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THE ROLEX AWARDS FOR ENTERPRISE 1981

OFFICIAL APPLICATION FORM

SECTION 1

Name of Applicant: (Mr/Mrs/Miss) HARIDAS

First Names HANS

Address Malaver 1046
1706 HAEDO
Buenos Aires
Argentina

HANS HARIDAS is a pseudonym, under which I wish to appear at all stages of the competition, publicity, publications, etc. My actual name is
JUAN JOAQUIN SCHULZ POQUET

Tel. No. (Day) 659-3806 (Night) the same

Short Title of Project

THE VELOCITY OF LIGHT, -REALLY A UNIVERSAL CONSTANT?

Statement

I declare to the best of my knowledge and belief that all the statements and particulars made with regard to this application are true, and I agree that this application and declaration form the basis of an agreement with Montres Rolex S.A. under the Organization, Rules and Conditions set out for "The Rolex Awards for Enterprise 1981", copy of which I have received together with this Official Application Form. I hereby certify to be the sole and true author of the project submitted herewith and that to the best of my knowledge, there are not third parties' rights infringed.

Signature of Applicant H Haridas (signature) Pseudonym (signature) Actual

Date Buenos Aires
April 17, 1980

(N.B. – Only one Official Application Form may be submitted by any one person or any one group.).

Entries must be typewritten in English only on one side of the pages of the Official Application Form. Every effort should be made to present the project so that it may be judged on the basis of what is written on these sheets. If extra materials seem essential to a full understanding of a proposed project, they may be sent with this Form, and will be kept with this Form by The Secretariat, where they may be consulted by members of The 1981 Selection Committee wishing do do so.

OFFICIAL APPLICATION FORM (continued)

SECTION 2

PERSONAL DETAILS

A. Name Hans Haridas (actual: Juan Joaquín Schulz Poquet)

B. Date of Birth April 4, 1939 see pag. 7

C. Nationality Spaniard

D. Present occupation. Job description and position if applicable.

Manufacturer of Incenses Sticks

E. Education and qualifications, with institutions and dates, where applicable.

Bachellor (High School), Colegio Nacional Mariano Acosta
Buenos Aires, 1956

Industrial Engineer, Universidad Nacional de Bs. As.
Buenos Aires, 1969

Executive of several areas in the Supply Department of
General Motors Argentina S.A., 1969 - 1975

Chief of Purchasing of Hiram Walker S.A., 1975-1979(april)

SECTION 3

PROJECT DESCRIPTION

A. Give a brief description of your project.

A series of optical experimentes intended for checking directly the validity or otherwise, of the basic postulate of Einstein's Special Theory of Relativity.

B. Under what field of Enterprise do you classify this project?
- Applied Sciences and Invention ☒
- Exploration and Discovery ☐
- The Environment ☐

C. Write a detailed description of your proposed or actual project, including a description of any special techniques you might wish to employ. This description should be full enough for The 1981 Selection Committee to be able to judge entries up to the shortlist stage. You may be required to furnish further details if your entry reaches the short list.

Following description, please do not fail to list all enclosures added to your project.

1. Introduction

In my opinion, no difinitive and unchallenged conclusion has been experimentally reached so far regarding the validity of the postulate of the Special Theory of Relativity, claiming the constancy of the velocity of light, whatever the relative movement between source and observer. Rather, the universal acceptance of the Relativity Theory is the outcome of the numerous verifications of its predictions. These results, I understand, cannot be doubted of. However, if doubts do subsist concerning that postulate, this is because it is hardly amenable to human reason, and because the experimentes made for its verification are based on certain hypotheses on the nature of light and its propagation, hypotheses that have not been completely proved either. As a consequence, the interpretation of the phenomena, sought for or found, had a different outcome, according to the hypothesis of the author of the experiment, or the one adopted by his critic.

On the other hand, direct measurement of c, the velocity of light emitted by a source in relative movement with respect to an observer, is encumbered by the difficulty of evidencing any non-constancy of c, which may easily be masked by errors of the measuring procedure; in other words, the accuracy of the method may be insufficient for assessing the velocity of the source and its influence on the velocity of light that is to be measured.

