(s),s]$ in the figure caption. But it is not shown on the Diagram. This is the point I always repeat to say : "Figure is more impressive than equations". The Fig. 6-1 looks like a ground battle at the first night of D-Day."

Surely, Dr. Feynman showed the Potential on the next figure as **[Fig. 6-2]**. However, it should be shown, clearly, on Fig. 6-1. This is very important point to lead to The "SPACE-TIME" CONCEPT 《Not Space-and-Time》 which Dr. Albert Einstein showed us for his life. **[Ref. 67]** Here is the most genius point, to my opinion, for Dr. Feynman's invention for the diagram. Hope you might realize how important it was to cleave the haunted space into three dimensional room, showing the axis [t] explicitly at the edge of floor.

Of course, Dr. Feynman was smart enough. We can see it on his other booklet, titled “QED” 《Quantum Electro Dynamics》. [Ref. 82 : Chapt. 3, p. 86, 87, Fig. 52, 53] These Figures are reproduced on Panel ⑩. He showed especially on Fig. 53, the relation of motion of Ball and Wall in The Space-Time diagram. You may say this is the case especially for the classical mechanics. No. We don't care either it is classical or quantum, so long as the topology concerned.

People who works with the Feynman Diagram may know well that where is the potential moving, in this Space-Time. However, even to my knowledge, some people appears still working in the black night combat of D-Day. For the sake of readers the movement of the potential is added in the [Fig. 6-1] Ref. 56, on Panel ⑩. Please be notice that the shape of the potential domain may change with time $[t]$, in general. For some extreme case, such as the “Wall in the Baseball Field”, [Fig. 52 or 53, in Ref. 82], it stays upright independent to $[t]$.

● Panel ⑪ : Special Relativity

[Fig. 2-4] which is shown in [Ref. 56, Chapt. 2, p. 35] is reproduced on the panel ⑪. This maybe just a genius's slip up. I said “maybe” because I have no experience at all to have calculated the Path Integrals for Special Relativity. However, as you know, in the Relativistic case, we cannot separate $[x-t]$ axes, in real space. Since, we have to consider the “local time” or “proper time” for the particle, at the same time. Of course, Dr. Feynman knew about it better than us, and he showed it in [Fig. 5-2, Ref. 67, Chapt. 5, p. 96]

However, in the [Fig. 5-2, Ref. 67], Dr. Feynman said "CORRECT" for the Oblique Coordinates, which is known as The Minkowski Space. This oblique coordinates make everybody feel hard and impractical, because this is the cradle of Covariant and Contravariant vector and tensor. I don't know what Dr. Einstein said, and the Experimentalists in Vatabia would be arguing. But as one of the "Post modern Formalist", I would strongly support that Dr. MØLLER said in his book. [Ref. 83]

By the way, don't have contempt in formalism. It is accepted, philosophically, to state that "New Formalism can create New Concept, SOMETIMES!" It is far much better than "No possibility at all". The US people would have some difficulty to understand this statement. But, in old country with Old Enough Identical Culture, the first encounter always occur at the boundary of Formalism. Because, Formalism is the strongest castle for Beurocracy, for example, which in turn the weakest point of their system. The same is true, I believe, for Physics.

The point where Dr. MØLLER worried mostly, is simplicity, beauty and complete structure of 4-dimensional, or what he called (3 + 1)-Space. This was shown by Dr. Poincaré and Dr. Minkowski. As Dr. MØLLER stated correctly, all of the Special Relativity can be represented just by single sentence :

"The Special Relativity is represented by The Lorentz Transformation, which in turn, mathematically say, The Rotation of Axis in the (3 + 1)-Space".

Dr. MØLLER worried so that his students may not forget about Dr. Ein-

stein's endeavor and physics behind mathematics.

Figure on Panel ⑪ is the copy of [Fig. 12] in Dr. MØLLER's book. Once you accepted the concept that Time axis should be represented by "Pure Imaginary, [ict]", then you have nothing to study any more except to refine your knowledge for the "Rotation of Axes (Coordinates)". However, the "Angle of Rotation is again Pure Imaginary [$\tan \phi = iv/c = i\gamma$]". This will be easily performed in Euclidean (3-dimensional) Space. However, this is not the end of the story, as you all know well.

So the Panel ⑪ is lifted by angle ϕ . Why don't we go ahead? We have no such Time to mark Time for reading the heavy, lengthy, nasty and expensive books of Relativity, which were published by T-JSSPs.

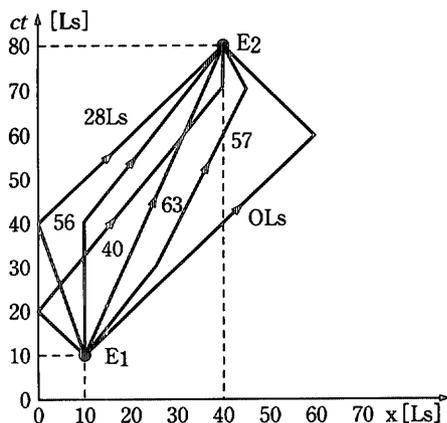


Fig. 29 A typical Minkowsky plane for the One dimensional Euclidean space. The local time or the Norm for the each path are plotted on the path. The light path which is shown on the right end, has No-Time to go from E_1 to E_2 . It corresponds to the refracted light path by an optical mirror.

Another point that I feel I must comment is the “Proper Time” in Figure on the poster panel ⑪. As you all know well, “Proper Time” or the “Local Time” is different from Ours. [Fig. 29] shows the simplest example which is copied from [Ref. 84]. In the Minkowski Space, the “straight line” represents the Maximum Space-Time “distance”, and any Path except straight line has shorter length for the proper-time world. For example, the Path that the light was reflected by a mirror, has distance ZERO, and the Time won’t go for the light. I don’t know at all, how these relativity effects are taken into account for the Feynman-diagram-calculator of T-JSSP.

I guess that’s about all for Panels. Why don’t we proceed to HOMOTOPY?

§14 Homotopy

“Never try to study Mathematics through Physicists”.

The best way to do is, to my opinion, to have a good friend of mathematician. However, this is very hard to do. I know more than dozen unhappy storys. The most spectacular tragidy for Japanese Physicists was the set up of Japanese Mathematical Society. However, The Japanese Physical Society keeps it in the official document for “The History of Japanese Physical Society” as the brightest historical Independence Day.

The most envious case may be Einstein-Grosmann’s case;which started at Zurig, went through Bern, until Berlin. Ironically enough, Einstein discouraged by Professor Minkowski’s lecture at Zurig, which gave him momentum to switch to Physics, they say. In order to keep balance, I might pick up

Newton-Barrow's case. Barrow was elder by 12 years, so somebody said he was the Teacher for Newton.

I recall hundreds curse words uttered for Mathematicians by T-JSSP. However, in turn, T-JSSP never know how much they are so deeply hated by mathematician. T-JSSP simply think, mathematicians are all Formalist, Individualist, Stone-Headed (石頭; stubborn). They regard mathematicians as if half or almost, or perfectly quite lunatic. Their storys for mathematicians always end up with stating their belief, "Mathematician ends his life in a bughouse"; for instance, Georg Ferdinand Ludwig Philipp Cantor (1845-1918).

On the reverse side of a coin, I think I can interprete how the Mathematicians are talking about Physicist. Since I walked out of The Physical Society of Japan couples of years ago, and trying to heading to Modern Math. But still, I feel myself, I'm standing at somewhere "Between Sanity and Madness"!

The reason for the cleavage is simple, but its depth is far much sharp than you might imagine. In short, "Mathematicians do have their own Pride". Yeah, I know, you Physicists also may have Yours. However, here begins the Tragidy (or Comedy. I don't know which !).

Here is the Mathematicians' Pride ;

"Mathematics has never made a Retreat nor a Turnover. It has come by this way ever since the age of Pythagoras or Euclid :

Surely, we made many Got-Stuck, and faced to seriously hard problems number of times; it was like the hard cliff to be climbed at NORD WAND (North Face). However, nobody retreated. We didn't need to think about it. True, it took almost half a century's marking time, just for the little problem, for some case. However once someone invented to overcome it, then there followed rush of progress. This is the way that Mathematics goes".

"This is because, Every Step of Logic of Mathematics should be constructed by the DIGITAL WAY : YES-or-NO, True-or-Fales, by 100-or-Zero %. If there were single step of NO (Fales) were sneaked in within the chain of logic, and it was found, then all the Logic after that step fall down; This is the Domino-Game itself."

"We won't go forward, unless each step of Logic were examined to be 100% True. To our (mathematicians') point of view, your friends (physicists) appear to be completely lack this sense. They don't know how awful it is to multiply the imperfection. Suppose, your work consists of only 10 steps of logic. However, if your each statement has ONLY 90% sure, then after the multiplied 10 steps, the reliability of your statement goes down to 31% ; No meaning at all".

"It's OK, for Applied Physics. It has another measure. However, under the name of The Theoretical Physics, what crimes were committed !"

You will be sure to think that you cannot stand with these people, don't you ? Here is the Reason why I am standing here. I am forced to swing "Between Sanity and Madness". However, this is not at all comfortable periodic-swinging. This is the completely violent Chaotic forced motion.

● Set : (open set) and [closed set] and (half open set)

(1) Open set (開集合)

【Fig. 30-A】 shows an Open Circular Disc (開円板), which does not contain the edge of the circle. It is shown by equation, $B_r(x)$, which reads “Internal part of circle of radius $\langle r \rangle$, centered at $\langle x \rangle$ “. The open circular disc is an (open set) for Real Number $\langle x \rangle$. An open set is represented by round brackets ; (……).

【Fig. 30-B】 shows (any open set) can be regarded as the (sum of open disc). (You may be noticed, it is easier to use picture than to rely upon equation). Three dimensional Euclidean Space is composed of (Infinite) Number of Open Balls, as shown in 【Fig. 30-C】 (You’ve past the Entrance Exam for Topology)

【Fig. 30-D】 shows the Overlapping of two Open Sets. You can get the radius of open circles as small as you may want. This leads to the same definition of “Neighbourhood” (近傍) as the old fashioned “ ε - δ method”. You will easily see that the “common part of open sets is again an open set. And, it is the sum of open discs, as shown in 【Fig. 30-B, -C】. (You’ve past the Qualifying Exam for Topology. It is tedious if you read above by equations.)

You may noticed that the important thing for Topology, and Physics, is Open Set in Space. This is because open set makes space continuous, in which Dynamics, or Trajectory keeps its meaning. On the other hand, the tedious things such as Boundary Condition, Friction etc, are related with the [closed set]. The closed set is represented by square brackets ; [……].

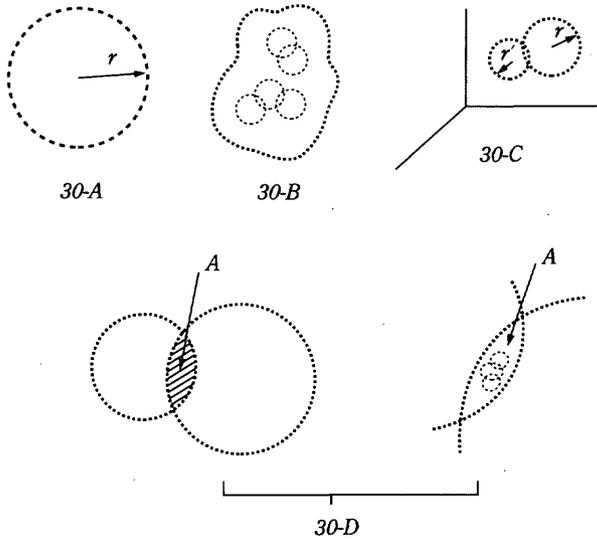


Fig. 30-A, 30-B, 30-C, 30-D

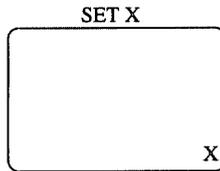
Fig. 30-A shows an Open Circle Disk. The broken circle means that the Set of real number which is contained by the circle is open set.

-B, -C, -D shows how the Open Set can be covered by the Open Circles. This time, open spheres can cover the 3-dimensional Euclidian Space.

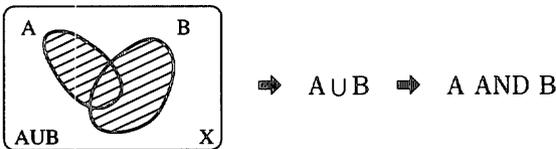
Japanese PTA and Ministry of Education abandoned the set theory from the curriculum, as I told. As the results, many people can only imitate or improve how to make the Memory for LSI, but they cannot create CPU design, definitely. Because they don't have even basic knowledge of mathematics. As you know well, the set theory goes completely parallel to The Computer Logic. I might show you small excursion below. It is known as The Boolean algebra, however, algebra is still harder than geometry. 《George Boole, 1815-1864, Ireland, GB》

● [AND, OR, NAND, NOR] vs SET

【Fig. 31-A】 is the most popular figure, which we find in the first page of text book of set theory. The outer square boundary declares that all the Element of the Set exists within the domain [X]. 《There is no place for ∞ 》 In Physics, the Element stands for “point”, and [X] for “Space”, for instance.



