FIVE COLLEGE RADIO ASTRONOMY OBSERVATORY
619 Graduate Research Center
University of Massachusetts, Amherst, MA 01003

Dear Jill,

The sensitivity of my search was: $1.3\ 10^{-24}\ \frac{\text{watts}}{m^2\ Hz} = 5 \cdot 10^{-20}\ \frac{\text{watts}}{m^2}$ 3σ

The following is a long winded derivation of the same:

$T_{sys} = 1000°\ K$

$t_{on} = t_{off} = 2$ sec (per position)

$f_{sky} = 115\ GHz$

b = binwidth (narrowest) $= \frac{5\ MHz}{128\ \text{chan}} = 39\ kHz$

So... $\Delta T_{rms} = \frac{\alpha\beta\ T_{sys}}{\sqrt{b\,(2t_{on})}} = \frac{1.78 \cdot 1.57 \cdot 1000}{\sqrt{39 \cdot 10^3 \cdot (4)}}$

$\Rightarrow 3\sigma = 3\Delta T_{RMS} = 21°K$

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now $21°K \cdot k = 21°K \times 1.38\ 10^{-23}$ watt/(°K Hz)

Boltz

$= 2.9\ 10^{-22}$ watt/Hz

A_e effective area $= \eta \pi r^2 =$

$.36 \cdot \pi \cdot 14_m^2 = 222.7\ m^2$

So $S = \text{watt}/Hz\ m^2 = \frac{2.9\ 10^{-22}}{222} =$

$1.3\ 10^{-24}$ watt/(m^2 Hz)

matched to a correlator channel, which amounts to a power of

$1.3\ 10^{-24} \cdot 39\ 10^3\ Hz = 5\ 10^{-20}$ watt/m

— Steve

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Number ______
Priority ______

FCRAO PROPOSAL SUMMARY

Title: Search for narrowband and broadband artificial signals near the CO J=1-0 transition, along the North Galactic Axis

Investigators: S. Lord and C. O'Dea

Molecule CO J = 1-0

Frequency (GHz) 115

Days Requested 2

LST Coverage $10\text{-}19^h$

Total Hours 18

1981 Lord, O'Dea, Mass., 14m, 115 GHz, North Galactic Axis
2 days $l = 5°$

System Configuration:

Receiver: Cooled 3-mm

Sideband filter? No

Polarizer? No

4 Backends: 256 x 1 MHz, Autocorrelator = 256 x 20 kHz, 256 x 125 kHz, 1 x 400 MHz

Special Scheduling Requirements:

The 256 x 1 MHz backend is only avaliable during the given LST during the next two months.

Sensitivity at 1/4 MHz ≅ 1

Abstract:

A globally well-defined direction in which to search for the transmitter of an advanced galactic civilization would be the galactic rotation axis. As well as being readily locatable, such a transmitter could broadcast evenly to the entire galactic plane while appearing relatively unobscured to all potential observers. Such a transmition could be broadband, or, if narrowband, might display such features at frequencies adjacent to prominent naturally occuring spectral lines. We propose to search along the North Galactic Axis, (l=0, 0<b<90) in the vicinity of the J = 1-0 CO transition, for both broadband emission and narrowband features.

PROPOSAL SUMMARY

Introduction:

The search space that characterizes the SETI problem (Search For Extraterrestrial Intelligence) is very large. If we consider the free space microwave window as a reasonable candidate for a communications window, and multiply the number of 1 Hz channels contained therein by the number of independent spatial locations accessable to a moderate sized radio telescope, we obtain a search space containing $\sim 10^{20}$ cells. Even so, NASA is now preparing a 300 million channel spectrometer that will require a decade to search this space with a sensitivity of 10^{-23} Watts/m^2.[1] Increasing the sensitivity significantly would then require a greatly protracted search.

One historic way of attempting to circumvent this arduous route has been to make reasonable guesses as to the most probable frequency and location at which to expect transmissions, and to search these first. The favorites in this approach have long been the ubiquitous 21-cm line, and the nearby F, G, and K-type stars. While the 21-cm line does represent the most abundant element, and stands out conspicuously at a frequency of minimal galactic thermal emission, there are reasons to believe its use as a communications staging area are less than ideal. The superposition of the many 21-cm profiles found in every direction along the plane leaves no frequency adjacent to its rest frequency clear for transmissions. Further, interstellar dispersion is more detrimental to narrowband signals at this lower end of the microwave window. An alternative guess is to look for a signal near some other less pervasive, higher frequency transition such as SiO or CO.

As for the question of preferable stars, the search lists now compiled of solar type stars necessarily sample from such a very small fraction of the galactic volume that no statistical advantage is gained in the context of the overall problem.

A New Approach:

It is not unreasonable to consider that an extraterrestrial civilization might be far in advance of ours. Over half of the G-type stars presently found in our galaxy are believed to have been formed over 6.4 billion years ago.[2] Clegg and Bell[3] suggest that the mean metal abundance in the Galaxy has been roughly constant since the initial enrichment about 10^{10} years ago. Thus these stars are not likely to be deficient in heavy elements. This opens the possibility of an evolution beginning billions of years before ours. If we postulate that such an advanced civilization in an effort to initiate interstellar communication, has purposely placed a transmitter in an easily deducible location, where would that location be?

The galactic center might seem to be a suitable place, were it not for the violent nature of this region, and the fact that this position maximizes the confusion from natural sources within galactic plane. A better choice would be a location along the galactic rotation axis, where the confusion would be minimal.

The broadcast scheme from the axis is also the simplest, where a single beamed transmission could evenly illuminate the entire disk. All observers could then correct their velocity doppler shift to the rest frame of the galactic center.

Proposal:

We propose a modest search along the North galactic axis within the known error cylinder[4], which at this frequency would be only 15 beamwidths in diameter. Using the 115 GHz CO transition in the rest frame of the galactic center, we will search both for narrowband emission and excess continuum flux. In 18 hours we can expect to achieve the capability of detecting, at the 3 σ level, beacons of the following effective radiated power outputs, P :

$P > 5.2 \times 10^{30}$ ergs/sec	bandlimited to a single 20 KHz correlator channel
$P > 5.8 \times 10^{32}$ ergs/sec	broadband (256 MHz) signal centered on the CO rest frequency
$P > 1.2 \times 10^{34}$ ergs/sec	extremely broadband (100 GHz) emissio

References

1) Foncrief, F., Microwave Review, 19-23, March, 1979.

2) Tinsley, B., Astronomy and Astrophysics, 31, 463-465, 1974.

3) Clegg, R. and Bell, R., Mon. Not. R. astr. Soc., 163, 13-28, 197

4) Blaauw, A., Gum, C., Pawsey, J., and Westerhout, G., Mon. Not. R. astr. Soc., 121, 123-131, 1960.