HARVARD UNIVERSITY

DEPARTMENT OF PHYSICS

January 12, 1950

LYMAN LABORATORY OF PHYSICS
CAMBRIDGE 38, MASSACHUSETTS

Dr. Harlow Shapley
Harvard College Observatory
Cambridge 38, Massachusetts

Dear Dr. Shapley:

This letter is an application for a grant from the Rumford Fund of the American Academy of Arts and Sciences. The research project for which assistance is sought is an effort to detect, in the microwave radiation from interstellar space, a sharp line at the frequency associated with the hyperfine structure of the ground state of atomic hydrogen. The experiment has been undertaken as a Ph.D. thesis problem by Mr. Harold I. Ewen, a graduate student in the Department of Physics, under my direction. I shall outline briefly the background of the problem, and the method we plan to use.

The ground state of the hydrogen atom is split into two "hyperfine-structure" levels by the interaction between the spinning electron and the magnetic moment of the proton. The frequency associated with transitions between these levels has been measured very precisely by Nafe and Nelson at Columbia, using Rabi's method of atomic beams. It is 1420.41 megacycles/second, corresponding to a wavelength of 21.10 centimeters. Microwave radiation of this wavelength can be absorbed or emitted by free neutral hydrogen atoms, of which interstellar space contains a supply abundant for our purpose. We propose to search for this transition by studying the apparent noise temperature, in the neighborhood of the wavelength in question, of a microwave antenna directed toward the Milky Way. At this sharply defined wavelength we expect to find either a peak (bright line) or a dip (Fraunhofer line) in the apparent temperature, depending on whether the temperature of the hydrogen is higher or lower than that of the background of galactic radiation in this part of the spectrum. It is conceivable that the temperature of the hydrogen is so close to that of the background that no effect will be detected, but it seems unlikely that this situation will prevail in every direction. I have computed the transition probability and, on the basis of available astrophysical evidence, I believe there is a good chance that the line can be observed.

The techniques to be used are those now familiar in radio-astronomy with an important simplification permitted by the fact that we are here - for the first time - dealing with a sharp spectral line. The antenna itself will consist of an electromagnetic horn mounted outside the upper floor of the Lyman Laboratory. The associated equipment consists of waveguides, a microwave oscillator and superheterodyne receiver, and various auxiliary microwave and low frequency circuits.

I need not point out to you the astrophysical implications of the experiment, if successful; it would give fairly direct access to the condition of the interstellar hydrogen, since by suitable calibration a direct temperature measurement would be possible. It would be interesting also to study the red shift of this line. As physicists we have another reason to be interested

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