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When the Brightest is the Farthest

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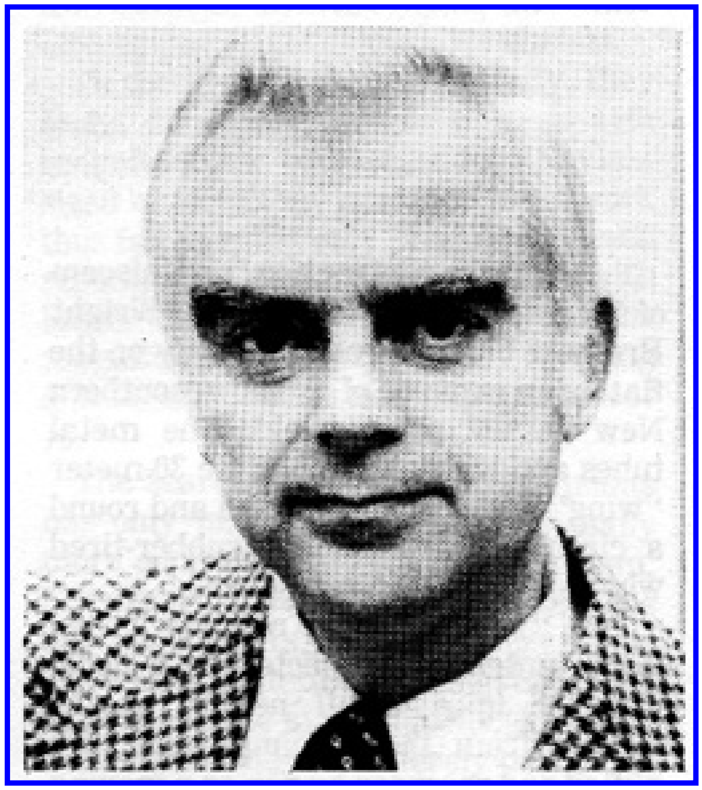
In the search for exterrestrial radio signals, where should we point our radio telescopes? The answer seems easy. Go out on a sparkling clear night and look at the sequin panorama of the sky; the blazing lights of the few first magnitude stars, seemingly silhouetted against the shimmering gossamer of the Milky Way and multitude of faint stars. Surely if we pointed our telescope at the brightest of stars, we would be looking towards the nearest of stars, and our chances of success would be greatest. Wrong!



The following is not a misprint: If you compare the list of the hundred brightest stars in the sky with the list of the hundred nearest stars, you will find only four stars in common: Sirius, Procyon, Altair, and Alpha Centauri. The nearest star, Proxima Centauri, is more than a hundred times fainter than the faintest star visible to the naked eye. The closest star after the Alpha Centauri system, Barnard's Star, is more than twenty times too faint to see. In fact, the typical magnitude of a star on the "closest star" list is something like the eleventh magnitude, about a hundred times fainter than the faintest star visible to the naked eye. Then just where are the ninety-six other bright stars on the "bright star" list? Far, far away. They still shine brightly because they are instrinsically very bright.

All of this is one of the cosmos' more clever tricks, almost as though nature were trying to invent a puzzle to prove that intuition can lead us astray. What has happened here? The processes of star formation have led to a huge range in the intrinsic brightness of stars, a range of a hundred million. There are far more of the faint stars than the very brightest; in fact, the density of the faintest stars is very roughly a million times higher than the density of the brightest stars. This relationship between star densities and brightness has been given the lofty name "luminosity function." It so happens that the luminosity function for our galaxy provides very few intrinsically bright stars. But, and this is why the trick works, there are enough of the brightest stars to cause the nearest ones, still so very far away, to outshine the truly nearest and faintest stars.

If an astronomer on Venus, theorizing that there are things like stars in the sky, lofted a small telescope above the canopy of clouds which had until then concealed the true appearance of the night sky from the Venusians, which stars would be first discovered (besides the Sun!)? We now know the answer to this. Not the nearest! They would be the farthest, the intrinsically brightest!

Now the luminosity function of the stars is nothing remarkable, no freak of the cosmos. All galaxies seem to have similar luminosity functions. And, so do the cosmic radio sources. The four brightest radio sources in the sky are not at all among the close sources; two are distant supernova remnants, one is a radio galaxy millions of light years away, and the other is one of the most distant radio galaxies we can photograph. The luminosity functions would have to be very different before the brightest things in the sky would be the closest.

There is a profound message here to those who plan the strategy for SETI. It is entirely reasonable that intelligent civilizations, too, have a luminosity function such that there are far more intrinsically faint civilizations than intrinsically bright ones. Then, as with the stars and cosmic radio sources, the easiest civilizations to detect will not be the **closest**, but will be the intrinsically brightest and **farthest!** A little math shows that this will be true even when for every 300 civilizations transmitting at certain radio power, there is but one civilization which transmits signals ten times more powerful. If anything, it is reasonable to expect the SETI luminosity function to produce even more relatively high power transmitting worlds than this. This will cause the brightest, farthest civilizations, to dominate the airwaves even more.

Alas, this says that the intuitively "right" strategy of "point towards the nearest stars," is probably not right at all. Instead, we should point in the directions where we will encompass the greatest number of stars within the radio telescope beam. Point towards the central plane of the Milky Way. Point towards the center of the galaxy in Sagittarius. Perhaps even point towards nearby galaxies. We can even cover all possibilities at once if we point in directions near the central plane of the galaxy where the telescope beam will also include nearby stars. The planners of SETI are aware of all this, and the plans for future major searches take the luminosity function into account.

The next time you are gazing at that glimmering night sky, and wondering where They might be, don't imagine Them to be next-door-neighbors. They, the bright ones, are probably among the myriad faint stars of the Milky Way.

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