【Fig. 31-B】 represents the SUM of SUBSET-A plus SUBSET-B. (補集合の和) Mathematically, it is shown as “ $A \cup B$ ”, and Computer Logic call it “AND”. Incidentally, I learned it when I was undergraduate that “ \cup ” came from German word UND (and)”, but I don’t guarantee. So ;



【Fig. 31-C】 shows the “overlapping of the subset A and subset B”. Suppose, you belong to this hatched area i.e., you never know “Where did you from”, either from Swiss OR from German ? Therefore, computer people call you “A OR B”. Mathematician write it “ $A \cap B$ ”. I don’t know where \cap from. At any rate ;

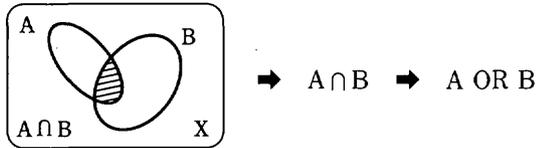
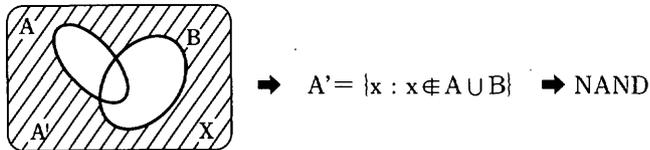


Fig. 31-A, -B, -C

- A shows the AREA of the Set.
- B shows "The SUM of Two sets".
- C shows "The OR" of the Two Sets".

[Fig. 32-A] shows the "compliment of the set" shown in **[Fig. 31-B]**. It is as if looking the Positive-and-Negative Print of the photograph. It is named "Compliment of a Set" (補集合). Mathematically, it is written rather awful shape, but it is popular as "NAND" Logic for computer peoples (Negative AND). Therefore it goes as follows;



Mathematical notation is written more simple style, sometimes, i.e., if $f(u)$ is a Set of element u , then "The Compliment of the Set $f(u)$ is $f^{-1}(u)$ ", i.e.;

$$f(u) \rightarrow f^{-1}(u) \Rightarrow \text{NAND}$$

Example (1):

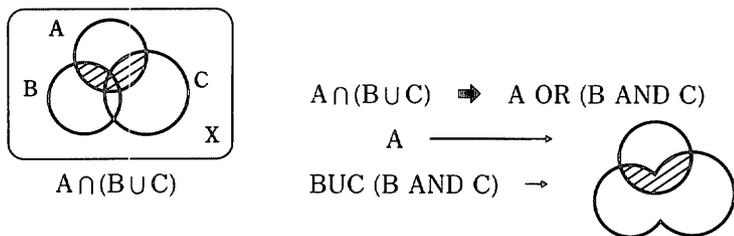
If $f(u)$ is "the positive Number in the Real Number Set", then the "Compliment of the Set" is "the negative Number in the Real Number Set, PLUS 0". You may think this is trivial and boring. However, when the Number of

Set goes up to three or more, you may find how the picturesque method is superior to equation and calculation. If you would find anything “This is obvious” in a text book, then you can skip all the following headachy pages and you MAY turn in.

$$\begin{array}{ccc}
 f^{-1}(u) & & f(u) \\
 (-) \text{-----} 0 \text{-----} (+) \\
 & \text{Forget me not!} &
 \end{array}$$

Example (2):

[Fig. 32-B] gives you another Example. How’s this? The number of subset went up to three. You might read the “equations” and look at the “figure”. Which is easier and quicker? You are sure to say “Obvious”, I guess.



[Fig. 32-C] shows you that The Computer Guys were very smart. They call this, which is shown in the Fig. 32-C, as NOR (Negative OR). This is Negative Print of Fig. 31-C.

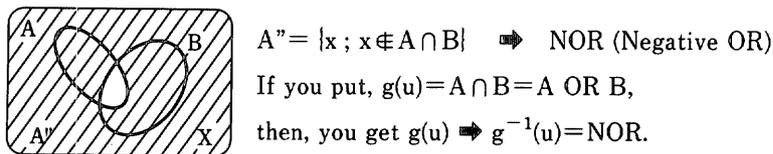


Fig. 32-A, -B, -C

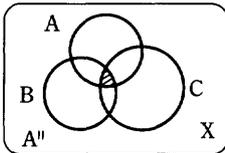
- A shows “The Negative Set to the Fig. 31-B (SUM of A-B)”
- B shows “The OR set to the Three sets, A, B, and C”.
- C shows “The NOR set to the Two-sets, A and B, in Fig. 31-C”

Example (3):

How about the OR or NOR for Three Subsets ? To say is easy, but to do is another ! To say, "I came from Swiss or German, or from Austria !" YEAH! BATTA, you got to write it down ! In "equations", it goes as following;

$(A \text{ OR } B) \text{ OR } (A \text{ OR } C) \Rightarrow (A \cap B) \cap (A \cap C)$ OK ? How this will be visualized ?

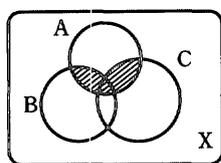
«Presto ! [Fig.32-D]!»



«No questions ?»

Example (4):

Finally, how come they call this is Boolean Algebra ? Why don't you look at [Fig. 32-E]? This is the copy of [Fig. 32-B], and you might look at the "auxiliary figure" at the right side-out. Then look !



$$A \cap (B \cup C) \Rightarrow A \text{ OR } (B \text{ AND } C)$$

Let's try to divide the hatched area. That is ;

$$\begin{array}{ccc}
 \text{hatched area} & = & \text{leaf} \quad \text{AND} \quad \text{leaf} \\
 \downarrow & & \downarrow \quad \quad \downarrow \\
 A \cap (B \cup C) & = & (A \cap B) \quad \cup \quad (A \cap C)
 \end{array}$$

Fig. 32-D shows the NOR set for the FOUR sets case. You would feel hard headache, if you try to solve the question by equation, I'm sure !

32-E shows how problem of Fig. 32-B can be solved by the Boolean algebra, which goes just like the common algebra in the sense of its Algorithm.

This is exactly the “Distribution Law” of Algebra! (qed:which was to be proved)

● Topology AXIOM

Mathematically speaking, every theory is constructed upon Definitions ; we have Definition for Vector (either number vector or function vector), for Group Theory, and for Set Theory. Toplogy is, however, constructed upon AXIOM (公理). AXIOM is accepted to be True without verification. You may feel it is as subtle as “Principle” in Physics. However, in mathematics, Axiom has much wider deductive area than principle.

There are 《Three Basic Axiom for Topology》. I recommend you, readers of this elementary Note, to “study by yourself” for this square knowledge to get. It will be nice help to have a friend of mathematics, too. However, let me state my opinion just to proceed for the moment. To my opinion, each

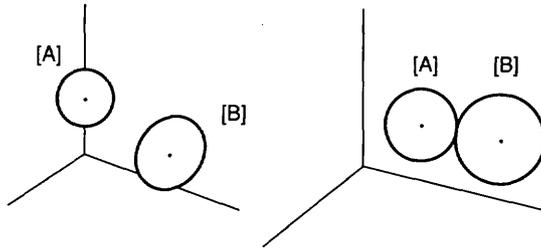


Fig. 33-A, -B shows that Closed Set cannot cover the Euclidean Space. They cannot do that, be it may be apart or in touch. Roughly speaking, they don't have NOR logic. Therefore, their arguments are incomplete. The author recommends not to touch with them.

three of these Axiom has the strongest connection with Open Set. I will show you a few example, why Closed Set are not welcome for Topology. (I am sure the Closed Set will raise serious trouble in Physics, too.)

[Fig. 33-A, -B] shows how the trouble will be generated. [Fig. 33-A] will be easily understood. There cannot be the OR section in Euclidean Space, and thereby the continuity of space, or the concept of Neighborhood is destroyed. Therefore, by falling down of the logic OR, everything falls down.

[Fig. 33-B] is the same sort of case. The concept of Neighborhood is cut off at the Boundary of the close sets. You may feel a serious trouble will be come out in case you have Connectivity Problem in Space. In this case, Topology can say "Something wrong's in'er", rather easily than the analytical method.

● Topology : The Kaleido-Scope of Space.

Do You know what the Kaleido-Scope is ? It's a kid's-stuff to look into to enjoy the beautiful and mysterious change of the Images by slightly rotating the scope. The trick of the scope is composed by small three pieces of mirror plates, which fixed by 60 degrees to each other. Also, there are just a few tiny pieces of feather, or straw are put into the triangled space.

According to [Ref. 20, (vol. I, vol. II)], we have the same sort of Beautiful Spectacle of Space. The author of the book [Ref. 20] says, there are 6-spectacles in Topology :

- (1) *Distance-in-Space*. This time, Space means not only the Number-Vector-Space. By realizing the problem of "The Distance between The Functions in Space", we've reached to the "Distace-in-Function-Space", or the "Norm etc" for functions. This problem finds the Hilbert Space and so on. Hilbert Space is a Function Space, where the "Norm" is defined in the same fashion as the Number vector space ($p=2$, if formalistically speaking). Hope you study by yourself, and enjoy yourself.
- (2) *Homology*. This is the most curious looking branch of the Topology application. Maybe you had some experience to see the "Wine-Cooler-like" artistic figure. This brain twisting business is, however, getting very important field for Biophysics , I would imagine ; the problem of protein chain or DNA and so forth. One of the very elemental knowledge is, however, that a "Ball can never be changed into Torus, provided that you put cut-and-fix onto it". They call this 《Ball and Torus are Not Homeomorphism》 (同相でない). Here is the formidable standing point for "Bloch who ? (No.1)" of this article serieese, by the way.

(3) *Topological Space*. This is straightly related subject to the Three Axiom that was stated before. The most fruitful application is the continuity and the connectivity of space. As the preliminary to this subject, it would be nice if one has a bit of knowledge on the set theory. (hope you like it) These are for the modern concept of "Neighbourhood", as I stated before.

(4) *Knot*. (結び目) This is again a strange looking, but very powerful tool of Topology. 【Fig. 34-A, -B】 shows the most popular example that "Coffee cup is Topologically Homeomorphic with Torus" (同相である);

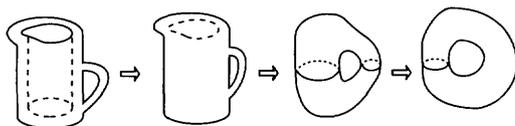


Fig.34- A

To examine the homeomorphism, we got to change the shape Continuously. Continuity is one of the essential point of topology. The continuity comes from the concept of neighbourhood. So, the commonly said expression, "To change the shape of a body as if it were made of rubber baloon" is mathematically sound.

【Fig. 34-B】 is the typical knot. It is incredible to hear that "Unless the both ends of a loop were connected, any knot can be solved". True ? Maybe ! However, the reverse statement "To tell whether this knot can be solved or not, when both ends were connected, is very hard. It is almost desperate to tell, without operating the knowledge of Topology". True ? Maybe !

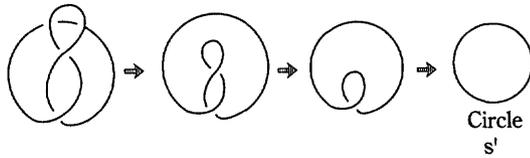
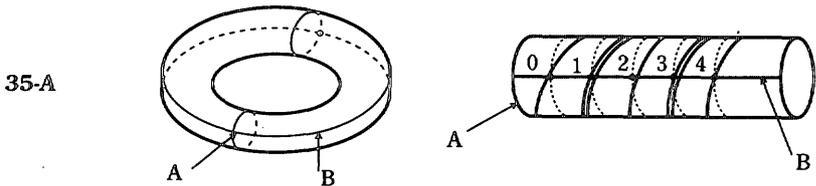


Fig.34- B

Fig. 34-A, -B shows the examples of Metamorphoses in Topology. They say "Think as if it were made by rubber". Yes, it works fine! But it would be much nicer, if you would imagine that behind this statement, there is the "Problem of continuity of Functions".

(5) *Graph.* [Fig. 35-A,-B] shows the application of Topology to Graphs.

[Fig. 35-A] shows how the Torus can be changed into Circular Rod, by cutting-A, and stretching continuously until to form the straight tubing. Another cutting-B and unfolding the tube into sheet, A-B, ends up with the Plane A-B, as shown in [Fig. 35-B].



[Fig. 35-B] shows you two things;

(1) "The Bloch function in 1-dimensional world" is actually, the simplest current on the Torus surface, as shown in [Fig. 35-A]. You may insist, "It is 2-dimensional as the Axes A-and-B shows! : Look at either [Fig. 35-A] or [Fig. 35-B]!" Yeah! But remember you said "in Euclidean space", however this is the Torus space, first of all. Besides, you picked up only Coherent Case that gave you 1-dimensional

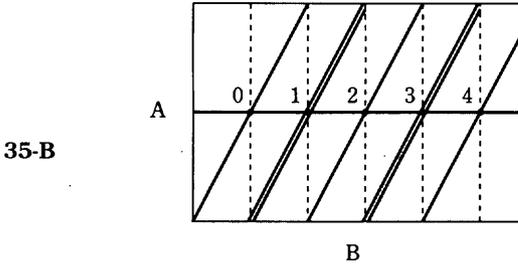


Fig. 35-A, -B

35-A shows the Torus World, where we can live with the continuity problem within the 3-dimensional Euclidean space. In this case, we can Cut and Stretch the Torus Surface down to 2-dimensional world. It is needless to say, if the trajectory was not closed, you will soon find the same problem as Dr. Poincaré told us about 100 years ago. 35-B shows that in the luckiest case, you would remind the sweet stories that Bloch, Wannier, and/or Dr. Brillouin told you.

current.

