UNDERSTANDING THE SEARCH SPACE FOR SETI.

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Introduction: The SETI enterprise is basically a scientific search for incontrovertible evidence for the existence elsewhere of intelligent life forms. The reasons for writing this paper are simple – i) there is increasing activity in SETI coupled to resources of increasing sophistication (typically OSETI work and the ATA); ii) there is increasing interest in the big question: "Are we alone?", which is stimulated by the ever lengthening list of known exoplanets (see [1] which records 405 planets as of 27th November 2009); and iii) the time is right for considering the bigger picture to see how best to plan for SETI for the next 10 – 25 years.

Dimensions: The following factors can be thought of as rather obvious 'dimensions' of the search space for SETI: active versus passive, direct versus indirect, electromagnetic spectrum (and 'windows' through the earth's atmosphere, when considering terrestrial observations). In addition there are background assumptions concerning the nature of intelligence, motivations for searching and signalling, and etc., and these can be considered in relation to the big question "Are we alone?" rather than in relation to the dimensions of the search space.

History. It seems that the conception of SETI as we know it today grew out of a general interest in the big question considered in terms of the emerging technology of radio around 100 years ago. The concept has been refined, as has the technology, to focus mainly on *passive* terrestrial reception of directed signals in a favourable part (window) of the electromagnetic spectrum sometimes dubbed 'the water-hole' [2]. Radio transmissions are sought (in *passive* mode) in the SETI@home project, and optical searching (*passive* mode) for directed signals from targeted stars has also been done [3]. More subtle couplings between the 'dimensions' which appear to undermine any presumed orthogonality are also important – for example, we can conduct an undirected search but with the assumption that ETI is transmitting in a targeted way for reasons to do with energy requirements for omni-directional transmissions (our problem is then understanding the ways in which we might be considered a target). Undirected and unintentional 'transmission' is discussed below.

Active mode SETI. Assuming that the three 'dimensions' are orthogonal factors to be considered when conducting/planning SETI, then one obvious 'gap' in coverage relates to the almost complete absence of *active* mode work. However, there are many problems associated with message design and related assumptions concerning the nature of intelligence, cognitive universals, and the like. Assumptions in this area need to be worked through explicitly, and the full paper will address this issue. Another theme to be developed in the full version of the paper is that attempts to work in *active* mode need to be much more modest than has been the case so far. But in contrast, the identification of targets looks likely to get easier.

The requirement for limited ambition in the sending of messages concerns the semiotic inevitabilities – especially unbridgeable incomprehension – associated with attempts to design messages that say anything recoverable other than that which is obviously recoverable from the fact of message transmission and reception. The identification of targets, on the other hand, can be more readily contemplated as deriving from work on exoplanets or the use of paradigms such as that introduced by Edmondson and Stevens [4].

Leakage. However, there is actually a much more serious concern about the future direction of SETI that is revealed through the dimensionality account – especially if some conjectures about ETI's motivation are also tolerated (but then such things tend to be assumed anyway, so there is nothing new here). It is this – undirected radio transmissions in the form of 'leakage' have been considered as a possible undirected signal for passive detection of ETI, and dismissed for sensible reasons as implausible. But undirected optical 'leakage' has not been considered as a means for passive SETI, and it should be. This is the other major 'gap' in SETI efforts highlighted in the dimensionality account (passive, undirected, optical).

The argument goes as follows: i) incontrovertible evidence for the existence elsewhere of intelligent life does not mean that the evidence is intentionally broadcast by an ETI interested in SETI to another ETI (perhaps ourselves) doing its own SETI; ii) increasing awareness of exoplanets makes directed optical searching in passive mode quite realistic; iii) increased sophistication and power of optical telescopes makes eventually inevitable the instrumental scale required for direct observation of exoplanetary surface details of the sort we can see readily on our own planet in satellite images [5].

In short, SETI could readily come to focus on the use of advanced optical instruments (required and designed for optical work irrespective of SETI) to search for visible signs of life/intelligence that are the observable properties of inhabited planets rather than the outcome of designed signalling. Early suggestions that humans could modify the planetary surface with de-

signs of sufficient scale to signal presence (cf. the Great Wall of China) missed the point that organized habitation is visible at night for reasons which are likely to be as enduring as major architectural efforts and much more enduring than inefficient radio transmissions of TV programmes. In other words, consideration of the 'dimensions' reveals a point in the search space towards which we are inevitably heading for reasons other than SETI.

Are we alone?: How does consideration of the big question feed into the dimensionally driven perspective? Theoretical work on cognitive universals can inform our expectations concerning motivation and the move to more active mode searching. Optical searching with giant telescopes sufficiently powerful to detect land-mass outlines, cities, roads, rivers… all lit up at night… requires no motivation at all on the part of the inhabitants of the planet concerned. We are likely, here on earth, to have been found already through very large optical instruments and for the ETI concerned the big question has been answered directly, and without intentional help from us. This is about as minimal as it gets, with regard to assumptions about ETI's motivations, or indeed our motivations. This way of construing the scientific enterprise of SETI minimizes the motivational conjecture – for such an ETI the efforts at SETI are contingent on other science, and need be no more complex than that.

The full paper will cover both the difficulties of 'messaging' as part of SETI, and the prospect of a move over the next 25 years to direct visual observation as the route to go for SETI, as this presumes least of the supposed ETI and most of our own astronomical knowledge and instrumentation. Nonetheless – the motivation for *us* is still the big question "Are we alone?".

References:.

[1] http://exoplanet.eu/

[2] Dick, S.J. 1998. *Life on Other Worlds.* CUP. Page 216 – the remark is attributed to Bernard Oliver.

[3] http://seti.harvard.edu/oseti/

[4] Edmondson, W.H. and Stevens, I.R. 2003. The utilization of pulsars as SETI beacons. *International Journal of Astrobiology* **2**(4) : 231–271 (2003)

[5] http://svs.gsfc.nasa.gov/vis/a000000/a002200/a002276/europe_night_web.jpg