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Planning for Reliable Earth-Mars Communication

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Human outposts on Mars are still many years away, but researchers on Earth are already planning for the day when two-way communication between the two planets becomes a 24x7 reality.

As things currently stand, continuous communication between planets isn't possible. Direct radio links between Earth and Mars can be strongly disturbed--and even blocked--by the Sun for weeks at a time. But a European Space Agency (ESA) researcher, working with engineers in Scotland, may have found a solution to the problem in the form of a new type of satellite orbit achieved with continuous-thrust ion rocket propulsion.

The problem facing the researchers was this: how to ensure reliable radio communication even when Mars and Earth line up at opposite sides of the Sun: a configuration that blocks signals between mission controllers on Earth and astronauts on the Red Planet. The natural alignment, known as a conjunction, happens approximately every 780 days, and would seriously degrade and even block transmission of voice, data and video signals.

According to the researchers' paper, "Non-Keplerian Orbits Using Low Thrust, High ISP Propulsion Systems," an innovative solution to the Mars communication problem may be found by placing a pair of radio relay satellites into a special type of orbit near Mars: a so-called 'B-orbit' (in contrast to an 'A-orbit', based on natural orbital laws). However, to counter the effects of gravity and remain in place, the satellites would have to be equipped with cutting-edge electric ion propulsion.

Ion thrusters, powered by solar electricity and using tiny amounts of xenon gas as propellant, would hold both satellites in a B-orbit in full view of both Mars and Earth. A solar electric propulsion system, using electricity generated from sunlight to emit chemical ions, would provides a tiny thrust--approximately equal to a strong human breath--but over a sustained period of time, "It's enough to move almost anything," says François Bosquillon de Frescheville, an engineer based at the ESA's European Space Operations Center in Darmstadt, Germany. Bosquillon de Frescheville is co-author of the paper, together with five engineers at the University of Strathclyde and University of Glasgow. With the ion thrusters' help, the satellites could then relay radio signals throughout the Mars–Earth conjunction season, ensuring that astronauts on Mars were never out of touch with Earth.

"What we have shown is that if you can provide continuous thrust, a pair of spacecraft could 'hover', respectively, over a point leading, and under a point trailing, the Mars orbit, and provide continuous radio communications between Earth and Mars," says Bosquillon de Frescheville.