- (2) From [Fig. 35-B], readers may find the Entrance to Chaos. If you have another current ringing round the Other-Way-Around, then you will easily get the Tent-Projection. And you will find the Poincaré Crosssection, when there is no harmonicity between the cycles for A and B. You know, we are looking from behind of these genius's backs, we can easily see how incredibly wisely they struggled.

At this stage of knowledge, I do kidding-the-peoples very often, by saying, "Theory of Metal does not belong to Solid State Physics".

● REMARK 14-1 :

The current for the Superconductivity should run within the Torus Ring in 3-dimensional Euclidean Space. That's very fine! However, we were out-cast out-to the Complimentary space, f^{-1} , if you remember. This raises Hell-of-the-Troubles, than you may think. Boundary problem plus Connectivity. You should looking forwards, what an interesting party can be held, say for Aharonov-Bohm-Effect for example.

(6) *Homotopy*

This is the last scene of Topology Kaleido-scope. However, this is the most directly connected subject with Space. It contains space-Time Mathematics and Physics. Hope you don't have allergy. When I looked back quickly the famous book "Surely You're Joking Mr. Feynman!", I found "He got me up to homotopy groups, and at that point I gave up." [Ref.78] He said also "Topology was not at all obvious to the mathematicians."——so was Dr. Feynman. He really had a bad friend mathematician. It must be "not at all obvious" for Old Fashioned Mathematician. Dr. Feynman said also, "I never did learn was contour integration". ——That's very nice. As I showed you, what a stupid calculations've been done on the complex plane! By the way, on the 2nd page of this \$4.95 paper back, the publisher says, "No part of this book may be reproduced or transmitted in any form or by any means . . ." Then what if "I reproduce just a word [a] or [at] of this book?"

In 1973, I visited David Sernof Research Center (DSRC), RCA Princeton, New Jersey, from April 22 through May 19. The purpose for the visit was the company business for RCA Res. Lab., Tokyo. The ex-Director of Tokyo Res. Lab., Dr. Philip K. Baltzer, in DSRC showed me around the Princeton Town and the University Campus. Dr. Baltzer pointed up the

Einstein Tower, and Department Building. The weekend of the day, I visited again the University Campus alone, and took pictures. I noticed the old-looking buildings were just for outside. The inside of many buildings were restructured and/or modified, and neatly painted white, milky white, and lower wall were sympathetic green. 《I could not peep down to the floor.》 It was "Neat and Clean"; the complete opposite to Japanese National University, which I don't know the words to describe for, except, "The Nest of Sparrows and/or Rats!".

I looked through a triangular opening of Ivy-window : The room was modified into high enough open space, from the basement to the second floor. The familiar banging sound of the machine-gun, Line-Printer of Those Days, was streaming out from the Ivy-Window. There were beautiful combination of the Old and the NEW.

I knew that Dr. Neumann and Dr. Einstein were in "The Institute for Advanced Study (IAS : 高等研究所)"; which is located in the suburbs of the town, about 30 minutes away by walking. I knew, Dr. K. Gambo (岸保勘三郎), who was the research associate of Dr. Shigekata Shyono, Professor of the Department of Geophysics, Meteorology Section, joined the project which was organized by Dr. Neumann, from 1951 through 56, and he attended a meeting which was held at the University. [Ref.85 ; Chapt.6, Ref.61 therein] When I was strolling under trees, three graduates came out of the building. They went across the green lawn field and disappeared. "They look smart and sharp ! But, they maybe Not-So-Many !" I thought.

When the farewell dinner at Dr. Baltzer's home in Princeton came, he gave the Prayer for Dinner. At the end of his phrase, he prayed for my safe

return to Japan. In the chat after dinner he had the pleasure to show his pretty low-teen daughter, and let her read a simple French rhyme. I forgot almost, but every phrase ended with ;

“J’aime savon, J’aime savon ! (I like soap, I like soap !)”

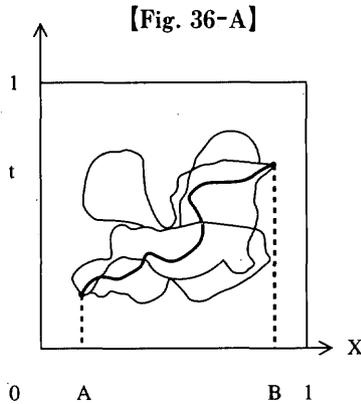
That was the Princeton ! And still it must be as it was. Dr. Feynman had the greatest opportunity that he might get sweepstakes the Poincare related work by the 20th century’s Math : provided that he had a good friend of modern mathematics ! However, “Homotopy Guys” destroyed everything. Incredible ! [Ref. 78 : “Surely You’re Joking, Mr. Feynman !” 《A Different Box of Tools》]

● Homotopy : The Screen Pass

【Fig. 36-A,-B,-C】 shows visually how it goes with Homotopy. You may realize at once that the 【Fig. 36-A】 is just a reproduction of 【Fig. 26-B】, which I called Panel ③, namely Okazaki Panel. This time, however, the Panel ③ is rotated by 90 degree, and we are looking into the panel from the back-side. This is because, as you know, Feynman diagram goes this way. Lucky enough, the Homotopy diagram goes the same way. Hope you would recall the *Complicated Reality of the World*.

After the Panel ③ in 【Fig. 27】, we saw “The Genius’ Illusion” on Panel ⑥. There were infinite number of “Gaussian Slit”. However, we have very simple Screen this time. 【Fig. 36-B】

【Fig. 36-A】, which is identical with 【Fig. 26-B】 : Here, the axis is ro-



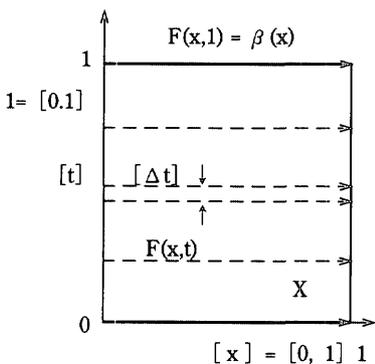
tated by 90 degree, and we are looking into Panel ③ from the back side.

[Fig. 36-B,-C] is the conceptual unfolding of **[Fig. 36-A]** by employing the Homotopy. This is the entrance for new section of the author's 2 x 4 house. Hope this will become the Starting Panel for the “Particle Dynamics”; from “Classical Dynamics” through “Quantum Mechanics”, including “Special Relativity”.

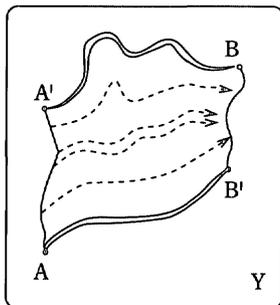
This is very important starting line for understanding the New Concept. Let's move a little bit slower than before. The main idea is to consider the Time-and-Space variables to be Equal. Mathematically speaking, we liberate [t] from the [implicit parameter] to [independent variable]. You may feel this is a retreat from “modern calculus of variations”. However, author asks you might recall the 4-dimensional special relativity's matrix. We took every 4 axes to have equal Rights.

In short, we regard the “Complex Reality” on **[Fig. 36-A]** is the result of a “Projection” from the “Simple Map” on **[Fig. 36-B]** to **[Fig. 36-C]**. Sup-

【Fig. 36-B】



【Fig. 36-C】



$$F(x, 0) = \alpha(x)$$

$$\left. \begin{array}{l} \text{AXIS} = [x] \\ \text{Figure} = X \end{array} \right\} \begin{array}{l} \text{Continuous} \\ \text{Projection} \end{array} \Rightarrow \left\{ \begin{array}{l} \text{; Visual} \\ \text{Figure Y} \end{array} \right.$$

$$[x] \times [I] \Rightarrow [Y] \quad ; \quad \text{Mathematical}$$

Fig. 36-A, -B, -C

36-A is just a reproduction of Fig. 26-B. However, we are going to “separate the variable of time-t, out of the x-t space”. Another words, Time-t is no more the parameter”. 36-B, -C is the most elemental treatment for the Homotopy. Readers will find that this is much more clear and neat method than the Classical Calculus of Variations.

pose, we have a function $F(x, t)$ on the map $[x-t]$; as shown in [Fig. 36-B]:

The thick straight line on axis- x shows the "Initial Condition" for the dynamics ($t=0$). As the time (t) proceeds by (Δt) , the value at all the point on axis- x changes due to the "Equation of Motion", be it linear, or non-linear, or whatever it maybe : let's assume for the moment it is "Continuous" at least, such as C^0 function. On top of the $(x-t)$ box, the "Final Condition" for the motion is shown by the function, $F(x,1)=\beta(x)$. As you see, functions $\beta(x)$ and $\alpha(x)$ do not depend on (t) any more. Now, let's "Project" the function $F(x,t)$ on to the map $[Y]$. If you have nothing to do anymore upon $F(x,t)$, then just plot your value itself. However, if you want further, to do Integration, or double Integration, or Path(line)-Integration, please go ahead and enjoy yourself. We don't say that "Only Action Integral has the Real meaning". You know, "Math goes first, and Physics comes later in this world". You may feel unhappy to hear that you are not sitting at the Top of The Tree. However, please forgive me.

The result would be as shown in [Fig. 36-C]. In the figure, hope you may noticed that the point-A (the origin) moved also with the elapse of time. But why? *Because, you didn't fix it.* The function $F(0, t)$ can be changed with the elapse of time, naturally. So it will happen on the point-B too. You, the expert of calculus of variation may think "No, this is not our thing! You are talking about something else!"

Let me ask a question about the [Fig. 26-B] then. "Who on earth knew that our final destiny will be at point-B? Doesn't it mean that you solved the problem before you solve it?" I used this phrase number of times, I am afraid. Does this mean that I've got old to repeat the same tune again and

again? Take it easy. You can fix your final station wherever you may want. However, before to show you the pleasure I have to leave some Remarks here :

● REMARK 14-2 :

- 1) Your working field is enough within $[0,1]$ closed set. You've seen this in "Bloch who? (No.1)". This is enough for you, since you are going to work with "Bounded Quantity and/or Bounded Function" (有界量). There is no place for ∞ in this case by the way ; ($\infty \notin \mathbb{R}$). Let's recall the pleasant "Jardin du Jordan" (楽しい, 楽しいジョルダン公園へ)
- 2) The argument here works for a discontinuous function too. However, the transformation must be the continuous transformation.
- 3) Axis $[x]$ is Reversible, but $[t]$ is Irreversible. You can go back to pick up your left-behind, or to the Lost-and-Found Office. However, by so doing, you got to go forward on the Time-axis. Everybody knows it. However, there're so many funny stories going arround. Some Theorist says, the Trajectory of Antiparticle goes the other way around. Well, we will see !

Before you gang upon the Old Modernist, you might recall there is "L" (Loop) in Chicago. We have the same sort of train called "Yama-no-te Line in Tokyo. (山の手線 : Actually this is Not a Line but a Circle!)" In these case, you need not run about for looking for your left-behind. The train should come back exactly 65 minuits later in front of your face. But(!) awful thing is discovered lately : The Quantization Rule for these

systems could be seriously different from which we had learned in The School. It is good just for the Euclidean Space, they say. [Ref. 81, 86, 87] Therefore, "Since The Quantum Mechanics governs the whole world even upto the classical system!", your left-behind cannot be guaranteed to appear! Take a good care, please! We will come to this point later.

- 4) The Product of $[X] \times [I]$ is the simple "Direct Product" when the Set is The Closed Set. More over, when the number of the element of the set is the "Bounded Set (of the points)" (有限集合), then the direct product reduces down to the simplest common "Product", which we learned in the elementary school. So much for the Remark 14-2.

Let's proceed to [Fig. 37]. The Figure shows you the Map you may really want to see.

[Fig. 37] shows the Homotopic Relation of $\alpha(x)$ and $\beta(x)$ when you have the Points A and B as the "Start and Goal". The Conditions you put upon these functions are much more severe than the previous case shown on the [Fig. 36-B,-C]. The "Mathematical Trick" you need is, visually shown by the two thick vertical lines on the [Fig. 37]. This condition means, "Any possible paths that may go from A to B must start at the same time $[t=0]$, heading to B. All the integrations, if you would like to take integration as the project for $[X] \times [I]$, must be taken care of at the same time. You would be very busy, and you would understand what Dr. Feynman said.

