Re: Fermi's Paradox and Seti

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- *From*: terry@xxxxxxxxxxxxxxxxxxxx (Terry Pilling)

- *Date*: Thu, 2 Feb 2006 20:26:50 +0000 (UTC)

Terry Pilling wrote:

Aside about Sagan: Probably you know that Sagan designed a famous plaque which was carried on the two Pioneer spacecraft and are now headed out into the galaxy like a ``galactic message in a bottle''. Well, on the plaque are some interesting and informative things, in particular, a distance scale is set by the hydrogen atom, which also sets a time duration scale in terms of the number of hyperfine transitions of the hydrogen atom. A time duration which we know to be 7.04024183647 x 10^−10 seconds and we can assume any other intelligence would also know this. With this time scale Sagan listed a bunch of pulsars along with their distance and periods of pulsation. For example, the 7th pulsar listed is PSR 0531 in the crab nebula (M1) [see: http://chandra.harvard.edu/photo/2002/0052/movies.html for something I consider to be very cool! I even put a question on an electrodynamics midterm exam last semester about the magnetic fields generated by this thing.] Its rate is given on Sagan's plaque as 47057538 hyperfine transition periods. This is 33.1 ms. However, the pulsar is slowing down at a rate of 10^−8 seconds per day! This means that since the launch in 1972 the pulsars rate has slowed down and is now only 33.3 ms. So any aliens getting our message (especially in a few million years!) will have great difficulty triangulating our position (all of the pulsars on the list are slowing down over time). In addition to this, the pulsars are all moving through space! So by the time an alien civilization gets the message the pulsars will all be in completely different relative positions to the earth, making the message useless!

So I have an idea for an update of the plaque: We should list, in addition to the pulsation periods, the decelerations of the pulsation periods. The decelerations would allow them to find the pulsars (assuming the decelerations are also constant) and the period data themselves will allow them to figure out the travel time of the spacecraft since launch, These will allow them to back trace the original positions of the pulsars at time of launch (assuming they know the relative motions of at least 4 pulsars) and thus finally triangulate our position at time of launch. Then forward track our local motion to find our position at the time of their discovery of the spacecraft!

> Whew! Sounds complicated I know, but the original plaque, without
> the deceleration data is impossible. As it stands now, the best
> way for an alien to find the earth from a discovery of the pioneer
> is to back track the spacecraft itself and forget the plaque altogether!

In the above, I say that one needs at least 4 pulsars to triangulate the position of the earth. I read that somewhere but now I am not so sure. Why can't one do it with fewer pulsar positions?
So on the plaque (http://en.wikipedia.org/wiki/Pioneer_plaque) there is the distances to the pulsars from the earth and on my revised version there would also be the deceleration data along with the period data of the pulsars. So the problem is this:

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Problem:

Given the distances to the pulsars _today_, the periods, and the decelerations of the periods, and assuming you can experimental determine the trajectories through space of the pulsars, what is the minimum number of pulsars needed at any time in the future so that a triangulation of the earth's future position can be made?
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The way I was thinking about it is that you would need 4, first determine the travel time of the probe since launch based on the current periods of the pulsars given the decelerations. Then track the pulsars back to their positions on the date of probe launch. Then draw spheres centered on each pulsar with radius equal to the distances given on the plaque. If there is a unique point of intersection of these spheres, then you have found the earth. In fact, even if there is a _discrete_ but finite number of intersection points, or even a finite one−dimensional line of intersection points (like a circle of relatively small radius), then enterprizing aliens could find us. So the problem could be restated (I think!) as `how many spheres does one need in 3 space so that their intersection is a `findable' set?' where by `findable' I mean finite discrete set of points, or a compact 1−dimensional manifold of points.

Anybody know how to solve this and what conditions are necessary to guarantee a solution?

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−Terry

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