In contrast, the method here proposed differs substantially from these mentioned above: it compares directly, and in the same instant, the velocities of light beams emitted by two sources moving with different velocities with respect to the observer, and tries to evidence their supposedly different velocities, without aiming at measuring these velocities, and without recourse to any phenomenon of interference. In synthesis, it is a cualitative method designed to yield an undoubted "yes" or "no" regarding the question whether the movement of a source alters the velocity of light, and independent from any hypothesis about the nature of light and its propagation.

2. The Project

The project in which I am engaged aims at carrying out a series of experiments comprising two parts; the first group of these is shown schematically in Figure 1 (see annex), and consists of experiments making use of elements shared by all of them, viz.:

- S: Source of 2 beams of light with velocities c+v and c-v respectively (in case c sums up with v, proposition which we want to check).
- R: Unit of beam resolution.
- D: Detector of resolution.
- δ: Beam deviation, which might be used (if so desired) for determining the velocity of light, c
- $\Delta\delta$: Separation of the beam in two single beams; if detected, it would mean NO to the postulate of the invariance of light velocity. (If correctly measured, it will enable us to determine v)

3. Components

Let us first describe the components and fundamentals of this group, and postpone consideration of a further experiment (point 4) which, although responding to the same scheme, makes use of specific devices of resolution and detection.

3.1. Source S: This group is set out for 3 different sources, of differents origin and characteristics:

3.1.1) The most simple: a spectroscopic double-star, to be observed at an instant when it presents itself under the aspect shown in Figure 2. In this case v can reach values of the order of 80 km/sec.

3.1.2) Light from the Sun and the Moon, conveniently combined by means of a semi-mirror (beam splitter) F, to be observed about sunrise or sunset near full moon, as indicated in Figure 3. Here v is the tangential velocity of the Earth's rotation about its axis. For an observer not too far away from the tropics, $v \cong 0.4$ km/sec.

3.1.3) A laser beam, split and combined by means of semi-mirrors; the beams run on opposite paths by a system of rotating and fixed mirrors in such a way that the peripherical velocity of a support, carrier of the rotating mirrors, is added to their own velocity in one case, and substracted in the other case. The device resembles the one used by Majorana* in his experiment for determing the possible variation of c trough the possible variation of wavelenght of light emitted by a moving source; to this end he used, in addition, a Michelson interferometer. From that arrengement I take only the rotor, the principle of which I pass to explain; additional units introduced in my device are described below.

Let v_n be the instantenous velocity of a mirror M (Figure 4) in the direction of its normal; the light, emitted from S with velocity c, will then, after a first reflection on M, arrive at the fixed mirror F with the velocity $c - 2v_n \cos I$, I being the angle of incident with respect to the normal. It is easily seen that after k reflection on the moving mirrors, the light will emerge with velocity

* Q. Majorana, Physical Review XI (5), 411-420; 1918.

$c - 2k \cdot v_n \cdot \cos I$ with reference to a fixed point and considered in the direction of the emerging beam. Now since the plane of M makes an angle α with respect to the radius of the rotor, $v_n = \omega r \cdot \cos\alpha = \pi n \cdot d \cdot \cos\alpha$, where n is the number of revolutions per second, and d the diameter of the circle described by the centers of the moving mirrors. The velocity of emergence will be, after the k^{th} reflection, $c - 2k\pi n d \cos I \cos\alpha$ if the sense of rotation is as indicated in the figure, and $c + \ldots$ in the opposite case.

