Chapter 4

INTERFEROMETRIC EXPERIMENTS ON THE SPEED OF LIGHT FROM MOVING SOURCES

The Lloyd mirror interferometric experiments, by Tolman in 1910 and by Beckmann and Mandics in 1964, on the speed of light from a moving source are shown to be unproductive of conclusive results. The related Rotz experiment in 1963 with moving slits is inconclusive since no experimental knowledge of the effect of slits on the speed of light is known.
The four closed-path interferometric experiments on the speed of light from moving reflecting and transmitting secondary sources are evaluated. The negative results obtained in three of them are shown to be due to a failure to correctly adjust and maintain adjustment of the interferometer at the optimum condition for the detection of a fringe shift. These three experiments are inconclusive rather than a confirmation of the Einstein absolute speed of light postulate. The *qualitative* "yes or no" experimental results reported by the author in 1962 still remain as an undiscredited contradiction of Einstein's second postulate on the *absolute* speed of light.

Most physicists, and others, have had it drummed into them that the famous Michelson-Morley interferometric experiment, intended to detect motion through the ether, is also an experimental confirmation of Einstein's second postulate on the absolute speed of light from a *moving source*, albeit that the source in the Michelson-Morley work was stationary. This point of view has been received as an awesome piety that must not be questioned.

The experiment and its many repetitions have shown no detectable motion through an ether. It is, therefore, rather conclusive that there is no detectable ether attendant on motion. In the absence of an ether, the Michelson-Morley experiment would clearly be expected to yield *nothing but* a trivial null result; the *light rays emitted from the stationary source* in the experiment propagate with equal speed, in each direction, along each perpendicular arm of the interferometer. Only if the light source is in motion relative to the interferometer can the interferometric type of experiment, with certain careful precautions, provide a direct test of Einstein's postulate of absolutivity.

TOLMAN'S EXPERIMENT

The possibility that a mirror acts as a "new" source of reflected light led Tolman,[1] in 1910, to use a Lloyd mirror in an experimental check on Einstein's second postulate on the absolute speed of light from a moving source. By means of a lens he focused the image first of one limb, and then of the other limb of the Sun upon a slit, behind which was mounted a Lloyd mirror. It was Tolman's assumption that the speed of a ray of light reflected, at grazing incidence, from the mirror would be altered to c if its relative speed before reflection was $c \pm v$, where v is the tangential speed of the limb of the Sun. Tolman did not find his predicted relative shift of two fringes in the interference pattern formed by the direct and reflected light from the slit illuminated by the image of each limb of the Sun. He interpreted this result as proof that the speed of light was not relative, but was *absolute* in the sense of Einstein's second postulate that the speed of light is independent of the relative motion of its source.

There is the tacit assumption that the slit, which diffracts the incident solar light, would not alter the relative speed of light $c \pm v$ from a moving source to c from a stationary source. There is no experimental evidence (indeed, the point has hardly been considered) on the effect that a slit might have, acting as a "new" source, on the speed of light from a moving source. Afterwards, Tolman indicated in a footnote in 1912 the problems involved in a comprehensive approach to various propagation phenomena: "Optical theories in which the velocity of light is assumed to change during the path are not considered in this article. It might be very difficult to test theories in which the velocity of light is assumed to change on passing through narrow slits or near large masses in motion, or to suffer permanent change in velocity on passing through a lense."[2] Fox[3] has indicated that it can be supposed on theoretical grounds that a slit behaves like a new source. This theoretical indication is the basis of his conclusion that the Rotz[4] experiment is inconclusive. This experiment involves the diffraction pattern produced by three comoving slits, the central one of which was covered by glass. Experimentally, nothing is known of the effect of an open (uncovered) moving slit on the speed of light emergent from it. The experimental investigation of the effect of "open" slits undertaken by Rotz[4] in 1963 has not, as yet, been published. The behavior of a slit either as a moving light source or as a stationary re-emitter of light from a moving source is a matter of complete experimental ignorance at this time. The null results of experiments involving slits on the absolute or relative speed of light are therefore ambiguous and inconclusive.

