Scots engineers prove space pioneer's 25-year-old theory

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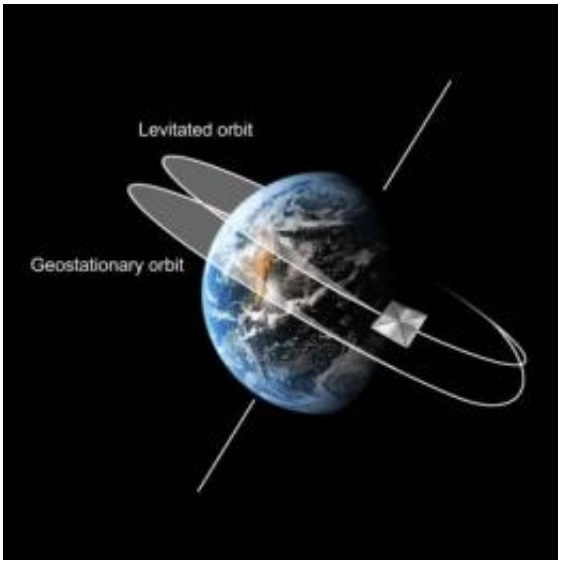

This is a schematic of displaced geostationary orbit. Credit: Advanced Space Concepts Laboratory, University of Strathclyde

When American space pioneer, Dr Robert L Forward, proposed in 1984 a way of greatly improving satellite telecommunications using a new family of orbits, some claimed it was impossible.

But now engineers at the University of Strathclyde's Advanced Space Concepts Laboratory have proved that Forward was right.

The late Dr Forward - a renowned physicist who worked in the United

States and from his second home in Scotland - believed it was possible to use 'displaced orbits' to deploy more satellites to the north or south of the Earth's equator, helping to meet the growing demand for communications.

He proposed that the orbit of a geostationary satellite could be pushed above - or below - the usual geostationary ring around the Earth, which follows the line of the equator, by using a large solar sail propelled by the pressure of sunlight. However, critics later claimed that such 'displaced orbits' were impossible due to the unusual dynamics of the problem.

Now graduate student Shahid Baig and Professor Colin McInnes, Director of the Advanced Space Concepts Laboratory, have shown that Forward was in fact correct, in a new paper published in the *Journal of Guidance, Control and Dynamics*.

Professor McInnes said:"Satellites generally follow Keplerian Orbits, named after Johannes Kepler - the scientist who helped us understand orbital motion 400 years ago. Once it's launched, an unpowered satellite will 'glide' along a natural Keplerian orbit.

"However, we have devised families of closed, non-Keplerian orbits, which do not obey the usual laws of orbital motion. Families of these orbits circle the Earth every 24 hours, but are displaced north or south of the Earth's equator. The pressure from sunlight reflecting off a solar sail can push the satellite above or below geostationary orbit, while also displacing the centre of the orbit behind the Earth slightly, away from the Sun."

Although the displacement distance above or below the equator is small - of the order of 10 to 50 km - work on hybrid solar sails, which use both light pressure and thrust from a conventional electric propulsion system,

is underway and aims to improve the displacement distance.

Professor McInnes added: "Other work is investigating 'polar stationary orbits', termed 'pole-sitters' by Forward, which use continuous low thrust to allow a spacecraft to remain on the Earth's polar axis, high above the Arctic or Antarctic. These orbits could be used to provide new vantage points to view the Earth's polar regions for climate monitoring."

More information: The papers described here are:

-- R L Forward, Light-levitated geostationary cylindrical orbits using perforated light sails, can be found in the Journal of the Astronautical Sciences, Vol.32, Apr-June, pp.221-226, 1984.
-- S Baig and C R McInnes, Light-Levitated Geostationary Cylindrical Orbits are Feasible, Journal of Guidance, Control and Dynamics, Vol. 33, No. 3, pp. 782-793, 2010.
-- A pre-print of the new paper is available at: strathprints.strath.ac.uk/18865/

Provided by University of Strathclyde