Let us ~~put a set~~ now put a set of similar mirrors M, but with the opposite inclination, on the under surface of the rotating plate, and have part of the beam, previously split by a semiimirror G, incide on them; we will thus have an arrangement similar to the one shown in Figure 5. In it, A and B refer to the upper and under surface, respectively, separated, of course, by the thickness of the disk. We shall have, then, two emerging rays with velocitys

$$v_A = c - 2k\pi\, n \cdot d \cdot \cos\alpha \cos I = c - v \qquad (1)$$
$$v_B = c + 2k\pi\, n \cdot d \cdot \cos\alpha \cos I = c + v$$

In (1), v will depend on the parametres k, n, d, α, I. Majorana used in his experiment the following values: $k=4$; $n=60/\text{sec}$; $d=38$ cm; $\alpha=29°$ and $I=27°$. If we adopt $k=5$ and $n=500/\text{sec}$, with the remaining parameters unchanged, we shall have

$$v \cong 2 \cdot 5\pi \cdot 500/\text{sec} \cdot 0.38\text{m} \cdot 0.87 \cdot 0.89 \cong 4{,}600 \text{ m/sec} = 4.6 \text{ km/sec}$$

3.2 Unit of Beam Resolution R: To illustrate it schematically, let us refer to the rotating mirrors used by Foucault in his famous determination of the velocity of light, as shown in Figure 6. In it, suppose M to rotate at an angular velocity $\omega = 2\pi n$; after the time $t = R_1/c$ which it takes for the light emitted from S to cover the stretch M-F-M, the mirror will have rotated by an angle $\alpha = \omega t$, so that the beam emerging from M will pass trough D' rather than D, these two points being separated by the distance $\delta = 2\alpha R_2$. Obviously

$$\delta = \frac{4\pi n \cdot R_1 \cdot R_2}{c} \qquad (2)$$

Now in our case we have, instead of a beam with velocity c, two beams with c+v and c-v, respectively. So at D' there will be two images D'_1 and D'_2, separated by the distance

$$\Delta\delta = \delta_1 - \delta_2 = \frac{4\pi n \cdot R_1 \cdot R_2}{c - v} - \frac{4\pi n \cdot R_1 R_2}{c + v} = 4\pi n \cdot R_1 \cdot R_2 \frac{2v}{c^2(1 - v^2/c^2)}$$

which, neglecting v^2/c^2, becomes

$$\Delta\delta = \frac{8\pi n \cdot R_1 \cdot R_2}{c^2} \cdot v \qquad (3)$$

To get an idea of the magnitudes involved, and of the practical possibilities of these formulas, let us assign values to the parameters of equation (3). Remember that Michelson, in his last determinations of the velocity of light, in 1927, used for a mirror an octogonal body rotating at 528 revolutions per second, and had the light cover a distance of more than 70 km between the first and last reflection. It does not appear, therefore, to be unreasonable to adopted $n = 500/\text{sec}$ and $R_1 = R_2 = 10$ km, so that

$$\Delta\delta = \frac{8\pi\, 500 \cdot 100 \text{ km}^2 \cdot v \cdot \text{km/sec}}{\text{sec} \cdot 9 \cdot 10^{10} \text{ km}^2/\text{sec}^2} \cong 140 \cdot 10^{-7} \cdot v \text{ km} = 14 \cdot v(\text{km/sec}) \text{ mm}$$

With these values and the velocities specified for our three double sources, we would have the following first order approximations:

(follows at page 11')

1) Double Stars ($v \sim 80$ km/sec) $\Delta\delta \sim$ 1,120 mm (1.12m)
2) Sun - Moon ($v \sim 0.4$ km/sec) $\Delta\delta \sim$ 5.6 mm
3) Majorana disk ($v \sim 4.6$ km/sec) $\Delta\delta \sim$ 64.4 mm

In practice, we may use for a resolution unit the same rotor which can provide us with the double laser source (3.1.3).

