Astronomy. — *"On the parallelism between radial velocity and intensity of light."* By Prof. W. DE SITTER.

(Communicated at the meeting of May 3, 1924).

In *Zeitschrift für Physik* XXI, **6**, p. 333, 1924 M. LA ROSA points out that, if the velocity of a source of light is added to the velocity of light, then a star periodically approaching and receding from the observer will appear variable, as the quantity of light emitted by the star in equal intervals of time is perceived by the observer in intervals of unequal duration, the difference increasing with the distance of the star. This is, of course, entirely correct, but contrary to the opinion of Mr. LA ROSA, it does not afford an argument in favour of RITZ's theory of the propagation of light, but rather against it.

If the waves emitted by the source during the interval of time Δt reach the observer during the interval $\Delta t' = \Delta t(1+q)$, then the observer will ascribe to the source the intensity $i_0/(1+q)$, if i_0 be its real intensity, and on the other hand he will ascribe to it, according to DOPPLER's principle, a velocity of recession v determined by [1] $(c+v)/c = 1+q$, c being the velocity of light from a source which has no radial motion relatively to the observer. Both effects depend on *the same* factor q. We have thus, neglecting the square of q:

$$\frac{\Delta i}{i_0} = q = \frac{v}{c},$$

or since one stellar magnitude corresponds to a change of 0.4 in the common logarithm of the intensity

$$v = 277000\,\Delta m,$$

the difference Δm being expressed in stellar magnitudes, and the velocity in km. sec.$^{-1}$. Thus, if this were the real and the only explanation of the variability of stars, the change of observed wave-length, corresponding to a change of intensity of some tenths of a magnitude, would already be so large as to be interpreted as a

[1]) According to the classical theory, if the observer is at rest and the source is moving. According to the theory of relativity the formula of course is $\sqrt{(c+v)/(c-v)} = 1+q$.

velocity of the same order as the velocity of light itself. Inversely the change of magnitude, which undoubtedly accompanies any real change of velocity, is, for the velocities actually observed amongst stars, so small as to be entirely unobservable. To a change of velocity of 300 km. sec.$^{-1}$, which is about the largest velocity occurring amongst double stars, would correspond a change of 0.001 mag.

Take as an example a star moving with uniform angular velocity n in a circle of radius a, of which the plane passes through the observer.

The distance from the star to the observer is

$$\Delta = \Delta_0 - a \sin n t,$$

and the component of the velocity of the star towards the observer is

$$v = a n \cos n t.$$

If now the velocity of the light emitted by the star were

$$c' = c + \varkappa v,$$

where $\varkappa = 1$ for RITZ's theory and $\varkappa = 0$ for the ordinary theory, then the light leaving the star at the time t will reach the observer at the time

$$t' = t + \frac{1}{c}(\Delta_0 - a \sin n t)\left(1 + \varkappa \frac{a n}{c} \cos n t\right)^{-1},$$

and consequently, if we neglect the squares and higher powers of an / c,

$$\frac{dt'}{dt} = 1 - \frac{a n}{c} \cos n t + \varkappa \frac{a n^2 \Delta}{c^2} \sin n t, \quad \ldots \ldots \quad (1)$$

or

$$\Delta t' = \Delta t \, [1 - K \cos (n t + \varepsilon)], \quad \ldots \ldots \quad (2)$$

where

$$\tan \varepsilon = \varkappa \frac{n \Delta}{c}$$

$$K = \frac{a n}{c} \sec \varepsilon.$$

LA ROSA has neglected the first term in (1) and only taken account of the second term. ZURHELLEN (*A. N.* **198**, 4927, p. 1, 1914) has pointed out that the angle ε occuring in (2) would, if it reached at all appreciable values, in the case of an eclipsing binary give rise to a difference between the phase as derived from the observation of the eclipse and as derived from the radial velocity, and has concluded from the discussion of 7 stars that the value of $\varkappa$ must be smaller than one millionth.