# A Search for 1.35-cm Line Radiation of Possible Artificial Origin

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We propose a program to search for 1.35-cm line radiation from the vicinities of nearby stars that are likely to have accompanying planetary systems. The aim of the program is to seek evidence for the existence of extraterrestrial intelligent life.

Our present understanding of star formation and evolution, of cosmochemistry, and of terrestrial biochemical and biological evolution strongly suggests that life resembling terrestrial life may be abundant throughout Population I in our galaxy. The evidence favouring this conclusion is

1) Theories of star formation suggest that planets with gaseous atmospheres and surface liquid water may be quite common in the neighbourhoods of slowly-rotating single stars of Population I.

2) The biochemistry of terrestrial living organisms is based on the more abundant of the heavy elements in Population I environments.

3) Abiological synthesis of the probable chemical precursors of living matter has been successfully demonstrated under a wide range of plausible simulations of primeval planetary conditions.

4) The main-sequence lifetimes of the slowly-rotating Population I stars are sufficient to permit biological evolution to proceed on other Population I planets for as long as it has on Earth.

These considerations encourage the conclusion that the average distance between Earthlike biospheres in the solar neighbourhood could be as little as three parsecs, which is well within the "mutual detection range" of our more advanced radio transmitting and receiving systems. The average distance between technologically advanced societies capable of such radio contact must however exceed such a three-parsec estimate by a factor (call it F) depending on at least the following questions:

1) Whether or not the development of what we call intelligence confers long-term evolutionary advantages on an organism

2) Whether or not technical societies can forestall population overgrowth and/or self-destruction

3) Whether or not technical societies that become stable in terms of the problems in #2 can retain the capability for, and the interest in, interstellar communication for long periods of time.

The current literature of "exobiology" is full of essentially subjective estimates of F derived from terrestrial biological and sociological knowledge. All such estimates are <u>biassed</u> (because we could not make them if we ourselves had not evolved) and <u>of totally unknown variance</u> (because we are forced to base the estimate on one sample). It is therefore impossible to decide a priori whether F is close to unity, much greater than unity, or very much greater than unity. Our proposal is based on the premise that the philosophical, cultural and scientific value of being able to assign an empirical value to F would be so great that even "long-shot" experiments that could achieve this are worth some expenditure of telescope time on existing instruments.

Suppose we attempt to estimate the optimum "frequency window" for interstellar electromagnetic contact between societies that desire it. We can make an estimate independent of short-term technological limitations by considering the essential natural noise limitations in an interstellar communications channel. These are: at decimetre wavelengths the nonthermal galactic background, at centimetre wavelengths the 3 K background, and at millimetre and submillimetre wavelengths quantum noise (the rate of information transfer of a signal is limited by the number of photons transmitted in given time). The "minimum-noise window" is then approximately from 1 to 30 GHz between its 3 dB points.*

A systematic search of all Population I stellar neighbourhoods throughout this entire frequency band could well lead to detection of artificial transmissions that would lead eventually to the determination of F, but such a search is manifestly impractical with present resources, even if F were indeed close to unity. Perhaps the only palatable substitute for such a systematic search will be the use of radioastronomy equipment that already exists (for "established" purposes) to make much more spectrally limited searches.

We suggest that the 22-GHz water line has particular merit as a frequency for a limited search, because

1) It lies within the above "minimum-noise" window

2) The natural water-vapour sources in HII regions are unusual, anomalous emitters likely to attract the attention of astronomically-interested societies. Their "astronomical peculiarity" could serve to distinguish the water-vapour frequencies in the thinking of precisely the class of society with which communication might be achievable, i.e. "astronomers thinking something like us".

3) Water is of great biochemical significance to all terrestrial life and might therefore be of similar significance to other life.

There are few line frequencies that could meet all three of these (very possibly subjective) criteria.

We therefore propose a two-level program of 1.35-cm line observations of Population I stars that are likely to have planets, in search of "beacon signals" transmitted by water-based life to attract the attention of other astronomically-interested water-based life. The two levels of investigation would be

1) Fairly intensive ($\sim$1 day per star) observation of about a half-dozen very nearby (within 4 pc) stars that are likely on general grounds to have planets, or for which there is astrometric evidence for planets.

2) Less intensive ($\sim\frac{1}{2}$-hour per star) investigation of a much larger sample of stars, for example the list of several hundred stars included in the 21-cm "Ozma Revisited" program currently being carried out by Palmer and Zuckerman at the NRAO 300-foot. The scope of this study could be tailored to the willingness of the Program Committee to assign telescope time to an experiment with these aims.

The proposed initial search would be for <u>any</u> detectable line emission from the "target" stars. The incidence rate of "false

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* The window is narrower at the high-frequency end for present terrestrial technology because of atmospheric water-vapour emission, but this would not be a factor of importance to more technically advanced societies.

alarms" due for example to previously-unknown HII regions or to instrumental difficulties, could be estimated from the Purton-Feldman radio-star water-line program and by inclusion in this program of "random targets". Such "random targets" could, if observing time were at a premium, be synthesised by interchanging the role of the 'ON' and 'OFF' spectra for each target star. A merit of carrying out a search of this nature in the 1.35-cm line, compared to a similar search at the 21-cm line, is that the natural line background should be much weaker and less spatially extensive at 1.35 cm than at 21 cm.

The total observing time requested would be one week during the next six months for Part #1 of this proposal, and up to ten days during the next year for Part #2. More observing time would, of course, be requested if line radiation were detected from target stars, to investigate whether or not such lines could be of natural origin.

It will, clearly, be arguable that this experiment has a very small a priori probability of success, because of the essentially subjective and perhaps inevitably anthropocentric nature of the arguments that can be used to justify it. We submit however that this small probability of success may be balanced by the large potential impact of a positive result.