3.3. Detector D: A convenient telescope of high resolution can be made available.

4. Another Convenient Experiment

Still a different approach would be to use an "optical Wheatstone bridge" (Figure 7), comprising the following elements:

L: Dye laser producing ultra short pulses of order 10^{-12} sec.
F: Fixed mirrors suitably orientated.
G: Semi-mirror (beam splitter).
C: Fluorescence cell.
D: Photographic detector

The basic principle is as follows: A micropulse produced by L is split at G and joined anew at C in such a fashion that the two parts, on crossing with each other at C, will excite the cell and can be detected by the photographic camera D. By stating that the two parts will be detected on "meeting", we want to refer to a threshold gate not responsive to one single pulse. Obviously, in view of the extreme shortness of the light pulse, such a device will allow us to gauge with great accuracy the position of C so as to secure the equality of pulse paths in both branches. In fact, if the duration of the pulse is t, its lenght will be $l = c \cdot t = 3 \cdot 10^{11}$ mm/sec $\cdot 10^{-12}$ sec $= 0.3$ mm, and it will be seen that this "band width" is sufficient for detecting a possible shift of the meeting point, which would happen if the pulses in each branch propagated with different velocities. Such a difference can be obtained by placing the dye laser L at the input of our rotor described in 3.1.3. (S in Figure 5).

From Figure 5 we can see that by giving a suitable inclination to the mirrors F_A and F_B, we will get the arrangement shown in Figure 7, in which each of its branches corresponds to one of the sections of Figure 5.

We thus have a "light bridge" with different light velocities, v_A and v_B, in each of its branches (it being understand that this is exactly what we want to test). If this happens, the meeting point will undergo a shift from its original place (obtained by calibration with the system of Fig. 5 at rest), by an amount $\Delta\delta$, which can be calculated as follows:

Let $G\text{-}F_B\text{-}C \equiv R_B$ and $G\text{-}F_A\text{-}C \equiv R_A$ be the light paths for pulses B and A, respectively, at the instant of meeting, and v_B and v_A their velocities, we can state for that instant the equations:

$R_A + R_B = R$ (complete path described by a pulse after emerging at G, until returning there)

$R_A/v_A = R_B/v_B = t$ (time interval between splitting at G and meeting at C)

Solving these equations, we have $R_A = \dfrac{v_A}{v_A + v_B}$

Let

(follows at page 11")

Let $R_o \cong R/2$ be the meeting point for the system at rest; then $\Delta\delta = R_o - R_A = R/2 - R_A$

$$\therefore \Delta\delta = \frac{R}{2} - \frac{v_A}{v_A + v_B} R = R \left(\frac{1}{2} - \frac{v_A}{v_A + v_B} \right)$$

But, according to (1):

$$\begin{matrix} v_A = c - v \\ v_B = c + v \end{matrix} \qquad \therefore \Delta\delta = R\left(\frac{1}{2} - \frac{c-v}{c-v+c+v}\right) \qquad \text{which finally yields}$$

$$\Delta\delta = \frac{R\,v}{2\,c} \qquad (4)$$

If $R_o = 1$ km, and considering that $v = 4.6$ km/sec, as result from 3.1.3., we find

$$\Delta\delta = \frac{R\,v}{2\,c} = \frac{2 \text{ km } 4.6 \text{ km/sec}}{2 \cdot 3 \cdot 10^5 \text{ km/sec}} = 1.5 \cdot 10^{-5} \text{km} = 15 \text{ mm}$$

Note that this $\Delta\delta$ represents the shift with respect to the geometrical center C. If our disk is rotated first in a sense and then in the opposite one, we will obtain a shift twice as large, namely $2\Delta\delta = 30$ mm. Comparing this shift with the "pulse width" (0.3mm), we see that is 100 times greater, thus enabling us to obtain a perfect detection, even if we push the magnitudes of R and v down to values more practicable than those adopted above.

5. <u>Conclusion</u>

From the different values which $\Delta\delta$ would adopt according to 3.2 for the group of the first three experiments, and according to 4. for the last, it is evident that there is a broad margin for reducing the values shown for the parameters involved in its diverse formulas.

For a final decision on the values to be adopted, we will have to take into account the practical limitations imposed by the equipment and devices available, both fundamental and accesory, provided that the appropriate standards of precision can be secured in order to exclude any doubts on the results.

In view of the diversity of light sources and of the types of relative movement between the sources and the observer, as suggested in the different sections above, I consider it convenient, and even necessary, that experiments be carried out incorporating each of those alternatives, as well as any further arrangement that may come up.

