A DETERMINATION OF THE VELOCITY OF LIGHT FROM THE GROUP OF EXTRA-GALACTIC NEBULAE IN URSA MAJOR*

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It is now well known that the light from the very distant nebulae has a different wave-length from that from terrestrial and galactic sources. The effect is in some way connected with the distance, and may be due to an outward velocity, to actual differences in the atoms emitting light, or to an effect on the photons during their long travel in inter-galactic space. It is often maintained that the frequency of the light has decreased, but we never measure frequencies directly. We infer them from the relation $c = \lambda\nu$. To be sure that the frequency has actually decreased in the same proportion as the wave-length has increased, we must be sure that the velocity of light is the same as for terrestrial light and star light. Although all modern theories of light (except the practically abandoned ballistic theory) agree that the velocity of light depends only on local conditions, and is entirely independent of the motion of the source and of the previous history of the light, it nevertheless seemed to the writer well worth the effort to determine the velocity of light from some very distant nebulae, particularly since this could be done in a very simple way. This work was planned over a year ago, but only recently was it possible to secure the needed photographs. In the meantime other astronomers have advocated a similar study.

The method is based upon the fact that the aberration of star light is equal to the ratio of the velocity of the observer perpendicular to the incoming light beam and the velocity of light. For objects close together in the sky the observer's motion is very nearly the same, and any large difference in the velocity of light would produce a shift in a certain direction. This shift would vary with the time of the year, and is a maxi-

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mum when the observer is carried perpendicular to the line of sight by the Earth's orbital motion.

The writer has measured two photographic plates of the group of nebulae in *Ursa Major*. The radial velocity of these nebulae is about 11,700 km/sec., as determined by Humason, and the distance is about 70 million light-years, estimated by Hubble. The plates were taken at the Newtonian focus of the 60-inch telescope, where the scale is 27″ to the millimeter.

Six nebulae and nine comparison stars were measured. The difference between the aberration constant for the nebulae and the stars was found to be

$$\Delta k = -0''.006 \pm 0''.050 \text{ (probable error)}$$

From this we can determine the velocity of light from the nebulae in terms of the velocity of star light and we find

$$c' = (0.9997 \pm 0.0024)c$$

The errors of measurements are thus of the order of 0.2 per cent, and within these errors the velocity of light from the nebulae is the same as that of star light. We are thus justified in inferring that the frequency of the light from the nebulae is changed in the same proportion as the wave-length.

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