14. The dragging of light through a moving body in accordance with the relativity principle; *by M. Laue*.

Because Einstein's electrodynamics,[1]) which is based on the relativity principle, agrees with the (older) Lorentz theory, provided one limits oneself to the first power of the relations of all body speeds to the speed of light, then it is natural that it also allows for the correct computation of the Fresnel drag coefficient as the first approach. However, nowhere in the literature can it be found, how much easier the relativity principle is able to solve this problem, not even with the other theory in the simplification, which Mr. Lorentz communicated only recently.[2])

It is merely an example of the Einstein theorem of the addition of speeds. Let there be two coordinate systems with parallel axes, which are "primed" and "unprimed", with a movement against each other with the speed v along the X-direction. One with speed w', is related to the primed system, whose direction with X'-axis forms the angle ϑ', relative to the unprimed system, then the speed corresponds to a speed of

$$w = \frac{\sqrt{v^2 + w'^2 + 2vw'\cos\vartheta' - \frac{1}{c^2}v^2w'^2\sin^2\vartheta'}}{1 + \frac{1}{c^2}vw'\cos\vartheta'}. \quad ^{3})$$

Now, if a body of refractive index n rests in the primed system, then the phase velocity of the light in the primed system is

$$w' = \frac{c}{n}$$

([1]) A. Einstein, *Ann. d. Phys*. **17**. p.891. 1905.
([2]) H. A. Lorentz, *Naturw. Rundsch*. **21**, p.487. 1906.
([3]) l.c. p. 906

The corresponding speed in the unprimed system is therefore

$$w = \frac{\sqrt{v^2 + \frac{c^2}{n^2} + 2v\frac{c}{n}\cos\vartheta' - \frac{v^2}{n^2}\sin^2\vartheta'}}{1 + \frac{v}{cn}\cos\vartheta'}.$$

As with the Fresnel attempt, if the directions of the speeds v and c/n are aligned, then $\vartheta' = \pm 1$, so

$$w = \frac{\frac{c}{n} \pm v}{1 \pm \frac{v}{cn}}$$

$$= \frac{c}{n} + \left(1 - \frac{1}{n^2}\right)\left\{\pm v - \frac{v^2}{cn} \pm \frac{v^3}{(cn)^2} - \frac{v^4}{(cn)^3} \pm \ldots\right\}.$$

However, if for example, $\vartheta' = \pm\pi/2$, then it becomes

$$w = \sqrt{\frac{c^2}{n^2} + v^2\left(1 - \frac{1}{n^2}\right)}$$

$$= \frac{c}{n} + \frac{1}{2}\frac{v^2}{nc}\left(n^2 - 1\right) - \frac{1}{2}\cdot\frac{1}{4}\frac{v^4}{nc^3}\left(n^2 - 1\right)^2 + \frac{1}{2}\cdot\frac{1}{4}\cdot\frac{3}{6}\frac{v^6}{nc^5}\left(n^2 - 1\right)^3 \ldots$$

With dispersive substances, of course, the value to be used for n is the one which corresponds to the frequency in the primed system.

For the group velocity is exactly the same when the refractive index n is substituted by the expression $n + \nu\left(dn/d\nu\right)$ (ν is frequency).

According to the relativity principle, the light is thus carried perfectly by the body, but this is precisely why its speed relative to an observer, who does not take part in the movement of the body, is not equal to the vector sum of its speed against the body and that of the body to the observers. There is no necessity to interject into the optics an "ether" which penetrates bodies without having to participate in their movement, for which we are relieved.

Berlin. July 1907.

(Received 30 July 1907.)