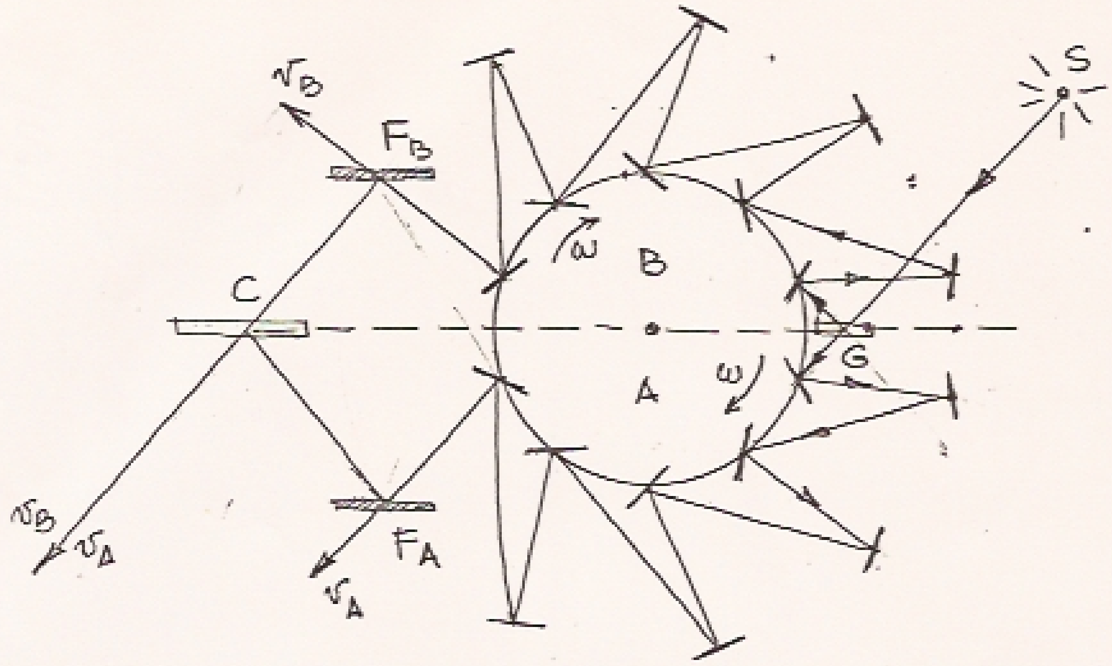

Fig. 5

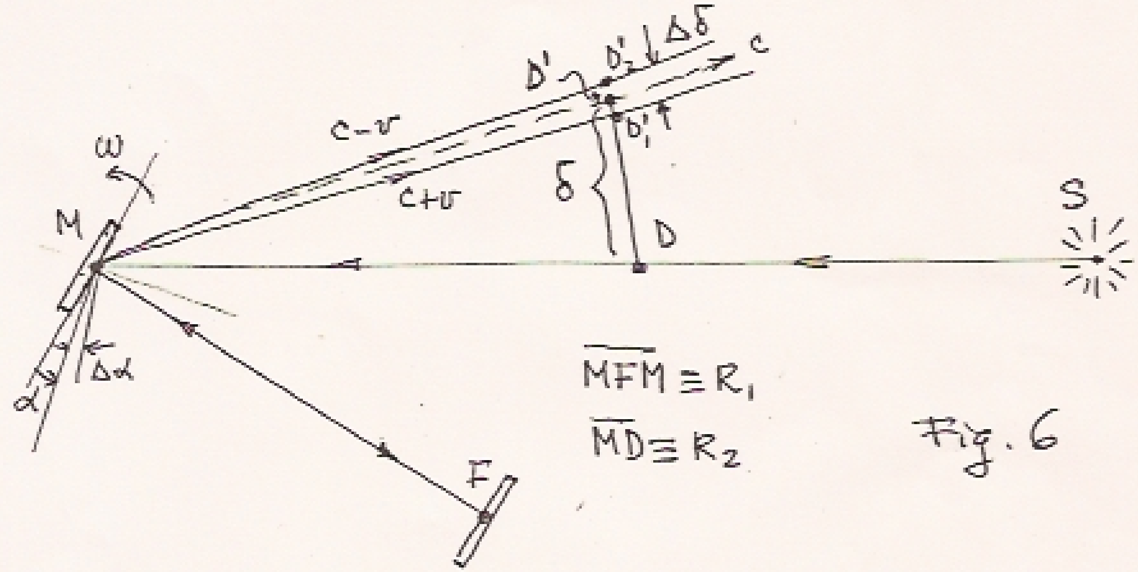

Fig. 6

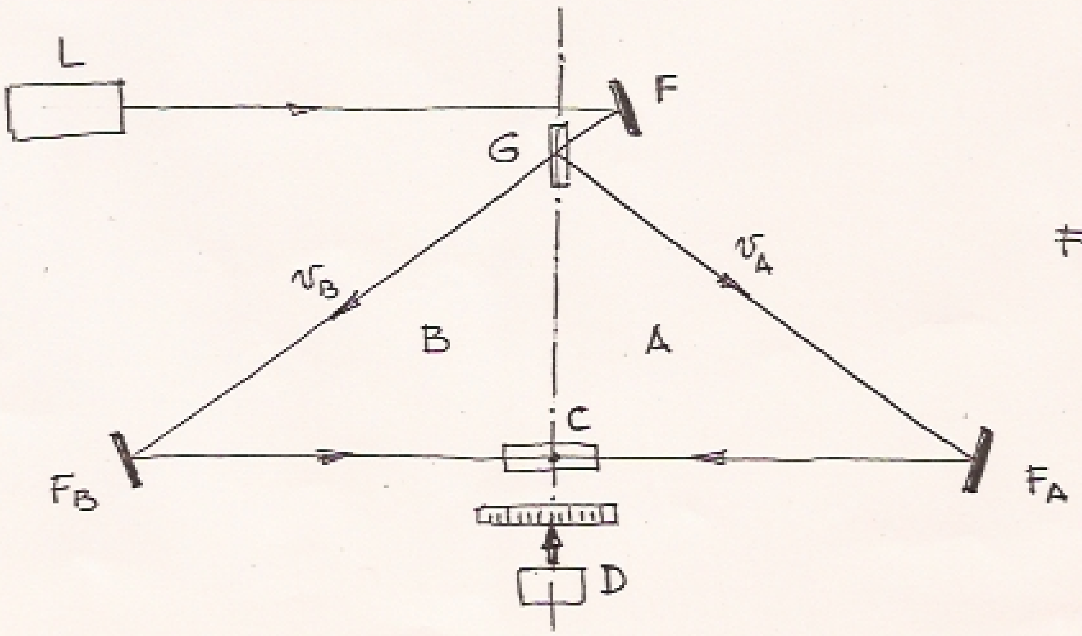

Fig. 7

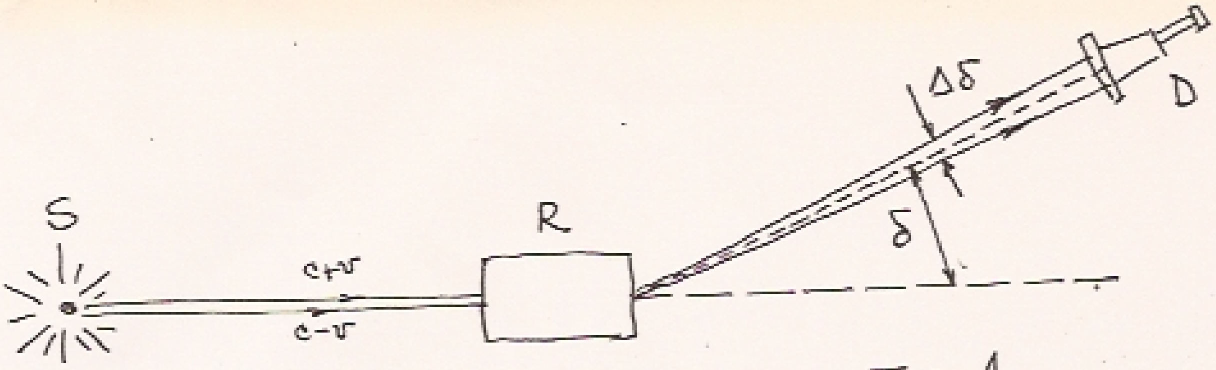

Fig. 1

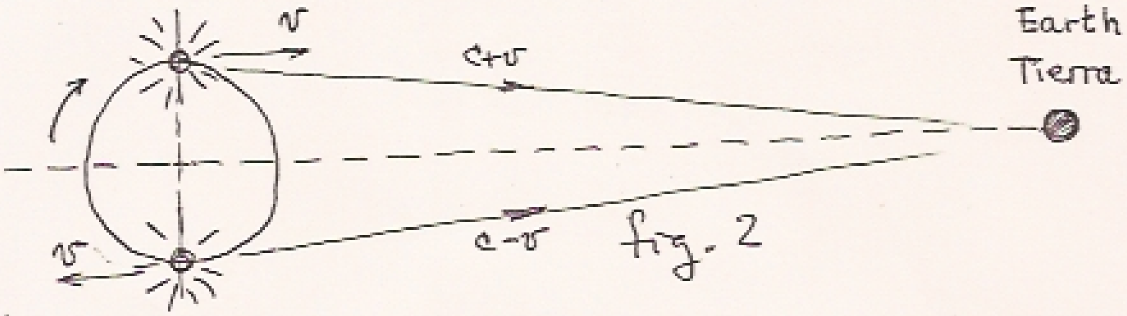

fig. 2

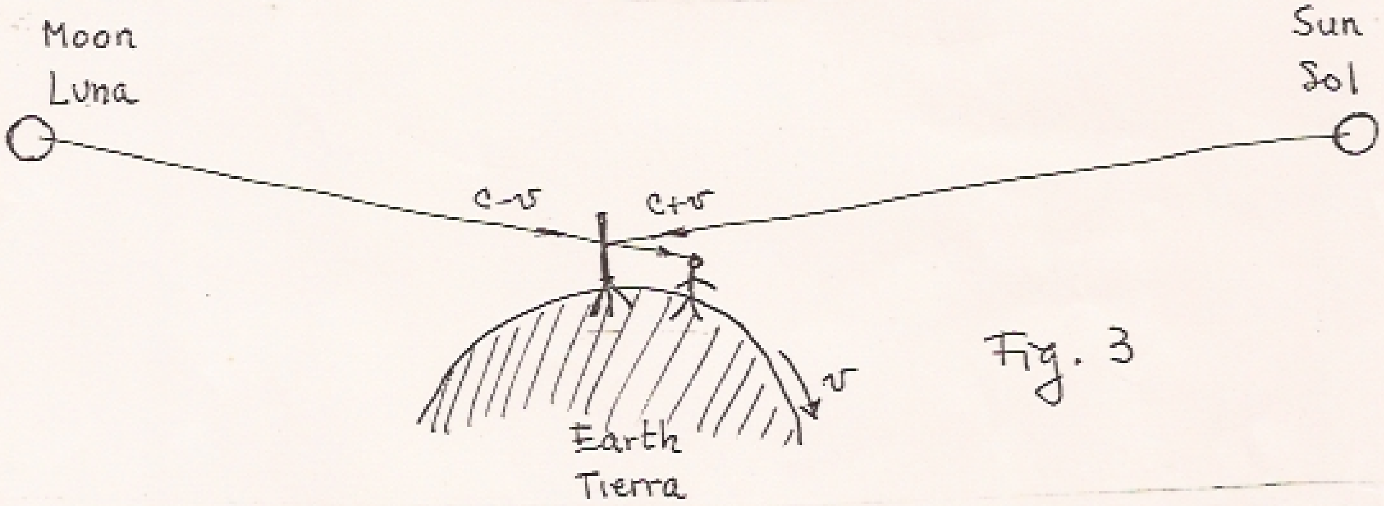

Fig. 3

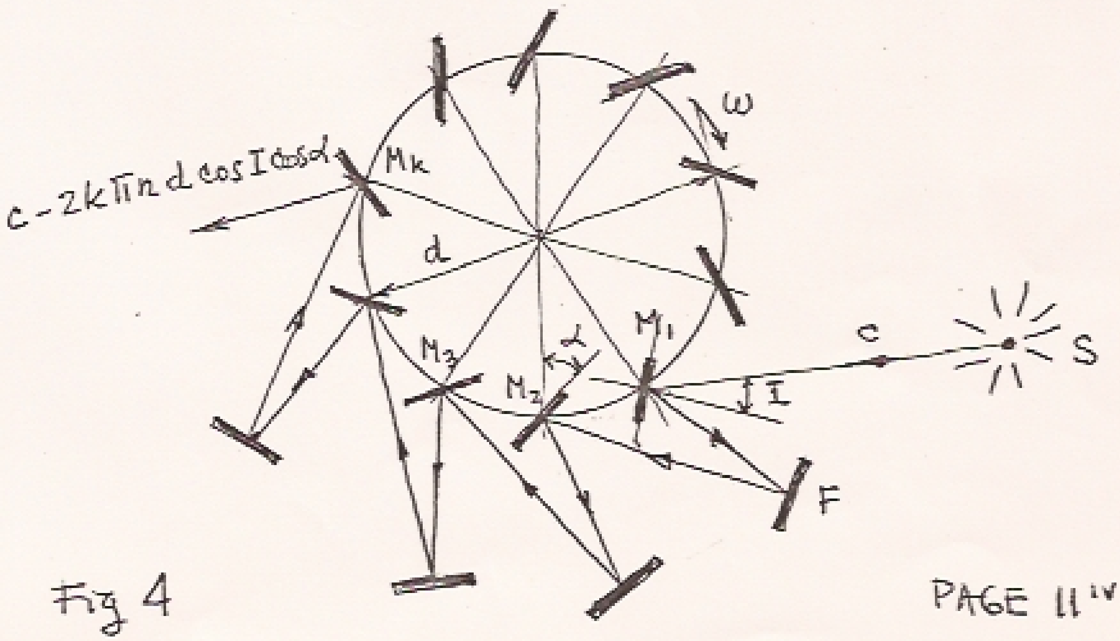

Fig 4

SECTION 4

PROJECT DETAILS

A. Expected duration of project (start date and date of expected completion). These dates can be approximate, and will not be treated as final or binding.