[Fig. 37] "With Start and Goal"

Mathematically, conditions are handled as following;

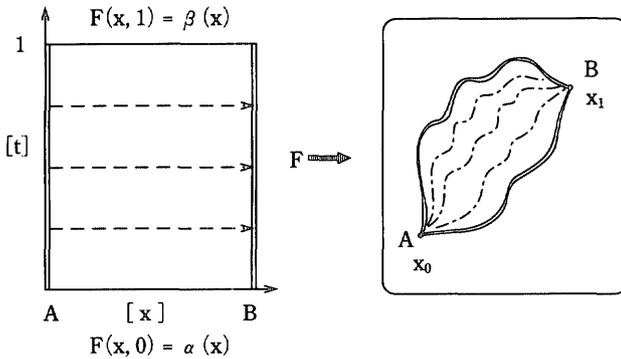


Fig. 37 This is a method of application of Homotopy. Here, you can play back to the common Method of Variation, which seeks the trajectory for the Minimum-seeking Game.

● For Space $[x]$, $(0 \leq x \leq 1)$

$$F(x,0) = \alpha(x), F(x,1) = \beta(x).$$

● AND, For Time $[t]$, $(0 \leq t \leq 1)$

$$F(0,t) = x_0, F(1,t) = x_1.$$



$\Rightarrow \alpha(x), \beta(x)$ are Homotopic functions.

● REMARK 14-3 :

1) In case of Homotopy, the paths from x_0 to x_1 i.e., the trajectories can be crossed over each other or winding by itself. The only condition imposed of for these paths is they should be changed to the other paths by the continuous projection. Here is a good possibility to enclose chaos problem in this concept.

2) You would be noticed that the destiny x_1 is not always obvious where it is. This would be often true for the Non-linear Equation of Motion; you may say by Hamiltonian if you would prefer. However, by very simple Algebra, you can find the necessary condition to clamp $F(1,t)$ at x_1 .

By the reverse way, you can easily find the fundamental error for someone who tries to solve the problem by employing the Perturbation Theory. I repeat, he solved the problem before he solves it, by putting the point x_1 to be fixed. You may giggle out and you can save time to quit reading his article further.

I thought I might put some examples in this work, but I noticed my time is running out : It's March 15 (Sun), and the Dead line is April 22 (wed). It's impossible to clear up and make straight the way for those who come later, only by one person within such a short period of time. As I said before, there are too many ugly rocks and jolting monument were built. T-JSSP admired these debris for more than half a century. I might put off the work to the Next. Hope I can show you some constructive work.

【Fig. 38-A, -B, -C】 "Reverse, and Double Reverse, and so on".

American people knows it quite well, how it is exciting to watch a beautifully succeeded Double Reverse! *To deceive is virtue, to be deceived is sin!* However, I'm not sure if everybody knows the double reverse is a very busy play for backs. They must run much faster than usual play ; maybe factor 2 or 3 times faster. They got to do many things at a time. Stupidly enough, SOME physicist doesn't know this at all. Maybe he doesn't like football. How about Japanese Physicists, did you say? Out of the question.

【Fig. 38-A, -B, -C】 will show you how it works. I guess you've used to the visualized Homoty. So now, I might point up just new features in the Figure. There are TWO points that I must stress. Suppose, you are one of the Half-back. Then you will soon realize the following 2 points :

(1) Firstly, you have to pass the appointed Space $[x_1]$. Otherwise, you cannot do the trick-play at all. If you fail, your team fails to touch-down. In other words, half-backs got to Got-Together at $[x_1]$ by all means. This is shown on [Fig. 38-C], and every body understand it very easily.

(2) However, an interesting thing happens between [Fig. 38-A] and [Fig. 38-B]. You, half-backs, and the coach are all aware of this quite well, but Physicists appear to be ignorant about the Trick.

As you see on [Fig. 38-A], you got to get to the Space $[x_1]$ within $[1/2]$ on [Time-Axis]. Otherwise, what's good for Reverse? Obvious? Obvious! Now, the confusing thing is the meaning of the horizontal axes of [Time]. You know what does it mean by the thick vertical lines at $x=0$ and $x=1/2$. I would repeat, the vertical thick line at $[x=0]$ means, there is NO $[\Delta t]$ on this line (axis). And the broken horizontal lines mean the $[\Delta t]$ goes upwards, step by step, just like a chaos' projection, all at a time from $[x=$ to $x=1]$. Another words, the vertical thick line at $x=1/2$ does NOT mean for the players from $1/2$ to the right need not move! What a grief and anger for the Coach, if he found the half of players to the right from the center won't play at all for the Reverse! I guess you've got it. Therefore! Your [Space-Time] chart got to be rewritten as [Fig. 38-B] ; for lower part and upper part as you see it.

In [Fig. 38-B], Your-space-Time is indicated. This is the Space-Time that the coach is expecting for your actions. You should notice that all the players on the $[x]$ axis should Start-to-Move at $t=0$. What's more, all action for the Phase-I should be completed at $(x=x_1, t=1/2)$. This is indicated by thick vertical line at the center of x -axis. The lower diagram in

[Fig. 38-B] covers up to $t=[1]$. This is because it is always convenient to perform integration within $I=[0,1]$, rather than within $I/2=[0,1/2]$.

Actually, you got into high gear, until Doubly High! This is because you have to finish your action within the given $1/2 \cdot I$ [time]. I guess you've understood this Trick. Then, there is nothing new for the upper diagram in **[Fig. 38-B]**. This is just Phase II of Double Reverse. Why don't we look into the **[Fig. 38-A,-B,-C]** carefully. Some mathematics and a Remark should be followed :

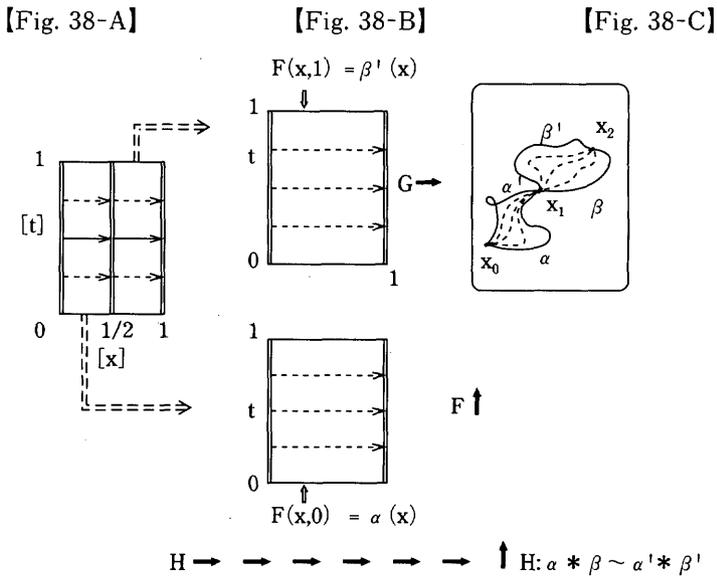


Fig. 38-A, -B, -C This is actually an extended play to the usual Variational method. The rule is changed so that every path should pass-through at an intermediate point between goal and the terminal as shown.

Mathematically speaking, the above story becomes a bit headachy. We are going to speak about the “Product of Paths”. I would assume you are good at now about the Homotopy of each function that appear on each square ; the lower and the upper square in [Fig. 38-B]. This is the same business as in [Fig. 37]. There is nothing new to be mentioned further.

Question is how to connect the two Phase of operations, before and after the Reverse Trick were performed. As it may be easily seen, it will be perfect if we simply “Multiply” the two stages before and after point x_1 . Dr. Feynman and Dr. Dirac repeatedly said that they can multiply “Probability”, which they are going to connect to their wave functions. However, we are not talking about “Probability” nor “Expectation Value”. We are talking about “Functions”, or “Counting up the possible numbers of Trajectories”. We are like travellers, who want go all through France “From Dunkerque through Paris to Bordeaux”. We are not talking which “path” is the most plausible, or the quickest one, or maybe independent. Everything is left for later arguments. Then I think it is obvious ; we should Multiply at every Star-structure-point.

American Midwest City's route is Cartesian. So, it is only possible to go East-West, or North-South. Kyoto has the same street system. However, when you go down to Paris, or Sapporo you will face the Star-Structure. Then after miserable experiences, you will get quick lessons about the “Multiplicity of Trajectories”.

It is at this point that I called the Panel⑥ is the “Genius’ Illusion”. You know, if we have to pass through the infinite number of slits, that means we have to play the Reverse infinite times, which in turn we have to speed up

untill infinity. Of course, every Genius has his "Grand Illusion". This is the evidence to demonstrate he is the real Genius. Through the Illusion he gets to finally the Reality.

As you may realized now, Homotopy has separated the easy-to-confuse Concepts about "Probability, or Expectation Value, or Possibility", and "Space-Structure". As you may see later, there is the different "Quantization Rule" where there is the "Different Space Structure", they say. [Ref. 86, 87]

● Mathematics

(1) If, $\alpha(x)$ and $\alpha'(x)$ are Homotopic (continuously connected), and $\beta(x)$ and $\beta'(x)$ are also homotopic, then we can write (or say) that the Product of α and β are also Homotopic to the product of α' and β' . We write this as;

$$\alpha * \beta \sim \alpha' * \beta' \quad (* \text{ means to Multiply, and } \sim \text{ means homotopic})$$

which corresponds to, $(F \times G \rightarrow H)$.

(2) Since you got to squirrel around quickly, your x-vialible should be multiplied, so that you should get higher velocity, dx/dt. Therefore,

$$F(x, 0) = f \{ \alpha * \beta \} \rightarrow \begin{cases} \alpha(2x) & \because (0 \leq x \leq 1/2) \alpha = [0,1] \\ \beta(2x-1) & \because (1/2 \leq x \leq 1) \beta = [0,1] \end{cases}$$

Author recommend you should confirm the above concept by yourself; be sure to remember that you are a player of Double Reverse.

● REMARK 14-4 :

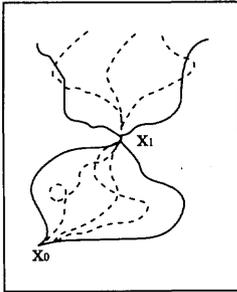
(1) As you know well, the Ground Area for Reverse Play is not limited to the down-left quarter section in [Fig. 38-C]. It is the “prejudice” that came from the “classical dynamics for a particle motion”, if the first half play must be performed within there. Hope you would agree with me. The reality is as shown in [Fig. 39-A]; the only necessary condition is to get through the point x_1 .

(2) You cannot move around either “half in advance or half in retarded”. This is the classical space. Everybody must live with his own real-time. Fundamentally speaking, the “Half-Time Business” came from Laplace or Heaviside Transformation. It is due to One-Way flow of Time, and SUD-DEN start for actions. There is nothing new when you speak about Green-Function in 2nd Quantization. Dr. Heaviside said already; “Nevertheless, theory for digestion is not clear, I won’t stop eating!” Yeah! Let’em keep eating! Someday, it’ll become clear what they’d eaten!

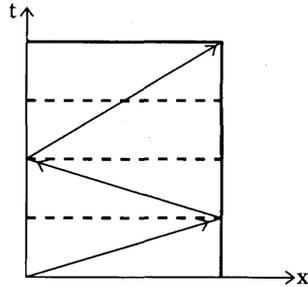
(3) You can go back on space-axes, but you cannot be back on the time-axis. In this case, you will find your Trajectory in 1-dimensional $[x-t]$ Space-Time will be as shown by [Fig. 39-B]. Author leave a homework for readers; “What function for $F(x,t)$ will give you the motion to go back to the Lost-and-Found Office to pick up you left-behind, as shown on [Fig. 39-B]?”

(4) You remember “L-in Chicago”. I said also, “You need not run around looking for your Left-behind in Tokyo. You have only to wait 65 minutes at the spot. The things will show up again in front of your face. Just step in, and pick’em up”. Let’s draw Trajectory for the case in $x-y-t$ space. Hope

[Fig. 39-A]



[Fig. 39-B]



[Fig. 39-C]

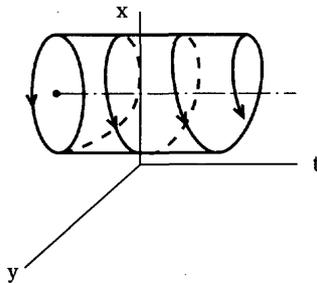


Fig. 39-A, -B, -C

39-A shows the more realistic trajectories of every path. It may be more or less true that we cannot predict where the trajectory leads us? -B and -C are the cases that the phenomena did repeat. Just remember, that we are not necessarily repeat by Simply Periodic motion.

you realize a problem in [Fig. 39-C]. Almost all text book for Physics 101, calls this is the “Simple Harmonic Motion”. How come this is Simple? Because The Theorists did simplify the problem. I mean, they are talking of the motion of a particle ; “Point Mass”.

Later, the theorists suddenly remind us of the Particle’s Face and Body ; what they call vector S and J . It means, they forgot about that the System is Non-Inertial-Coordinate-System. We, Meteorologists never forget of it ; never ! Astro-physicists are more smart! Behold, what had they done for the Voyager II to Swing-by Jupiter! [Fig. 40] They solved the problem without chaos knowledge. All the trouble comes from the clever Simplification to the Point-Mass. To start from [Fig. 41], [Ref. 88] would have saved hell amount of “Time and Energy” for students and Professors.

