by Ekstein combined with electro-optic theory explain the phenomena.

The analysis shows that the beam diameter can greatly affect measurements of the magnitude of the Pockels effect; we conjecture that this is a possible explanation for some of the wide variations in measurements of its value.

The large change in index of refraction with a low applied voltage also permits freely suspended crystals of the dihydrogen phosphate type to be used as light modulators at single frequency with surprisingly low half-wave retardation voltage.

ACKNOWLEDGMENTS

The author wishes to express his appreciation to E. Brock for his discussion of, and interest in the problem and to F. Unterleitner for his advice and suggestions. The interest and cooperation of the entire research staff at General Dynamics/Electronics has contributed much to this work.

JOURNAL OF THE OPTICAL SOCIETY OF AMERICA VOLUME 55, NUMBER 2 FEBRUARY 1965

Experimental Investigation of the Second Postulate of Special Relativity*

RAY O. WADDOUPS, W. FARRELL EDWARDS, AND JOHN J. MERRILL
Utah State University, Logan, Utah 84321
(Received 12 October 1964)

The addition-of-velocities hypothesis, which Kantor recently claimed to have verified, has been investigated using a different experimental arrangement. A laser beam was passed through a moving mica window, which might be considered as a Huygens-type moving source of light. An interferometer was built with which to detect and measure any change in speed of the emitted light. The apparatus allowed investigation of: the effects of window speed, which could be varied continuously up to 63m/sec; direction of window motion with respect to direction of propagation; and the effects of air in the beam path. Emission theory as used by Kantor predicted a $\frac{1}{3}$ fringe shift; however, no shift was observed under any conditions. The estimated sensitivity of the method is 1/20 fringe. Our results are therefore consistent with the second postulate of special relativity, but not with Kantor's hypothesis.

INTRODUCTION

In 1962, Kantor published experimental results suggesting that the velocity of light is dependent upon motion of the source, i.e., contradicting the theory of special relativity.[1] In the Kantor experiment, a light beam was passed through moving glass windows. The windows were considered to be Huygens-type sources and were moving with respect to the laboratory reference system. He reported changes in the light velocity on the basis of a shift in the interference pattern that was formed as the light passed around a time-of-transit interferometer. When the experiment was repeated by Babcock and Bergman, however, no shift was noted in the interference pattern.[2] We have built an interferometer to repeat the experiment with several modifications designed to clarify the results.

APPARATUS

The apparatus utilized a Jamin interferometer, a gas laser as a light source, two mica windows as moving Huygens-type light sources mounted on a rotation platform which could reach a speed exceeding that attained in the prior two experiments, and a vacuum system enclosing the interferometer path. The laser light source gave large, clearly observable, and readily photographable interference patterns, and well-defined, easily determinable light paths. The asymmetry of the Jamin interferometer, Fig. 1, permitted investigation of the effect of direction of source motion. Half of the lower beam B was passed through the moving mica window, while the other half was passed through a stationary mica window.

Both mica windows were cut from the same piece of mica, peeled to less than one thousandth of an inch, and carefully selected under a sodium light for uniform thickness. The mica windows were mounted on the rotating disk, and aluminum light stops were affixed in appropriate positions to prevent passage of light when the windows were not in the proper position in the light path. Window speeds were varied from 0 to 63 m/sec and the interference pattern was observed continuously over the entire range. The disk was run both in air and in vacuum.

RESULTS

Kantor's observations suggested that the portion of the interference pattern resulting from light passing through the rotating mica window would be shifted with respect to the portion unaffected by the moving window. The light may be assumed to leave the moving window

* This work was supported by the Utah State University Research Council.
[1] W. Kantor, J. Opt. Soc. Am. 52, 978 (1962).
[2] G. Babcock and T. Bergman, J. Opt. Soc. Am. 54, 2 (1964).

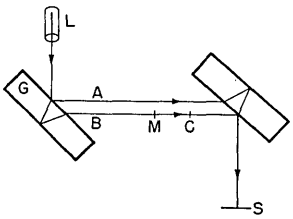

FIG. 1. Experimental arrangement. The beam from the gas-laser light source L is split by the glass plate G. Half of the lower beam B passes through the mica window M which is mounted on the rotating table. The other half of the beam passes through the stationary mica window C. The beams are recombined by the second glass plate, and the resulting interference pattern is observed and photographed at the screen S.

FIG. 2. Experimental fringe pattern. The left-hand side of the pattern was formed by superposition of part of beam A (see Fig. 1) with the part of beam B which passed through the stationary compensating plate. The continuous fringes indicate that there is no measurable effect of the moving mica window.

with a velocity $c+\alpha v$, where c is the velocity of light, v is the linear velocity of the moving source, and α is a parameter which depends upon the nature of the propagation. It arrives at the second interferometer mirror ahead of the unaffected light if α is greater than zero. Kantor interpreted his fringe shifts as indicating that α equals one. The mica window speed is $v=2\pi r v$, where r is the disk radius and v is the angular velocity in revolutions per second. The time of travel at velocity $c+\alpha v$ is $t=s/(c+\alpha v)$, where s is the distance of travel. Thus the predicted increase in effective path length is $\Delta s=t\alpha v$, from which it follows that the predicted number of fringes shifted would be $n=\Delta s/\lambda$, where λ is the wavelength of light used.

The apparatus described above had a rotating-disk diameter of 20.32 cm, a rotation speed of up to 6000 rpm, and a 7000-Å light source. Both mirrors were 1 m from the mica window. If α were equal to unity, the maximum linear velocity 62.8 m/sec would cause a shift of $\frac{1}{3}$ fringe in the interference pattern. At no time was such a shift observed.

Observations were made and photographs taken with the mica window moving with linear speeds of from 0 to 63 m/sec both in and against the direction of light propagation and with air pressures of 2.6×10^{-4} atm, and 1 atm. Under all combinations of these conditions, the interference pattern remained unshifted. The interference pattern with the disk rotating in air at 1 atm at maximum speed is illustrated (Fig. 2).

The sensitivity of the experiment was calculated in the following way: estimates were made using an interference pattern cut along the dividing line between the two sides of the fringe pattern. The two sides were shifted varying amounts, and a straight edge and machinist's rule were used to estimate the shift in the interference pattern. Four independent observers detected shifts of 1/20 fringe. Thus, at the maximum disk velocities investigated, dependence of the velocity of light upon the velocity of the source $(c+\alpha v)$ could have been detected for a proportionality constant "α," exceeding approximately 1/7.

CONCLUSION

Since no shift of the interference pattern was observed under any of the conditions investigated, the results of the present experiment substantiate those of Babcock and Bergman. Consistency of experimental results with special relativity was demonstrated; i.e., interference patterns observed indicated that, for addition of velocities $c+\alpha v$, $\alpha=0\pm1/7$.

ACKNOWLEDGMENTS

Dr. John K. Wood, Head of the Physics Department, Utah State University, helped immeasurably by supplying photographic equipment and a vast amount of information concerning optics. The Electrodynamics Laboratory at Utah State University was most cooperative in allowing use of their equipment.