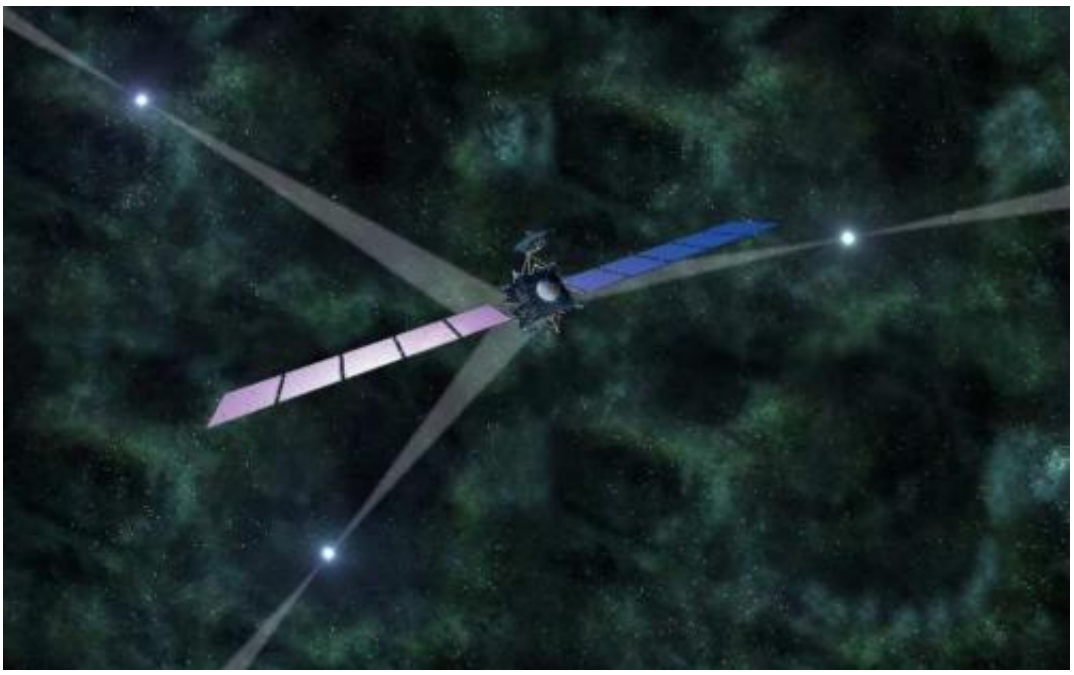
Scientists work out way to use pulsars to provide self navigation to spacecraft in solar system

May 24 2013, by Bob Yirka



Artist's impression of Rosetta, if it navigated in deep space using pulsar signals. The characteristic time signatures of pulsars are used as natural navigation beacons to determine the position and velocity of the spacecraft. Credit: arXiv:1305.4842 [astro-ph.HE]

(Phys.org) —A trio of German space scientists has worked out a way to use pulsars as navigation aids for space vehicles traveling in the solar system. As they describe in their paper uploaded to the preprint server

arXiv, the method relies on reading information from at least three pulsars to triangulate location information.

The current method of navigation for spacecraft is to send radio waves back to Earth—scientists can calculate its distance by noting how long the radio waves take to reach them. Unfortunately, that doesn't help to figure out its angular position. Generally, that's not a problem, however, because of the vast distances between objects in the solar system—it's likely to become more of an issue in the future, though, as space travel becomes more common. What's needed, scientists say, is a way for spacecraft to keep tabs on their position without assistance from Earth. That's what the team in Germany has done, using pulsars as guides.

Pulsars are strongly magnetized neutron stars that spin very rapidly. Because they spin, they appear to blink or pulse, hence their name. Scientists have suggested over the years that it might be possible to use them as navigational aids, but until recently, the equipment necessary to read and interpret such signals has been far too bulky to put aboard a space craft. Also, limited knowledge about pulsars has constrained their usefulness. The team from Germany says progress in both areas has now been made to such an extent that it should be possible to put such equipment aboard a space probe capable of keeping track of its position to within 5km.

Pulsars emit two kinds of signals that can be useful, radiation or x-rays. Both are emitted in cycles so precisely timed that they are comparable to atomic clocks. The researchers estimate a space vehicle reading pulsar radiation signals with 21 cm waves, for example, would require an antenna 150 square meters—that's still too big for practical purpose. For that reason, the team suggests a better approach would be to listen for x-rays. Optics have progressed to the point, they say, that a mirror on a space vehicle capable of hearing and interpreting them would weigh just 25 kilograms, small enough for actual use. That would be good enough,

they claim, to allow a spacecraft to triangulate its position to within 5km.

More information: Autonomous Spacecraft Navigation With Pulsars, arXiv:1305.4842 [astro-ph.HE] arxiv.org/abs/1305.4842

Abstract

An external reference system suitable for deep space navigation can be defined by fast spinning and strongly magnetized neutron stars, called pulsars. Their beamed periodic signals have timing stabilities comparable to atomic clocks and provide characteristic temporal signatures that can be used as natural navigation beacons, quite similar to the use of GPS satellites for navigation on Earth. By comparing pulse arrival times measured on-board a spacecraft with predicted pulse arrivals at a reference location, the spacecraft position can be determined autonomously and with high accuracy everywhere in the solar system and beyond. The unique properties of pulsars make clear already today that such a navigation system will have its application in future astronautics. In this paper we describe the basic principle of spacecraft navigation using pulsars and report on the current development status of this novel technology.

via ArxivBlog