To brush up the story of “L”, I will point up the Golden Monument. The problem of energy levels in Hydrogen atom were solved by Quantum Mechanics. It’s the complete Triumph, they say. No Professor told me, the “Rule of Quantization” i.e., the famous Poisson Bracket Business, $[q,p]$, won’t work in (r, θ, ϕ) system. Surely, Professor Yamanouchi told us, very quickly, and switched to the famous $[H,1]$ or $[H,1^2]$ subjects. No kidding! The beautiful parallelism works out only in Cartesian Coordinate System. (You can try!) [Ref. 86, 87] Everything was kept behind so carefully. Mathematically speaking, the Concept of the Cartesian Coordinate is Narrower (lower) than Euclidean Space. This is the “normal” 2 and 3 dimensional Space, where the Open Ball is the Base for Topology. My goodness! Where is the Space then that Quntum Mechanics really holds?

【Fig. 40】

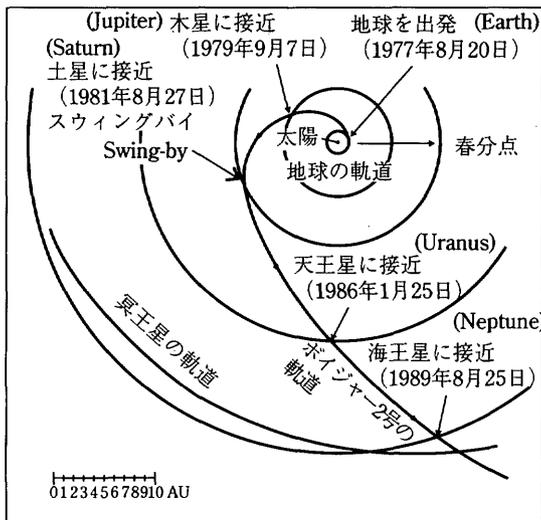


図8 ボイジャー2号の軌道

各惑星の軌道は正しい比で描いてある。1AU=太陽-地球間距離。

Fig. 40 This figure was put just to show people that "How clever they were!". They solved the three body problem without the knowledge of Chaos. What's more they saved Energy to get to Pluto, by employing the Trick which is known today as "Swing-By"! Readers who did not interested in Classical Mechanics are recommended to study what is the swing-by? [c.f. M. Toda "PARITY" (in Japanese), Vol. 6, No. 7, 1993, p. 60.]

Now, it appears the time has come to proceed to the last Panel ⑪. Here is the well known picture for the 1-dimensional Special Relativity. The reason I show you this thing is that the attitude, or the way taking care for the Theory is different from Dr. Feynman. [Ref. 67; "Six Not-So-Easy Pieces", Ch. 4, Fig. 5.2]

【Fig. 41】 From “Classical Mechanics 101” ; [Ref. 88]

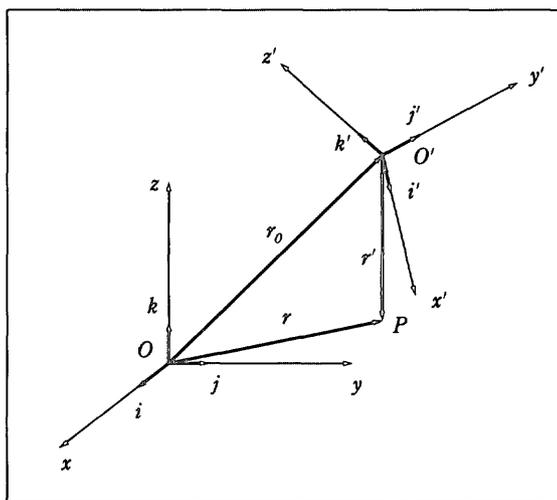


図4.1 慣性座標系と相対運動を行う非慣性座標系

Fig. 41 The mostly recommend starting point for the Classical Mechanics. The Simple Oscillator physics are the worst thing that produces the great amount of Simple Minded students.

§15 Special relativity and still another haunted space to get through

Here is the last Panel ⑪ which I'm ready to show you so far. This is nothing new actually. I made a copy from Dr. MØLLER's book. [Ref. 83] In Chapter IV, §33, Dr. MØLLER shows the Lorentz Transformation Matrix as following;

$$\alpha_{ik} = \begin{pmatrix} \gamma & 0 & 0 & i\gamma/c \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -i\gamma/c, & 0 & 0 & \gamma \end{pmatrix} \rightarrow \begin{aligned} x_1' &= x_1 \cos \phi + x_4 \sin \phi \\ x_4' &= x_1 \sin \phi + x_4 \cos \phi \\ x_2' &= x_2 \\ x_3' &= x_3 \end{aligned}$$

Of course, Dr. Feynman knew this well. However, after some arguments he concluded that "We shall not deal with the geometry, since it does not help much; it is easier to work with the equations." I won't argue on this point. Since if the focus of the argument is on "Which is easier to work?", then it's up to individual person. Dr. Feynman could work easier with equations; he said in the popular booklet that he could recognize the difference of complicated elements by "Different Colors on sub-indices in his (vector, tensor) equations"; which for any other people not to be seen! This is the real Talent for Genius. However, geometry shows us commons, clear Vision and/or visual Images!

(1) First of all, I would say, Dr. MØLLER's lecture can be finished, within the first quarter of an hour, as far as the special relativity concerned. This is the "Rotaion of Axis" along, say x_2 . However, the rotational angle is Pure Imaginary, such as;

$$\cos \phi = \gamma, \sin \phi = i\gamma/c, \text{ and } \tan \phi = i\gamma/c. [\phi = \tan^{-1}(i\gamma/c)]$$

What's wrong with Pure Imaginary for Angles? We've given Pure Imaginary Time Axis by Dr. Minkowsky and so forth. However, his Oblique Coordinate is really tedious, and it is much more TERRIFIC than that if we can go ahead with Rectangular Cordinate and its Rotaion!

(2) What's more, Dr. MØLLER says this is the Pseudo-Euclidean-Space. The only difference between Pseudo and Normal Euclidean Space is the Length, or Distance between the Points; you know since $x_4 = ict$, "Norm" can be Zero, nevertheless there is the Distance between the two points, if it were measured by the Straight Line in the Minkowsky Space. Another words, the "Local Time" is Zero for the Light to travel between these points by The Path where the Norm is Zero. [Ref. 84] Hope, all the space theory and Topology can survive within this Space: maybe someone had already verified this.

If it works OK, there is a hope we can go further. If not, we will discover the uncrossable cleavage between Quntum Mechanics and Relativity at this spot! That's must be great, too! As I pointed up so far, it appears many heavy jobs are still left for us to work for Quantum Mechanics. It must be carried on by another-another geniuses.

However, here is one thing that I can point out to you. This is Not-So-Great thing but we got to get through before we would go ahead. That is, again, the Haunted Space Problem. It is still crying, "Remember Meeeeee!"

● Haunted Space

As you've noticed, we have been talking about 1-dimensional [x-t] Space-Time problem. However, as you saw at the Chicago-L story, it will raise amazingly complicated problems, when we go up into 2-dimensional or higher Space-Time. I'll show you an example of this monster on [Fig. 42]. They are waiting to show up in front of you.

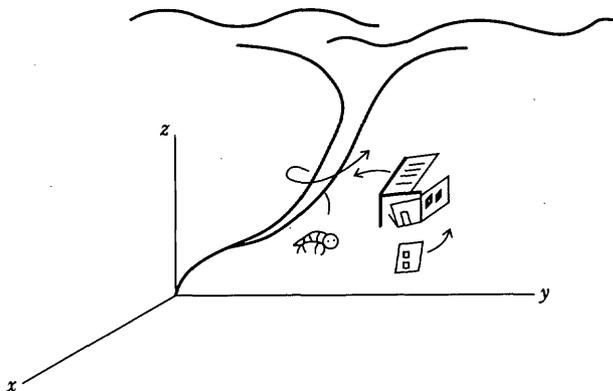


Fig. 42 shows an example of 3-dimensional motion in a real space. However, as you may comment, it should be taken-in into a 4-dimensional phase space. The problem is that the change of the potential, or non-conservative force itself maybe changeable with time, and these things should be taken into account. I am not saying that we should solve these problems. To the contrary, all that I want is we should know clearly "What we are doing".

Imagine a particle or a bug, (which has "Face and Body" I must warn you), was hit by a tornado. Heaven knows, whether it may go up to heaven or may touch down to the ground. At any rate, we must deal with this problem, eventually by quantum mechanics. Did you say why?; this is the chaotic cyclotron resonanse, isn't it?

What if a sneaky "potential" is moving around along the tornado funnel like a worm? Let's suppose the worm changes its shape humpty or skinny, depending upon the x-y-t coordinates. This could be from a light interstitial impurity atom, say H, in Solid State Physics. I don't know how realistic potential about this worm. However, the point is, worm is followed by the connectivity problem of Space. It raises the serious boundary condition

problem from new math. I hope I might make some comment, on Aharonov-Bohm effect for instance, from experimental point of view, taking Topology into account.

§16 The Final View and The Temporal Conclusion

[Fig. 43] shows the backyard view when we've got through the Shot-Gun-Style 2 x 4 Panel Structure. I didn't realize that such a boudless football field was already rolled out. Surprizingly enough, Dr. Einstein is kidding us from that far already! However, either Dr. Einstein or Dr. MØLLER could not be good at Topology.

Dr. Einstein and Poincaré were in friendly terms in 30'. However, it was too premature even for Poincaré to talk about Topology too much. We can be sure at least this point we are studying more Modern Math than these great precursors. To be lucky, the football field appears straight. But where's the End Zone? Do you see it?

The author wishes to conclude temporarily as following;

(1) There are many things left untouched to study the character of Space. Many things got to be "kick'em out and throw'em away". Surely, Dr. Einstein brushed up the Time-axis in Space-Time. However, it is needed for Quantum Mechanics to be shaped up from the Space-Concept. They say, where there is a different space there is a different Quntization. [Ref. 87] Our goal is in Non-Euclidean Space.

The bright boys, they all study math (mess)
 And Albie Einstein points the path (Feynman' s)
 Although he seldom takes air
 We wish to God he'd cut his hair

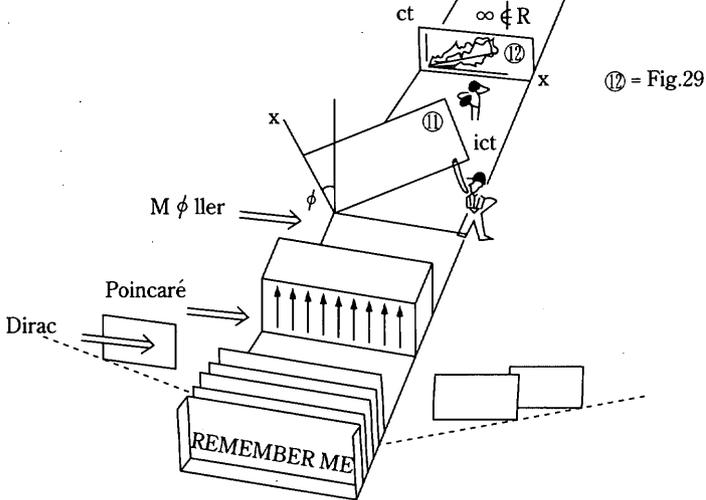


Fig. 43 This is the summary of this work. No. 3. The author's desire is just to find a glimpse of the way which maybe able to lead us to a goal through the entangled forest and/or the Fog.

(2) In order to make break through, we need to study New Math, and/or Topology. For this purpose, American (and Japanese) should over come our French Allergy. The Reasons for this neighbouring two nations have got this same disease are different, but the "Results are the same". You know, the era of the simple minded causality i.e., "Different causes get to the different results, vice versa" is gone forever.

One of the unconscious reason why they hated Chaos and Topology was its French flavor. The man said ;

“But he might as well have told a gathering of paleontologists that dinosaur had feathers. They knew better”. “When I said that? Jee-sus-Christ, the audience began to bounce up and down. It was, ‘My daddy played with the Duffing equation, and nobody seen anything like what you’re talking about.’ You would really run across resistance to the notion that nature is complicated. What I didn’t understand was the HOSTILITY.”! [Ref. 89]

I guess I know it is Mr. Mark Twain who provoked American Patriotism; “A French laught at American people, saying——Americans spend most of Time, figuring about what was my grandpa? ——Mark Twain replied——Frenchs spend most of his Time, thinking about who was my daddy?” All right! Let me finish up this Raku-Go (落語: Japanese classical one-man-story-telling show);

“American laugh at Japanese people, saying——Japanese spends most of his Time, thinking about who is this kid’s father?” Ok? This IS the dialectics! And your malady is gone! I hope.

The origin of Japanese French Complex is just historical. For the “Civil War” or the “Revolution”, what ever heck you may call it, British backed up Anti-Edo Rioters, while French backed up the Old Edo’s Woodenheads. After that, all thru to the end of Pacific War, *Everything* went under the stupid controll. That’s all!

