August 29, 1942,
212 W. Seminary Ave.,
Wheaton, Illinois.

Dr. Edwin Hubble
Mount Wilson Observatory
Pasadena, California

Dear Dr. Hubble:

Several places in your book entitled "The Observational Approach to Cosmology" you suggest that a new principle of nature is required to explain the red shift in the spectrum of the nebulae. I would like to offer the following.

Two papers by Simon Ramo and S. P. Blewett (Phys. Rev. April 1940, page 635 and J. of. Ap. Ph., 1941 page 856) show theoretically and experimentally that the dielectric constant ϵ of the medium may be reduced below unity under condition of space charge and axial magnetic field according to the relation $\epsilon = 1-(\lambda H/15100)^2$

This is another way of saying free electrons must be present and a magnetic field which has a component in the line of sight be available. Under these conditions the phase or group velocity of electromagnetic waves passing through the medium will be increased. This has the apparent effect of an increase of wave-length or a decrease in frequency.

Now little evidence exists on the condition or contents of space between the nebulae. However, according to several investigators the electron density is about one electron per cubic centimeter in our region of the milkyway system. It appears not too remote a hypothesis to suppose a density a few orders below this throughout all space. Likewise since the earth, sun and probably all the stars are provided with a magnetic field it again seems within the realm of possibility that all of space is pervaded by a very weak but complex magnetic field originating in the nebulae and flowing out therefrom to distances large compared to each one.

While such electron densities and magnetic fields may be very weak, the distances are tremendous and for simplicity these phenomena may be considered uniform at all places and at all times in the past. We, therefore, arrive at a condition where the apparent wave length is increased

in proportion to the distance light travels through the medium or the length of time it has been on the way from source to us. Such appears to be the case according to your exposition of the evidence.

Referring to the above formula, the phenomenon will be less pronounced for blue light than for red light. Is any evidence available on this point?

Now as the light travels through the medium the effect increases and eventually the result becomes a decrease in ϵ to negative values. This causes the propagation constant β to become imaginary. The product of $j\beta$ is then real and adds to the attenuation constant α. Under such conditions very great losses appear and it will be impossible to see much farther. The effect will first come into prominence at the red end of the spectrum. It seems from laboratory studies of magnetron tubes that the energy will be transferred to the free electrons by an increase in their velocity.

While the above discussion may lack clarity and quantitative analysis please consider it carefully and put it into the hands of someone familiar with such matters.

Yours very truly,

GR:EJ

Grote Reber