Start date: approximately one year after receiving the award, in order to get the necessary equipment, especially the rotor described in 3.1.3. The duration of the mounting and realization of the measurements can be estimated in 6 months.

B. Amount and nature of any additional contributions toward this project. For instance, if you are receiving, or applying for aid from a university or other organizations or individuals, please give details.

The Optical Research Center (CIOP) is expected to supply the dye laser (scheduled for reception in 1982), and give technical assistance in carrying out the experiments, in case the award is granted and the rotor can be secured.

C. Previous grants received for this project, grants now available, or applications to other organizations which are now pending, stating whether they are additional to your request for a Rolex Award for Enterprise 1981 (i.e., if one of them is granted, will it make this Award unnecessary?). If you have previous grants for any project, please list these grants also.

SECTION 5

ADDITIONAL INFORMATION

This page and the two following may be used for adding other relevant information to that called for on the previous pages.

I wish to express my thanks to Dr. Mario Garavaglia for his patience shown on occasion of my visits in search of criticism and advice for my project. It was thanks to his suggestion that I incorporated the experiment with the Dye Laser, of whose existence I had not been aware.

I likewise wish to thank Dr. Otto Schneider, who not only translated the present paper from Spanish, but also reviewed some of its concepts so as to render it more easily readable.

Finally, I wish to make it clear that the individuals cited under 3.D. of the Application Form shall not be held identified in any way with the views here expressed nor with the results expected.