

ART. XIX.—*Speculations upon a possible method of determining the distance of certain variably colored Stars*; by JOSEPH WHARTON.

ARAGO conceived the idea of testing the correctness of the corpuscular or emission theory of light by subjecting two rays of different velocities to the same refracting influence; for, as that theory explained refraction to be due to retardation of velocity caused by the molecular attraction of the refracting medium, rays entering the medium at different velocities should be differently refracted. To get rays of different velocities, he took light from a star toward which the Earth in its orbit was moving, and from another star which the Earth was moving away from. Supposing the ray to strike the Earth from the first of these stars at the real velocity of light plus the velocity of the Earth, and that from the other at the real velocity of light minus that of the Earth, Arago had two rays entering his refractor at velocities differing by about $\frac{1}{80000}$. Arago found no difference in the refraction of his two rays, and his conclusion thence derived that the corpuscular theory of light is untenable, has been generally accepted; this experiment having in fact been frequently quoted as one of the props of the adverse, or undulatory, theory.

It seems, however, rather surprising that any great weight should be attached to an apparent disproof, by a single test, of one merely imaginary function of corpuscular light, especially as the test itself is utterly fallacious; for who shall say that retardation by attraction is the only possible means by which emitted light could be refracted? and how can we know that the two stars selected by Arago had either no proper motion of their own, or none of a sort to affect his result?

Perhaps the only cases in which we can be sure of receiving star-light of absolutely different velocities are those of such binary stars the plane of whose orbit is not at right angles with the line from thence to the Earth. When that line lies in the

plane of such an orbit, and the two stars are situated at right angles to that line, it is clear that the velocity of the rays reaching us from one star exceeds that of the rays from the other by double the speed of those stars in their orbit. That light reaches us at various velocities from all the various stars is of course as certain as that they have proper motions, or that our solar system is moving through space; but the difficulties in the way of gaining any accurate comparison of those velocities are very great.

In reflecting upon the undulatory theory of light I have been quite unable to conceive how the luminiferous æther could "tremble laterally" as the phrase is, causing vibrations transverse to the line of propagation, without a direct relation existing between those lateral vibrations and the forward impulses by which the phenomena of light are translated. The æther being continuous and material and elastic, being in a word capable of sustaining a vibration, a vibratory impulse in it at right angles to the course of a ray of light seems fairly comparable to a lateral displacement of a point in a rope, or to the merely vertical vibration in a water wave not of translation, or to the vibration of air by a sound, all of which vibrations produce (we may almost say *are*) longitudinal undulations.

But if the lateral vibrations of the æther produce the onward propagation of the ray, then the number of lateral impulses in a second equals the number of forward impulses arriving in a second at a relatively stationary point, and as it is established that the number of lateral impulses varies according to the color of the light, so the number of forward impulses striking a relatively stationary point—say a retina—must vary with the color of the light; and if the source of light, instead of being at a constant distance, should rapidly approach the retina, the latter must receive a greater number of impulses per second, and its impression of color therefore must be correspondingly modified. If the retina and the source of light rapidly separate from each other, the number of impulses striking the retina must on the other hand be diminished, producing the corresponding change in the perceived color.

Now, if we imagine a star emitting white light to approach us in an orbital movement at a sufficient rate of speed, its light should appear to us reddish, changing at the perigee into white, changing again into blueish as the star departs, and again into white at the apogee. There are, however, variable stars whose colors undergo exactly those changes, viz: passing from one color to its complimentary, and back again, with periods of white light intervening. The binary stars, whose colors are frequently complimentary to each other, should, under the proper circumstances, exhibit the same circuit of change, but I am not pre-

pared to say that they do so in any case: it is in fact asserted that the larger star is usually red and the smaller one blue.

Supposing this train of thought to be sound, and that by extremely careful observation a difference could be detected in the position of a variably colored star when it appears red, from its position when blue, we should then be upon the track to calculate its distance. We should need to know the differing rates of light impulses required to produce the observed colors, the time occupied by the star in passing from one extremity of its course to the other, and the angular distance between those extreme positions. Let us assume that such a variably colored star has been found, which has a measurable change of position in one line, in other words the plane of whose orbit coincides with our line of vision, and let us assume that its extreme colors indicate a difference in the rate of arrival of light impulses (or in other words a difference in the velocity of the light arriving from that star at the two periods), equal to $2v$, then the actual speed of the star in its orbit $=v$ and as the orbital period of the star has been found $=t$, it follows that $\frac{v \times t}{8.1416}$ is the real length of that diameter which is the measured angular distance between the two extreme positions of the star. Knowing the angle, and the length of the base which subtends it, we have the distance of the star.

If a pair of binary stars could be found whose colors alternate, and which alternately eclipse each other, the matter would be simplified by so much as accurate measurement of the angle of parallax would be facilitated.

Should it be objected that no such binary stars have been observed, and that no change of position has been noticed in any single stars of variable color, I can only reply that possibly it may be worth while to direct attention to those points.

Should it be said that this hypothesis of the cause of variable color in stars would oblige us to believe that rays of different colors are propagated at different velocities, and that this whole suggestion is valueless until those velocities have been determined by direct experiment, I answer that very probably rays of different colors have different velocities, and that to determine them would be a most important achievement.

To conclude, I offer the analogy of the changing tone of a locomotive whistle as you rush past it on another train. Here, as you approach the sound, its impulses reach you more frequently than if its source, and you, were at rest. At the instant of passing, you receive the normal number of impulses, and after passing the impulses reach you less frequently. The shrill shriek, the real tone, and the low roar in this case are facts which I suppose to be parallel to the red, the white, and the blue light of a star moving swiftly, first toward, and then from us.