Due to This Complex, majority of Japanese, including Professors, believe in that the “French Culture” is to drink Nouveau-Beaujolais, just to get alcoholic, and to EAT at ★★☆☆ (quatre étoiles; I repeat, Four Stars!) Hotel and Restaurant!

(3) *In Appendix I*; A New Principle which can replace the Huygens' Principle is presented. Actually, Mr. Huygens was 17th century's man (1629-1695). It is an amazing surprize that books of Modern Optics still starts from such an ancient myth. Has anyone ever read his original article, which is supposedly appeared on "C. Huygens : Traite de la Lumière, Leyden, 1690" ? [No paginal citation] **[Ref. 91]**

Look, Sir Isaac Newton (1642-1727) was the contemporary with Mr. Huygens. What did he say about Huygens secondary wave principle? I don't have time to go back that far!

In Appendix II; The root of the fairy tale of "Young's Fringe" is presented, for "The First Time". It must be an interesting discovery that Professor Young showed the Young's Fringe **[Ref. 91]**, BEFORE any silver photo plate was invented by Monsieur L. J. M. Daguerre (1789-1851) **[Ref. 31, and 92]**. Needless to say, it took more than half an hour exposure for the primitive silver plate. The date of Finish-up of the method is formally recorded as of 1838. While, Professor Young's "Bakerian Lecture" was presented on November 12, 1801.

Incidentally, it is Mr. Eastman who started to improve the dry-glass-plate, on 1880, at Rochester, NY. The combination of his "American Film" and "Kodak Camera" rolled up the world, untill Japan island. They could fool Europeans. But they can not fool Japanese, (maybe nor Americans). They've forgot of "Jap likes Camera!"

All the Japanese experimentalist knew that it is "impossible to reproduce the Young's Fringe" in his laboratory, provided that he is a honest-and-dili-

gent Experimentalist of Optics. It was only after the He-Ne laser was invented when they could see the Young's Fringe through His primitive "Double Slit".

Then what was the "Plate-I" that Professor Thomas Young had shown to the people at the Bakerian Lecture, on November 12, 1801? You will find an interesting story in Appendix II, and you will say "Who affraids of Born-wolf?" Professor Thomas Young appears to be an Theorist, by the way. [Ref. 93]

In Appendix III, you will find a very elemental application of the Laplace-Heaviside Transformation. This is just to show J-TSSP that we can feel electrons without touching or capturing. This is the simplest common knowledge for the Photo-conductivity experimentalists.

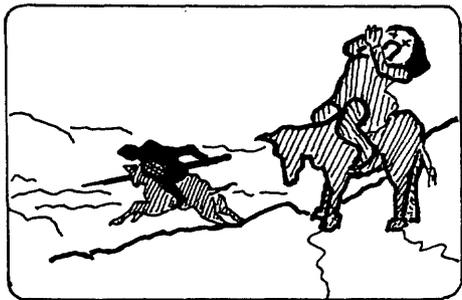
In Appendix IV, the well twice-told story in many textbook that "The Photo-emission of an electron is the Top-Strongest-Evidence to demonstrate that the Light can be A Quantum (named PHOTON)" is Not necessarily true! You may wonder "How about Dr. Einstein himself, then?" It is his slip on the chance, I might reply! Every body slips, you know. Why not for Dr. Einstein?

In Appendix V, Some birth story of PHOTON is introduced.

ACKNOWLEDGMENT :

Thank you very much for your long-long patience to read up to here! This

should be my Final Part for Destructive Work ; I hope. [hiizu : March 28, 1998]



Domia

The last moment
I saw the man
of La Mancha.

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● Appendix I : An Estimation of Phase Delay

In this Appendix, author shows how much phase lag will be generated between the center and the edge of the wave front, after the plane electromagnetic waves have past through open space of the classical metal channel. Let's think about two typical cases ;

- (1) E vector is parallel to the surface, [Fig. A-1-(1)]
- (2) E vector is perpendicular to the surface, [Fig. A-1-(2)]

Actually, the [Fig. A-1] is the reproduction of [Fig. 14-10, in Ref.90, "ANTENNA"]

Case (1) : This is what they call "E-Plane Type, or TE₀₁ of metal-plate lens". This problem is already solved completely, and nicely. [Ref. 90 ;

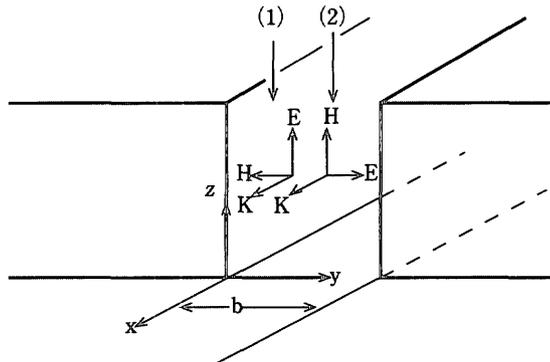


Fig. A-1, -(1), -(2)

The schematic layout of the "Exit section of the Optical Slit".

(1) is the case that E-Vector is parallel to the "Wall" of the Knife-Edge.

(2) is the case that E-Vector is perpendicular to the "Wall".

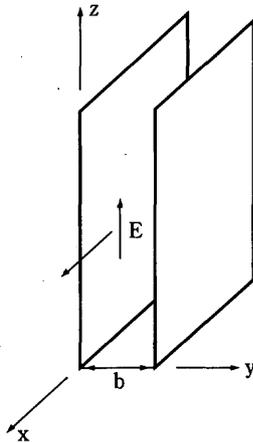


Fig.14.10 Wave between plates in *E*-plane type of metal-plate lens

Fig. A-1, -(1)

For this case, a thorough analysis were performed by the "Microwave peoples". (cf. Ref. 90)

§14-4, pp. 673-674, cf. Fig. 14-10]. This is the case for a "wave guide", and the wave-velocity through the lens, ends up with ;

$$V = V_0 / [1 - (\lambda_0 / 2b)^2]^{1/2} \dots \text{eq.(1) in Ref. 90.}$$

Surprisingly enough, the numerical results of this CLASSICAL equation shows that the electromagnetic waves cannot get through the channel, if their wavelengths were longer than the Half of the channel width, $b/2$, which is known as the cut off wavelength. This "Channel Effect" is shown numerically on [Fig. A-2], which is the reproduction of [Ref. 90, Fig. 14-11]. However, there is no change for the light velocity, if the spacing is greater than 2λ , as shown in the same Figure. I'll be back soon at this spot.

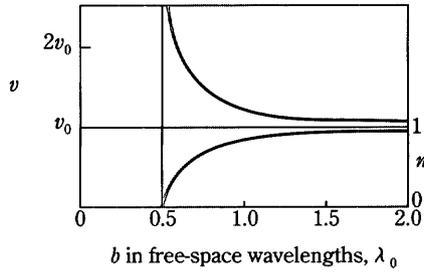


Fig.14.11 Velocity v of wave between parallel plates and equivalent index of refraction n as a function of spacing b between plates.

Fig. A-2

There is a “Cut-off wavelength” for the above “E-parallel vector case”.

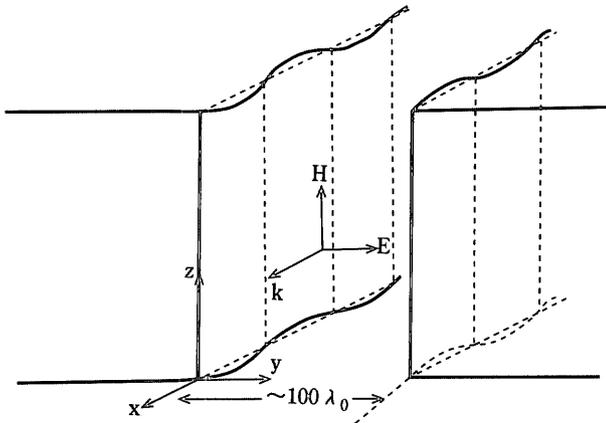


Fig. A-3-(1)

The schematic layout of the E-perpendicular case. The wavy effect on the Knife-edge wall is exaggerated, and supposed to be sinusoidal.

Case (2) : This is the case, which author wants to stress. “The Reality of the Optical Slit is the Optical channel”, as is stated repeatedly in the text, is shown on **[Fig. A-3-(1)]**, rather exaggeratedly.

[Fig. A-3-(2)] is the further exaggeratedly blown-up surface conditions of the side wall of the optical slit (channel). This is the essential point of arguments of Appendix I. As I said repeatedly before, you will see this surface if you would down-sized yourself to the near-wavelength dimension. But still, this is the problem of “Classical Electrodynamics”, I believe.

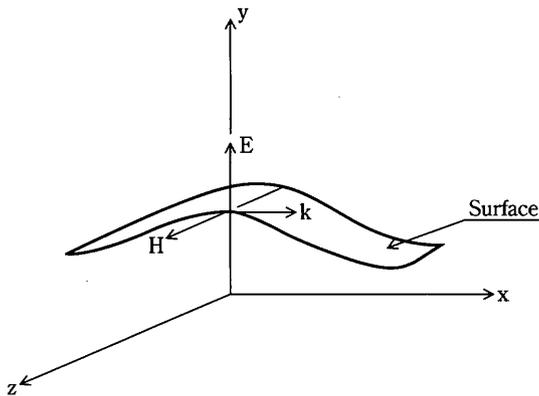


Fig. A-3-(2)

The Figure shows the boundary effect of the Sinusoidal surface to the E-perpendicular electro-magnetic wave.

[Fig. A-4] is the simplified “Boundary-Condition Problem” for calculation. You know, the point is, the E-vector at-on the surface got to be always Normal to the surface. Therefore, the k-vector of the light at-on the surface is flickering up-and-down, like the light emitted from the Wiggler within the Storage-Ring.

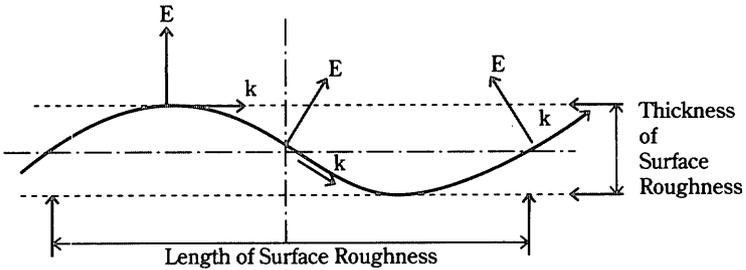


Fig. A-4

The boundary effect of the sinusoidal surface to the E-perpendicular light wave is shown in the exaggerated fashion.

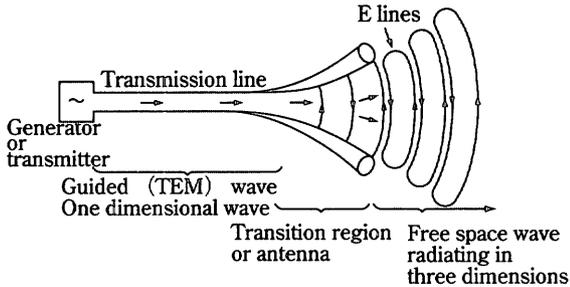


Fig.2.1 The antenna is a region of transition between a wave guided by a transmission line and a free-space wave. The transmission line conductor separation is a small fraction of a wavelength while the separation at the open end of the transition region or antenna may be many wavelengths. More generally, *an antenna interfaces between electrons on conductors and photons in space*. The eye is another such device.

Fig. A-5

The hint was came from the “Transition region or Antenna” region. The E-vector must be perpendicular to the surface of the Antenna.

Actually, this is not-so-modern problem, and the ANTENNA people "knew it better". I'll show you the simplest lay out of Their-Idea, on [Fig. A-5 : Ref. 90, ANTENNA, p. 19, Fig. 2.1] This shows, how the electro-magnetic waves can be emitted from the Horn-Antenna into Free Space.

In [Fig. A-6], I'll show you the extended-idea that I borrowed from the Antenna people. I guess, the physical origin of the Diffraction became obvious, except T-JSSP, probably !

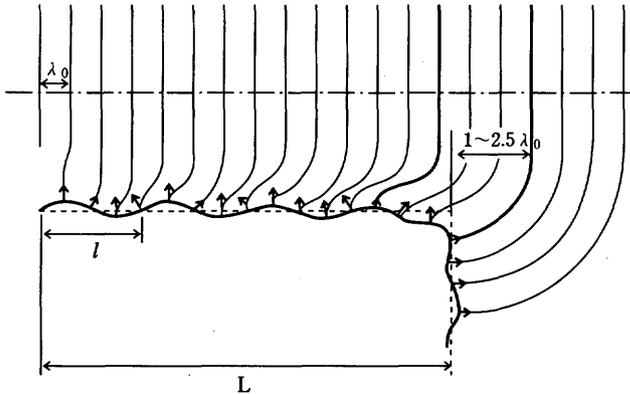


Fig. A-6

An example of the "Surface-effect" calculation. The parameters are ; Surface Roughness = $\lambda/4$
 $l/L=2$. Then, we obtained, the phase delay at the exit surface, $\Delta\lambda \sim 2.5$ (as shown). In the text, we've got another number, i.e., ~ 20 .

Once the model for calculation were got set, like [Fig. A-4], then it is the matter of hi-school calculation.

