November 19th, 1950
P.O. Box 4868
Cleveland Park Station
Washington, D.C.

Dr. Jesse L. Greenstein
Mount Wilson Observatory
1201 East California Street
Pasadena 4, California

Dear Jesse:

I am writing to you in the belief that you may be interested and, if so, I have confidence that you are capable of carrying out the necessary computations. The proposition revolves around the hyperfine structure of hydrogen[1,2]. Consideration is being given to constructing radio equipment to look for this phenomenon at 1420 megacycles. If it exists, interesting information could be secured about magnetic fields, line of sight velocities, etc. Furthermore, if it exists as an emission line the absolute sensitivity of the apparatus need not be nearly so great as if it exists as an absorption line.

In the region of hot stars the hydrogen is strongly ionized and gradually falling back to neutral state, only to repeat the process upon receipt of another photon. As the hydrogen falls back to neutral, a small percent of the ions will stop at a level of about 21cm wavelength. After a short stay at this level they fall back to neutral and thereby release a small amount of 21cm energy which should appear as an emission line. To get some quantitative idea of the subject it will be necessary to know the number of hydrogen atoms per unit volume; how often they cycle between ionized and neutral state; what percent stop at 21cm level; and how long they stop at this level. The net emission radiation may then be computed and some figure for surface brightness of the sky obtained at 21cm wavelength.

The alternative action involves a continuum provided by free-free transitions. Radiation is now allowed to flow thru empty parts of space where the hydrogen is all in neutral state. Some of the 21cm energy of the continuum is now extracted by the hydrogen; thereby raising it to this level and producing an absorption line. To solve this it will be necessary to know the capture area of the hydrogen atom at 21cm wavelength; the intensity of the continuum; the time an atom will stay at the 21cm level and what happens to the energy upon its release. Off hand it seems that neutral hydrogen is capable of creating an impenetrable haze in the sky at 21cm wavelength. This is because it would be fed from behind by 21cm energy which it would later release in a random fashion in all directions. In other words, it would be a selective scatterer. If this be true, a frequency of 1420mc would tell where the neutral hydrogen is, and that is about all. Obviously it would be a poor frequency to observe far away abjects.

These remarks apply in like fashion to deuterium, at a frequency of 327 megacycles. While there is much less deuterium than hydrogen in space, the circumstances may be better, so this possibility should also be looked into.

If you care to follow up this matter, I will appreciate learning of your findings in order that I may form some judgement upon the advisability of embarking upon construction of equipment. If I can be of any further assistance please advise.

Sincerely yours,

Grote Reber

1. "The Hyperfine Structure of Atomic Hydrogen and Deuterium" by Nafe, Nelson & Rabi, Phys. Rev., 15th June 1947, Vol 71, no 12, pp 914-915.

2. Same title and authors; Phys. Rev., 1st April 1948, Vol 73 no 7, pp 718-728.

P.S. Please accept my tardy acknowledgement of your letter of July 7th about point sources and the variability of same. We fished around a bit for the ones you suggest but were unable to find anything at a frequency of 160mc. While the point sources of radio waves unquestionably exist the variability is purely imaginary. It is definitely introduced by the ionosphere and is a function of a whole lot of things which are now being studied. One of the main things is the type of receiver the observer uses. If he uses wide band widths (Cornell people are addicted to such) he gets a lot. Narrow band widths eliminate the phenomenon. From the point of view of an astronomer, I'd forget the whole business.

G.R.