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DEPARTMENT OF ASTRONOMY AND ASTROPHYSICS
1100-14 East 58th Street
May 11, 1972

Dr. David Heeschen
National Radio Astronomy
Observatory
Edgemont Road
Charlottesville, Virginia 22901

Dear Dr. Heeschen:

In response to your letter of February 14, Ben and I have prepared a more detailed proposal for Project Ozma II. We hope we have now provided enough details to warrant serious consideration.

We would like to publish the results in a regular scientific journal like the Ap. J. I have talked to Helmut Abt, and he said that such a paper would be considered for publication. Therefore, any publicity should be handled in the same way as that for any other experiment: no press release (if anyone wants one) until publication and then follow the usual procedures. Such a press release should, of course, be a joint one with NRAO, Chicago, and Maryland. We do not think that any additional publicity would be desireable. We hope this is a satisfactory arrangement.

Sincerely yours,

Patrick Palmer

PP:h
cc: W. E. Howard
B. Zuckerman

MEMORANDUM

TO: D. S. Heeschen and W. E. Howard

FROM: B. Zuckerman and P. Palmer

SUBJECT: Observing time on the 300-ft. telescope

We would like to use the 300' telescope to carry out Project Ozma II. The great technological advances in the 11 years since Prof. Drake carried out Ozma I justify, in our opinion, a renewed search. Specifically, an increase in telescope aperture and a decrease in system temperature result in a gain of a factor of ~100 in sensitivity. We will not attempt to give a philosophical justification for such a project. This has already been done many times such as at the recent conference in Russia or by Professor Townes in his 1971 Jansky Lecture. Rather we will limit ourselves to a discussion of expected signal, sources, observing mode and telescope time.

A. Expected signal

Our plans are made with the assumption that we still cannot detect signals from an intelligent civilization unless they are deliberately trying to contact us. That is, if we looked at the earth from outside we would simply see variable radiation at low frequencies with no particular pattern or period and probably no one signal lasting long enough to be confirmed.

Consideration of what signal is most easily found if transmitted to great distances leads one to expect pulsed narrowband signals at some one or few frequencies. It is not clear that there is a unique frequency, but if there is, the 21 cm hydrogen line seems to be the most likely. It is not yet practical to search the whole radio frequency range for such signals, and a sensitive receiver is available for the 21 cm line. Thus, while our plans do not cover all possibilities for interstellar communications, we believe that this is the best experiment we can do at the present time.

Interstellar scintillations and effects caused by propagation of the radiation through a resonant medium are expected to be negligible as the stars to be observed are all so close that the 21 cm optical depth is small.

The estimated antenna temperature for an isotropic transmitter emitting a total power Pe (watts) into a bandwidth of 4 kHz from a star a distance D(pc) is

$$T_A = 2 \times 10^{-12} \frac{Pe}{D^2}$$

Clearly, any civilization at our level radiating isotropically would be completely undetectable at our expected sensitivity level of 0.2°K after one hour of integration. (See discussion of choice of bandwidth in section (C). On the other hand, a 10 Megawatt C. W. transmitter on a 100 meter antenna beaming at the solar system would be detectable out to ∿30 pc.

B. Sources

Prof. Drake observed a few sources for a long time. Our feeling is that a better way to search is by looking at many sources for a shorter time. We hope to cover about 200 stars in the time alloted (see D below). These stars will be of similar spectral class to the sun, will not be members of multiple systems, and will be as close as possible to the sun subject to the preceding constraints. The exact choice of spectral types is not uncontroversial: for example, compare Su Shu Huang (Chapter 6) and Cameron (Chapter 10) in Interstellar Communication (A.G.W. Cameron, Ed.). However, the range F5V to K4V seems to be acceptable to all, with the possibility of extending to later spectral types suggested by Cameron.

Our main list is stars in the F5V - K4V range in the Gleise catalog with parallaxes greater than 0.05 (within 20 pc). There are 225 such stars, of which 184 can be seen from Green Bank and 147 with the 300 foot telescope. This list is supplemented by the list of K5V to M8V stars from the Gleise catalogue. The closest of these will be used to fill in gaps. We will be looking into more recent information on colors and spectra for information about ages or peculiarities which might cause us to exclude some of these stars.

(C) Observing Mode

We prefer to have two 400 channel correlators, one for each of the two orthogonal polarizations available with the new cooled 21 cm paramp. If only one correlator can be made available for this program we would use it in the parallel mode with the A receiver set at 10 MHz bandwidths and the B receiver set at 625 KHz bandwidth (4 KHz resolution) both centered at the hydrogen line frequency in the rest frame of the star. It might be expected that to maximize the distance reached for a given power transmitted, the civilization would transmit over a much narrower band than 4 KHz. However, if we assume that the habitable zone around each star is that region where the stellar flux is within a factor of 10 of the solar constant then twice the orbital velocity of a planet around a K5 or an F5 star corresponds to 654 and 414 KHz respectively. Thus unless the civilization in question continuously adjusts their transmission frequency to the rest frequency of the star a bandwidth of order 625 KHz is necessary to cover the entire range of possible transmission frequencies. (For many stars there is a substantial uncertainty in the radial velocity which precludes looking at too narrow a bandwidth in any case). If two correlators were made available the resolution would be 2 KHz increasing our sensitivity by a factor of 2.

A possible problem is time resolution. We would use the shortest possible basic integration times (10 sec) and request that, if feasible, the on line programs at the 140 foot telescope be modified to include the possibility of recording data at times as short as 1 sec. Of course, even 1 sec is probably much too long to match any likely modulation rate so that it is not critical that our data be recorded at 1 sec intervals if it is difficult to modify the on line programs. Hopefully, the duty cycle of our hypothetical civilization will be such that our (long) basic integration times will not result in a substantial loss of signal to noise. Once a signal is detected (!) we would reobserve with much finer time resolution a la the pulsars. For the time being it would be fairly easy to pick out variations on a time scale of 10 sec by using Tom Cram's new programs.

(D) Telescope Time Required

We request one week of observing time on the 300 foot telescope preferably around the clock. Because our sources are distributed around the sky we could probably time share with other observers (but see polarization discussion below). However, as we eventually want to look at stars throughout the whole day, time sharing might not help out in the scheduling problem. Because we plan to look at many stars it is sufficient to examine each one for 4^m (or longer depending on declination) per day for seven days using the tracking feed. Time is lost between stars moving the telescope and in moving the feed back to the beginning of its track. However, even if one completely ignores the time to drive the 140 foot from star to star, the larger collecting area of the 300 foot telescope more than compensates for this lost time and, also for the slightly higher system temperature anticipated on the 300 foot telescope (M. Davis, private communication).

By analogy with terrestrial radars we guess that other civilizations are likely to transmit in circular rather than linear polarization. Thus we require right and left circular polarization. However, it should be possible to use the IF polarimeter (rather than an RF polarimeter) if we can obtain >20 db rejection between the two circular modes. Then, if necessary, we could time share with other observers. However, we understand that the performance of the IF polarimeter has been completely unsatisfactory in the past (e.g. large instabilities on time scales less than one hour and numerous breakdowns). If this situation is not improved we would like to use an RF polarimeter instead.