that β remains unchanged. His second result (*Phil. Mag.*, vol. xxxvii., p. 149) shows that α remains unchanged. The time of the double journey is accordingly obtained by replacing u by $u+v$ in expression (2), and the Michelson-Morley result requires that equation (3) shall remain true when $u+v$ replaces u. Since Majorana's results held over a considerable range of values of v, it appears that (3) must be true for a whole range of values of u, requiring at once $\alpha=\beta=0$, so that the two terms in expression (1) must represent separately the times of the inward and outward journeys.

Translate this into relativity language, and it appears that when x, t, x', t' are related by the usual Lorentz transformation, then the Michelson-Morley experiment, when supplemented by the observations of Majorana, shows that both on the outward and on the inward journey light travels with the same constant velocity c. J. H. JEANS.

Relativity and the Deviation of Spectral Lines.

THE prediction of the Einstein spectral-line effect rests on two assumptions, namely, (1) the radiating source behaves as a natural clock, and (2) the time-period of the source is transmitted by the radiation to the observer.

An alternative to the second of these assumptions is that the radiation transmits the Einstein interval ds rather than the time interval dt of a vibration. This alternative appears to be more in accordance with the general ideas of relativity.

Consider two light pulses leaving A at times t_A, t_A+dt_A, and arriving at B at t_B, t_B+dt_B. Since $ds=0$ along the world line of each pulse, it appears that the interval $\gamma_A dt_A$ between the two departures from A is equal to the interval $\gamma_B dt_B$ between the arrivals at B—that is, the Einstein interval, and not the time interval, is transmitted.

If this contention be correct, the Einstein effect should arise, not from the transference of the source, but from the transference of the observer to a different gravitational field.

It may be contended that the use of the principle of least time in the ordinary method of deducing the deviation of a beam by a gravitational field presupposes an underlying constant time period in the radiation. To this I would reply that it is possible to deduce the deviation without any reference to pre-Einstein physics. I propose to deal with this point in a communication to the *Philosophical Magazine*.

H. J. PRIESTLEY.

University of Queensland, Brisbane,
January 15.

Amplifying the Optophone.

MR. CAMPBELL SWINTON'S forecast in NATURE of March 3, p. 8, has been fully verified since he wrote. On Tuesday, March 1, the Marconi Co. kindly lent me one of their three-valve amplifiers working with an S. G. Brown loud-speaking telephone and wooden trumpet. Mr. F. Swann, of the Marconi Co., personally superintended the installation, and we succeeded without much difficulty in producing a sound which made ordinary printed matter "legible" to several blind pupils in a room. A reading demonstration from the amplified sound was given in the presence of Sir William Collins and Mr. C. P. MacCarthy.

This new development marks a great step forward, and I consider that Mr. MacCarthy and Mr. Campbell Swinton deserve credit for their initiative in this matter. E. E. FOURNIER D'ALBE.

10 St. James's Terrace, N.W.8, March 5.

WITH reference to the letter on the above subject in NATURE of March 3, it may be of interest to record that thermionic amplifiers were applied to the optophone a considerable time ago with the object of increasing the sound in the ordinary telephone, but although it was evident that the sound could be amplified, it was decided that to increase the cost and complexity of the instrument to the extent involved by the addition of an amplifying set was not justified.

In 1919 Messrs. Barr and Stroud, Ltd., applied to Messrs. Marconi, of Chelmsford, who were kind enough to prepare a special amplifying set.

At a later date, through the kindness of Major Henrici, the valuable advice and assistance of officers of the Signal Department at Woolwich were also obtained.

Mr. Swinton, by the application to the subject of his great experience of amplifiers, has attained most encouraging results in making the optophone notes audible for instructional purposes.

JAMES WEIR FRENCH,
Director, Barr and Stroud, Ltd.

Anniesland, Glasgow, March 7.

The Peltier Effect and Low-temperature Research.

I WAS much interested to see Mr. A. A. Campbell Swinton's letter to NATURE of February 24, p. 828, on the above subject. So far as I am aware, the first suggestion to attain low temperatures by means of the Peltier effect was made by me when a student some twenty years ago. If Mr. Campbell Swinton will look up NATURE of August 15, 1901, p. 376, and also the *Chemical News*, 1901, vol. lxxxiv., p. 73, he will see an article by myself entitled "On a Possible Method of Obtaining the Absolute Zero of Temperature," in which the method is suggested in detail. There is little doubt that a great field of research would open out once the absolute zero of temperature were obtained, and temperature as a phase vanished from matter.

Attention may also be directed to a paper by Mr. Brinkworth and myself entitled "On the Heatless Condition of Matter" in *Chemical News*, 1902, vol. lxxxv., p. 194. Of course, it must be recollected that we were writing twenty years ago, long before modern developments occurred. Unfortunately, I have been out of touch with such matters, and have not had the opportunity of seeing whether any researches have been carried out on these lines owing to my work developing in a different direction.

GEOFFREY MARTIN.

109 Corporation Street, Manchester,
March 2.

WITH reference to Dr. Geoffrey Martin's interesting letter, it was because I thought it very possible that the idea was not new that I put my suggestion in the form of an inquiry. I have looked up his several most suggestive papers, which fully bear out what he says.

As I have pointed out, since the date of Dr. Martin's communications to NATURE and to the *Chemical News* in 1901, Prof. Kamerlingh Onnes has verified the disappearance of electrical resistance at very low temperatures which Dr. Martin, amongst others, predicted. It does not appear certain whether at such temperatures, when electrical conductivity in metals becomes infinite, either the Peltier effect or the corresponding opposite thermopile effect would operate.

Perhaps these effects may be enhanced, but possibly they may disappear; much would appear to depend upon how these low temperatures affect heat conduc-