● Hi-school Calculation :

To begin with, the idea is, the k -vector at-on the surface must slide along the surface, as shown in [Fig. A-4]. The length (s) for the k -vector at-on the surface to go must be longer than another k -vectors within the free space of the channel. Therefore, we need to estimate the length of the line along the surface. This is the very elemental problem for differential geometry.

The integral starts at the Pythagoras's principle as shown in [Fig. A-7]

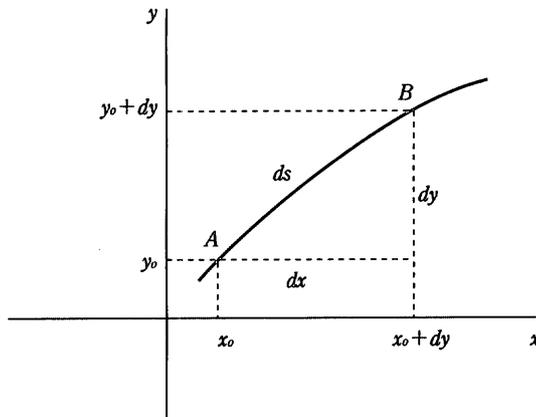


Fig. A-7
The primitive start-line for the Length calculus.

Since, $s ds = i dx + j dy$, where, (s) is the unit vector along the line.

$ds^2 = dx^2 + dy^2$, we get

$${}_A \int^B ds = {}_{A(x)} \int^{B(x)} dx [1 + (dy/dx)^2]^{1/2}, \text{ now we need } y(x).$$

[Fig. A-8] shows the model of the channel surface, where ;

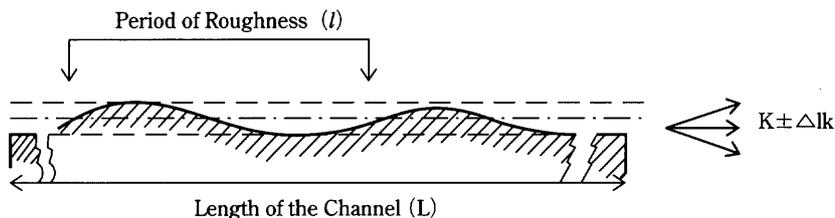


Fig. A-8

The concept of "Surface roughness" and the resulted origin for the "Degradation of coherence to the partially coherence".

[L]; the thickness of the knife edge of the optical slit, or the length of the optical channel, for our terminology.

[l]; period of the surface flatness, which we assume to be sinusoidal.

[a]; the amplitude of the flatness function, which is stated in a work order, such as "Finish it up, within the accuracy of $1/4\lambda$, or such as $1/10\lambda$ "

For our case, the flatness function is employed as ;

$$Y(x) = a \cdot \sin(2\pi x/l) + a.$$

The rest of the calculation is straight forward, and we get,

$$s = \int_A^B dx = l + \Delta l, \quad \text{finally we get,}$$

$$\Delta l = (\pi a)^2 / l.$$

Numerical assumptions :

$$L = 100 \mu\text{m} = 0.1 \text{ mm} \quad \lambda = 5000 \text{ \AA} \text{ (green color),} \quad a = \lambda/4 = 1250 \text{ \AA.}$$

$$l = 1 \mu$$

Then, simply putting these numerals into Δl equation, we get finally,

$$\Delta l = \pi^2 (\lambda/4)^2 / 2\lambda = 9.86 \times (\lambda/4)^2 / (2\lambda) = 10 \times \lambda / 32 \sim 0.3\lambda$$

$$\Delta l = (L/l) \cdot 0.3\lambda \sim 100 \times 0.3\lambda = 30\lambda.$$

Conclusion.

There will be, roughly speaking, always “The Phase Delay” of the order of about “10-wavelength-equivalent-retardation”, between the wavefront that past near the center of the open space of the slit, and these that swept through near the surface of the knife-edges of the optical slit. [Fig. A-9] shows “qualitatively” how light diffracts, due to the boundary effects. “Please feel free, if anyone wants to complete more RIGOUROUS results, by this PRINCIPLE”!

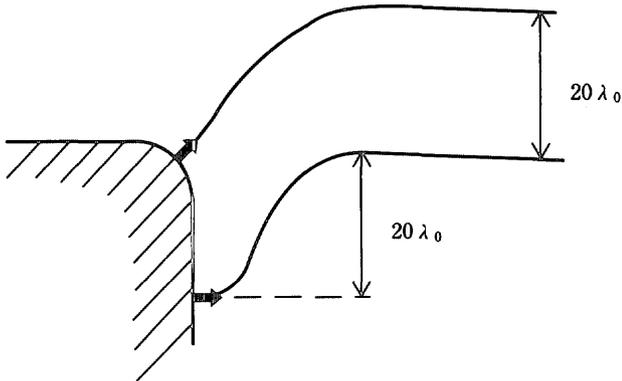


Fig. A-9

The result of the Phase-Delay ; about 20λ .

Dr. Max Born and Emil Wolf are saying even in their Sixth Edition, of “Principles of Optics” [Ref. 91, cf. § 8.9, p. 449];

“If the edge of a diffracting aperture or obstacle is observed from points within the geometrical shadow, it appears luminous. This was already known to Thomas Young who attempted, PRIOR TO FRESNEL, to explain diffraction, on wave theoretical basis. Young believed that the incident light undergoes a kind of reflection at the edge of the diffracting body, and he regarded the diffraction pattern as arising from the interference of the incident wave and the reflected “boundary wave”. However, Young’s view was expressed in a qualitative manner only and did not gain much recognition.

That Young’s theory contained an element of truth became evident after SOMMERFELD in 1894 obtained a rigorous solution for diffraction of plane waves by a semi-infinite reflecting screen (see § 11.5).”

All right! When you look into the RIGOROUS SOLUTION, darn-it!, you’ll find The Rigorous couldn’t beat The Saints! [Ref. 92] What’s more, the dumbski Experimental-JSSPs are disclosing their desperate ignorance of Reflection-and-Diffraction. The author believes, this is because the above cited idea have “gained too much recognition”, by T-JSSP. There are hell amount of their commentary on experimental results for AB-Effect. I may be back to this point soon, I hope.

In this very sense, Dr. Feynman was perfectly right, that “One thing I never did learn was contour integration”! [Ref. 78, A Different Box of Tools] However, it is interesting too much to hear, Dr. Feynman OKed for AB-article, while Dr. Mott, didn’t-ok, after all!

As the final comment for this Appendix, The author suggests to kick'em-out Huygens-Principle from optics at this spot. I told you "principle can be replaced when one can place the better". I would suggest to call it, as "Enrico Fermi Principle". You know, this is a "Bouncing Particle Problem between the two walls", which had read us to Chaos and the origing for the Cosmic-rays problem. You may name it "Ulam Principle", if you want. However, Dr. Fermi's name will get "much recognition"! Thank you for your patience, but still more left!

● Appendix II : Young's Fringe was not Young's.

This Appendix will be too pleasant for Americans to read. It will be too hurtful for Japanese Theoretical-and-Experimental Physicists to hear. (They hate to READ my articles, any way.)

Beginning from the conclusion, I must say, Professor Thomas Young had succeeded in taking "A PLATE", before Monsieur L. J. M. Daguerre completed the Photo-Plate [Ref. 93]; provided that, the photograph which is shown in "Principles of Optics"; Max Born & Emil Wolf, Sixth Edition, on page between p. 260 and p. 261, Fig. 7.4, were taken by Dr. T. Young himself. (I mean by "himself", includinghis staffs.)

Once upon a time, I bought a copy of the famous book, at Follett's bookstore which was located at Green-Wright, Champaign, Illinois. When I found the beautiful photo of the "Young's fringe", I felt a sense of full respect to the Thickness of the Pile of the Tradition for Science. But now, I must confess, that my pendulum is swifiting to the other side with the maximum speed.

I began to feel something weird of this Photo. The reasons are as following :

- (1) There is no figure caption. It says just "Fig. 7.4. Young's fringes."
- (2) There are only 8-black lines and 9-grey lines ; without fading area.
- (3) There is not a word for Fig. 7.4 in the text ; except on page 261, saying, "The interference pattern in the immediate vicinity of O thus consists of bright and dark bands called interference fringes (Fig. 7.4)".
- (4) There is, surely, the World Famous Double-Slit Arrangement (layout) on p. 260. However, about 20 years after this encounter at Illinois, I met again my Hi-school teacher, whose name was Hachiro Nakagome. He became a scientific photographer after he retired ; who takes photos such as milk-crown and so on. On the occasion, he said "I could not find any photo for The Young's Fringes. Finally I succeeded in by employing the He-Ne laser light. It is almost impossible to do by employing the conventional light source". I knew there is one in Born · Wolf, and the photographs which are shown on pages between p. 516 and p. 517, which were obtained by B. J. Thompson and E. Wolf, under the microscope. These are my favorite and respecting pictures.

I did not comment at all these things to my old teacher, trying to save his pride as a craftman-spirit. When I began to write this small work, I found the Soft-Cover Born · Wolf at the book center near Tokyo Station. That is the Sixth (corrected) Edition. By a nostalgic quick looking through the book, I found the citation for "Thomas Young" which were changed from Italic to Bold-print. So, I got the bite at it. **[Fig. A-10] [Ref. 94]** I sent a request to get a copy, and I got them after couple of week. (雉も鳴かずば撃たれまい)

⇒ I opened the package, and I saw it. Oh dear! It was NOT the article. It turn out to be a lecture that the book cited. The content of it is as follow [Ref. 95]

《The Bakerian Lecture. On the Theory of Light and Colours.

By Thomas Young, M. D. F. R. S. Professor of Natural Philosophy in the Royal Institution.

Read November 12, 1801.》

That YOUNG's theory contained an element of truth became evident after SOMMERFELD in 1894 obtained a rigorous solution for the diffraction of plane waves by a plane, semi-infinite reflecting screen (see § 11.5). This solution shows that in the geometrical shadow the light is propagated in the form of a cylindrical wave that appears to proceed from the edge of the screen, whilst in the illuminated region it is represented as superposition of the cylindrical wave and of the original incident wave.

The question arises whether also under more general conditions diffraction can be accounted for as the combined effect of an incident wave and a boundary wave. This problem had been investigated before the appearance of SOMMERFELD's paper by MAGGI, § but his results appear to have been forgotten. It was later investigated independently and much more fully by RUBINOWICZ. || The MAGGI-RUBINOWICZ theory was developed further by MIYAMOTO and WOLF. ¶

Consider a monochromatic light wave from a point source P_0 propagated through

* For discussions of this point see also A. RUBINOWICZ, *Phys. Rev.*, 54 (1938), 931; and C. J. BOUWKAMP, *Physica*, 7 (1940), 485.

† G. W. FARNELL, *Canad. J. Phys.*, 36 (1958), 935.

‡ THOMAS YOUNG, *Phil. Trans. Roy. Soc.*, 92 (1802), 26.

§ G. A. MAGGI, *Annali di Matem.* (2), 16 (1888), 21. MAGGI's analysis is also discussed in a paper by F. KOTTLER, *Ann. d. Physik*, (4), 70 (1923), 413; and in B. B. BAKER and E. T. COPSON, *The Mathematical Theory of Huygens' Principle* (Oxford, Clarendon Press, 1950, 2nd ed.), p. 74.

¶ Experimental evidence for the "existence" of the boundary wave was found by W. WIEN, *Inaug. Diss.*, Berlin, 1886; E. MAEY, *Ann. d. Physik*, (9), 49 (1893), 69; and A. KALASCHNIKOW, *Journ. Russ. Phys. Chem. Ges.*, 44 (1912), *Phys. Teil*, 133. See also S. BANERJI, *Phil. Mag.* (6),

JICST資料番号	巻	号	ページ	発行年	X
資料名	Phil. Trans. Roy. Soc. vol. 92, p. 26 (1802)			1802	
題文名	非常な面白い本籍の、入るべきの Fig. Photo 2 是非と云々、Thomas Young			著者名	Thomas Young
申込み上の注意					

Fig. A-10

A literal roots for the "Young's double slit".

Actually, this work appeared on 1802, for one thing, and the page 26, which is printed by the bold style in the reference of the book, was included this work which covers from page 12 through 48, for another. Let's look into the page 26, then.

Voilà! In the middle of the page 26, we see "Fig. I (Plate I)"! What sort of the plate could it be? Don't even imagine that it can be an OHP sheet, nor 2 by 2 inches slides for a Kodak projector.

As you may see in [Fig. A-10], I stressed to get the "Original Picture" of Young's Fringe Picture, if any. Please don't miss the point. "There was NO picture at all".

I've read through the Lecture from page 1 through page 26. My conclusion is; Professor Thomas Young was talking about his THEORY on The Wave Character, by picking up here and there from The Great Newton's patch of the speech and/or letters and so forth, so that Prof. Young's opinion should not appear to contradict to Great Newton!

The Figure Caption for the picture said, "Fig. 7.4, Young's fringes". It did NOT say, "Professor Young's Experimental Results". All the Professor's men of Japanese thought; "This is Professor Young's Experimental Fringes".