The destruction of the relative speed of light from a moving source (limb of the Sun) by the intervening media of the solar atmosphere, the "stationary" Earth's atmosphere, and the lens predetermined a null result in Tolman's experiment, apart from considerations on the effects of the slit. Tolman incorrectly argued that these intervening media did not obliterate the possible relative speed of light. He did this by the circular logic of applying the Einstein "addition" theorem of speeds, based on the absolute speed of light, to the case for the relative speed of light. Tolman claimed that, relative to the source, the speed of light in the moving lens is $(c/\mu) \mp v\theta$, where μ is the index of refraction of the stationary medium of the glass lens and $\theta = (\mu^2 - 1)/\mu^2$.

This Fresnel expression for the convected speed of light (in the moving lens) relative to the source follows as a first-order approximation from the Einstein "addition" theorem in which the relative lens speed v is "added" algebraically to the speed of the light c/μ propagating relative to the lens. Tolman makes the perplexing error of asserting, according to the classical addition of speeds, that "with respect to the medium it [the speed of the light relative to the lens] will be $(c/\mu) \pm v(1 - \theta)$"[1] rather than the correct value which is simply c/μ, as pointed out by Pauli.[5] By circular and inappropriate logic supported by a wrong calculation, Tolman justified a predicted fringe shift that was physically prevented to begin with.

With physically conducive conditions, a negative result, as Stewart[6] noted, could be regarded as merely showing that the specific assumption that $c \pm v$ is changed to c on grazing reflection is not correct. At *normal* incidence the specific inelastic ballistic hypothesis that $c \pm v$ is changed to c is based on the supposition that the incident photon is re-emitted with speed c from the stationary mirror acting at the point of incidence as a "new" source. At *grazing* incidence the inelastic ballistic hypothesis must not be uncritically accepted to be the same phenomenon as at *normal* incidence. Phenomenologically, the speed of reflection could be angle-dependent in some manner analogous to the angle dependence of the intensity and polarization of light reflected from a plane glass surface. Stewart championed what is in effect equivalent to an elastic ballistic hypothesis whereby the reflected speed of the light is equal to the incident speed of the light $c \pm v$ from a moving source. On the basis of such an elastic rebound (or Fermat's principle of least time) the angle of reflection from a fixed mirror would equal the angle of incidence with the consequent null result of the Lloyd mirror experiment to be expected (when $v/c \ll 1$). Einstein's second postulate that the speed of light is absolute also leads to the prediction of a null result since there is no speed or angle change on reflection of the light from a stationary mirror. Rather than speculate on other interesting ballistic hypotheses, a new experiment will be suggested later which may provide an experimental indication of the possible nature of an angle-dependent ballistic behavior of light from a moving source, when that light is reflected from a stationary mirror. In a corpuscular ballistic model for the behavior of light, the two factors that can be experimentally examined are the speed and angle of the reflected light for a specific source speed and a specific angle for the incident light.

Tolman's experiment is of doubtful value even if it is uncritically assumed that reflection at grazing incidence will change $c \pm v$ into c. The first-order fringe shift effect to be expected with a Lloyd mirror from such an assumption is relatively negligible and undetectable as will shortly be shown. This will prove quite relevant to other interferometric experiments on the relative speed of light.

Tomaschek's repetition[7] of the Michelson-Morley experiment used sunlight and starlight which were first reflected from heliostats into a telescope and then passed through a laboratory window to finally enter the interferometer. Naturally, the intervening glass predetermined a null result just as in Tolman's experiment.

BECKMANN-MANDICS EXPERIMENT

The same assumption for the change of speed for the reflection of light at grazing incidence was made by Beckmann in the experiment by Beckmann and Mandics.[8] A contradiction with Fermat's principle of least time is also explicitly made in that the angle of reflection r, shown in Fig. 1, is equal to the angle of grazing incidence i, even though the speeds of the incident and reflected light are assumed unequal. Beckmann and Mandics repeated the Tolman experiment in air and in vacuum fifty-four years later in 1964. Their moving light source, without the presence of a slit, was established by means of the reflection of light incident at 15° on a tiny mirror mounted on a rotor at 12.8 cm from the axis of rotation. For the reasons already given, their other null result experiments with a stationary-slit light source are inconclusive, and need not be discussed.

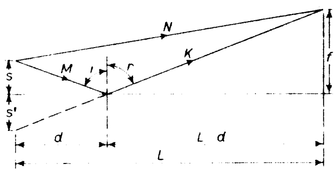

Fig. 1. Lloyd's mirror.

In Fig. 1, f is the perpendicular distance of a particular fringe from the