To deceive is virtue! To be deceived is sin!

The next question is, "What is this then?"

All right. I will answer the question;

This is the artificially painted, "State of the Art of those days!" Evidence? You said you need evidence? You don't believe in the history of Plate and Camera? OK. Just make an expanded copy, or try to make copies step by step, by any copy machine. Then you will find the CONTRASTS are just three steps: Black, Grey, and White.

Before finishing up this disgusting story, let me show you a bit more, honest text book. That is Dr. Ditchburn, University of Reading. [Ref. 96] On page 123, Dr. Ditchburn says;

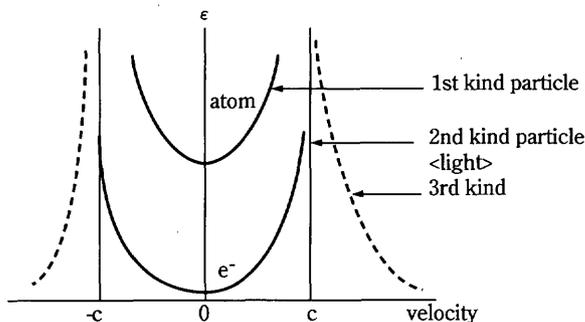
"In any modern repetitions of Young's or Grimaldi's experiments, a medium power eyepiece would be used to view the fringes". A HA! Professor Young, saw the fringes by A magnifier. And he made the drawing; it's not so interesting enough that Capalletti did the same way to Draw-up MARS.

You can call it "Ohm's law". Nobody would imagine, that is the Dr. Ohm's Data. Because, everybody knows "Law is not the Common Noun". I bet you agree to join me, "Who affraids of Born·Wolf?"

● Appendix III : A Formula for The de Broglie Wave

Readers may agree that PHYSICS is invented not only to study and to apply for humble matters of the human life. Non, Non, Non! Physics can be USED to ENJOY by itself. The best way to enjoy, is to make a treaty with Demons, I guess. The most famous demon that living within the shadow of Dr. Einsein is "Tachyon". Tachyon physics sounds like a "Simple Nonsense", but it is useful for some case.

They say, there are 3-kind of particles in this world; The 1st kind, the 2nd kind, and the 3rd kind particles. They claim, this 3rd kind particle is Tachyon. I will clap hands, when they observed Tachyon. However, the clapping day appears to come on some time, far-far-beyond, over 21st Century.



However, if you pay a look at Fig. A-11, you would FEEL there is "Something Reasonable". What they say is as following ["Super High Speed Particle-Tachyon" S. Homma; Blue Backs, 1982, (in Japanese)];

"In the Figure A-11, the 1st-kind particle is the Common particle. Their Energy-Momentum (speed) relation is determined by the Einstein Relation,

$$E = m_0 C^2 / \{1 - (V/C)^2\}^{1/2};$$

the velocity (V) can never be "C". [because this is the 1st kind particle]

Meanwhile, the "Light itself" is always, "V=C".

Light velocity cannot be any other value but "C in the vacuum, because this is the 2nd kind particle".

They claim, the Einstein Relation can be satisfied if the mass (m) were set to "Pure Imaginary (im)". Then the equation becomes

$$E = im_0 C^2 / i \{1 - (V/C)^2\}^{1/2}. \text{ ("Why not ?")}$$

Well, let's put aside the 3rd kind particle, and pay a good attention on the 1st and 2nd kind particle. "The Matter Wave or the de Broglie Wave" must be associated with the 1st kind. Shall we go with the best care on this point ?

Starting from the Einstein's Relation, i. e.,

$$\epsilon^2 - p^2 C^2 = m_0^2 C^4,$$

we get to $2\epsilon \cdot d\epsilon - 2p \cdot dp \cdot C^2 = 0.$

Then, we have $\partial\epsilon/\partial p = pC^2/\epsilon.$

Let's define the following notations;

$V (g. d)$: group velocity of de Broglie wave (matter wave)

$V (p. d)$: phase velocity of de Broglie wave

$V m$: mass velocity of particle (experimentally observable)

Again, let's assume the following theoretical relations do hold ;

$$\partial\varepsilon/\partial p = V(g \cdot d) \cdots \cdots (A-5-1)$$

$$\varepsilon/p = V(p \cdot d) \cdots \cdots (A-5-2)$$

Also, let's call for the following relations for the waves. (call these as Formulae or as Principle, if you want)

$$V(p \cdot d) = \nu_d \cdot \lambda_d \cdots \cdots (A-5-3)$$

[Note: "p" stands for "phase", and "d" stands for de Broglie], and

$$\varepsilon = h\nu_d \cdots \cdots (A-5-4)$$

Then we get altogether,

$$\begin{aligned} pC^2/\varepsilon &= pC^2/h\nu_d = V(g \cdot d) \quad \text{【due to A-5-1】} \\ &= (V(g \cdot d)/V(p \cdot d)) \cdot V(p \cdot d) \\ &= (V(g \cdot d)/V(p \cdot d)) \cdot \nu_d \cdot \lambda_d \quad \text{【due to A-5-3】} \end{aligned}$$

$$\therefore (p/h) = (\nu_d/C^2) \cdot (V(g \cdot d)/V(p \cdot d)) \cdot \nu_d \cdot \lambda_d$$

$$\begin{aligned} \therefore (h/p) &= (C^2/(\nu^2 d \cdot \lambda d)) \cdot (V(p \cdot d)/V(g \cdot d)) \\ &= [C^2/(V(p \cdot d)/\lambda d)^2 \cdot \lambda d] (V(p \cdot d)/V(g \cdot d)) \quad \text{【due to A-5-3】} \\ &= (C/V(p \cdot d))^2 \cdot \lambda d \cdot (V(p \cdot d)/V(g \cdot d)) \end{aligned}$$

$$\therefore \lambda d = (V(g \cdot d)/V(p \cdot d)) \cdot (V(p \cdot d)/C)^2 \cdot (h/p)$$

Many people put $V(g \cdot d) = V(p \cdot d) = C$ into the above equation, and get

$$\therefore \lambda d = h/p.$$

However, let's proceed with a bit of care. Another words, let's assume that the 1st kind particle can never be able to get to C. By putting

$$\begin{aligned} p &= (m_0 V_m) \cdot [1 / \{1 - (V_m/C)^2\}^{1/2}] \text{ we obtain,} \\ \lambda d &= (V (g \cdot d) / V(p \cdot d)) (V(p \cdot d) / c)^2 (h / m_0 V_m) \{1 - (V_m/C)^2\}^{1/2} \\ &= (V (g \cdot d) / V (p \cdot d)) (V (p \cdot d) / c)^2 (h / m_0 c) [1 / (V_m/c)] \{1 - (V_m/c)^2\}^{1/2} \end{aligned} \quad (qe\delta)$$

● Appendix IV : The Photo-Electrons : These Untouchables

As shown in [Fig. 20], the transient electric current due to displacement of photo-electrons within the crystal is "OBSERVABLE" by the Blocking electrode circuitry. This is a simple matter of classical electrodynamics. This can be solved by employing the Laplace-Heavisides' Transformation. The Hi-school calculation goes as following;

Let's assume that the starting equation is well represented by [eq. A-1], the primitive Lorentz equation;

$$m \cdot dv/dt - (e/c)[v \times H] + m \cdot v \cdot (1/\tau) = eE. \quad [\text{Ref. 45}] \cdots \cdots [\text{eq A-1}]$$

Where, m is the Effective Mass of an electron within the Crystal, v is the electron's Particle Velocity, which in turn related with Electric current J , shch a way as,

$$J = \sigma E = nev.$$

τ is the relaxation time for scattering

And $H=0$, for the photoconductivity measurements.

Let's rewrite the equation into simpler equation which has the mathematical flavour, then, it maybe written down as following ;

$m \cdot dY/dt + m \cdot Y \cdot (1/\tau) = eE$. This should be Transformed as,

$$m \cdot s \cdot Y(s) + (m/\tau) \cdot Y(s) = eE \cdot (1/s).$$

The Laplace tranformation of dy/dt and y itself is ; **[Ref. 97]**

Knowing, $L \{f'(t)\} = sF(s) - f(0)$, $L(K) = K/s$, the equation becomes,

$$(m \cdot s + m/\tau) \cdot Y(s) = eE/s.$$

$$\therefore Y(s) = (eE/m) \{1/s(s + 1/\tau)\}$$

which in turn, by employing the back Transformation as, **[Ref. 98]**

$$L \{Y(s)\} = L \{1/s(s-a)\} = A(\exp at) + K$$

where $A = 1/a$, $K = -1/a$.

We get finally,

$$v = (eE/m) \{-\tau \cdot \exp (t/\tau) - \tau\} = -\tau(eE/m) \{1 - \exp t/\tau\}$$

This is exactly the same equation that represents the "Photo-current

pulse”; which we observed and employed to analyse the data so that we should get the “microscopic mobility $(e/m) \cdot \tau$ ”.

In Case, you want to find the solution for the “Drifted Length (shubweg)” of an electron, you might start from the other way :

Starting from the Lorentz equation,

$$m \cdot dV/dt = eE + e/c[V \times H] - mV(1/\tau),$$

and $H=0$, we have ;

$$m \cdot d^2y/dt^2 + m \cdot dy/dt(1/\tau) = eE, \text{ which is transformed}$$

$$m \{s^2 \cdot Y(s) - s \cdot Y(0) - Y'(0)\} + m \cdot sY(s)1/\tau = eEK/s$$

with the initial conditions, $Y(0)=0$, and $Y'(0)=1$,

$$\text{we get } Y(s) = \{eE (K+1)/m\} \{1/s^2 (s+1/\tau)\}$$

You can find the answer $s^{-2}(s-a)^{-1} \rightarrow A \exp(at) + K + K_1 t(\text{qed})$

● Appendix V : Who Invented Photon ?

As I've stated at the final moment of this work, I met with a very interesting introductory work written by Professor Shimoda. [Ref. 99] It maybe not NEW at all for the western people, but I have never heard of it in this country. Beginn from the conclusion, Prof. Shimoda said in the article;

"In order to endorse the famous Einstein Relation, $E = h\nu$, Photoelectric Effectt is Not Necessarily good enough evidence." "The Photoelectric Effect can be derived without employing the Concept of Light Quantum". "As far as we understand, the Natural Phenomena that demand the Concept of Light-Quantum are the following FOUR phenomena :

- (1) Plank's Law for heat radiation (1900)
- (2) Compton Effect (1926)
- (3) Natural Emission of Light (1927)
- (4) Lamb-shift of Atom Energy lebel (1947)

There is no room for The Photoelectric Effect".

"The reason that Einstein strongly supported the concept of Light-Quantum for The Photoelectric Effect is just A Historical BY CHANCE. It is unnesecary to employ the concept of Light-Quantum to explain The Photoelectric Effect."

Professor Shimoda left a citation. [Ref. 100] I felt something interesting. I figured this may be related with the long-heard rumor of the World conflict for the Reality of Quantum Mechanics. I know there are unsettled arguments between "Authorized vs Heterodox" peoples. To my eye, however, both seemed to be "Unrealistic". Myself, I feel it maybe fun to stop off and study for a while, on this sort of arguments.

To begin with, I requested the copy of the interesting article, [Ref. 100].

"POLARISATION MATIERE ET RAYONNEMENT"

Volume Jubilaire en L'Honneur D'Alfred Kastler

Edite par La Societe Fransaise de Physique

Press Universitaires de France
108, Boulevard Saint-Germain, Paris 1969

On page 363, there came the Names of the authors;

Willis E. Lamb, Jr. Department of Physics, Yale University.

Marlan O.Scully Department of Physics and Material Science Center
Massachusetts Institute of Technology.

Incidentally, Prof. Shimoda said he knew well Prof. Scully as a contemporary research people on Laser; they were the frontiers of the laser development. Dr. Shimoda was Member of The Cyclotron development group at Dr. Nishina's group, and I'd suppose he shared the Electric-Oscillator section for providing energy into "D" sections. In the war-time he was engaged in the Rader Development for NAVY.

To my knowledge, Dr. Shimoda was the only scientist who made a practically successful gear during the War: the marine rader. I've forgot the effective range, but I remember it provided only 15 minutes margine for the crew. On 16 minuts later, they should be under the shower of dive-bombers!

At any rate, Dr. Shimoda moved to Tokyo University, and I sneaked in his class to learn Microwave-Electromagnetics. Then, I suppose he moved to the Maser-research, and bacame good at the Electron-Transition problem. So, his comment must be reliable one.

However, when I began to read the article above, I soon realized this article was handling the problem by employing "The Time-dependent purtervation". I expected to find the pure classical method solution such as Laplace-Heaviside transformation.

The difficulty to employ the 2nd-quantization for Chaos was already pointed out in Zaslavsky's book. [Ref. 60] This is just my feeling, but the real Duel would be happen between The 2nd quantization vs Chaotic method.

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- ⑨6 Ditchburn R. W. “LIGHT”, vol. 1, p. 122, §5.6, Fig. 5.2; Interscience Publisher, A division of John Wiley, Soft cover, 1964, pp. 122-123.

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