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Windmills in outer space

Light from the sun not only warms things it falls upon but also gives them a little push, says S.Ananthanaryanan.

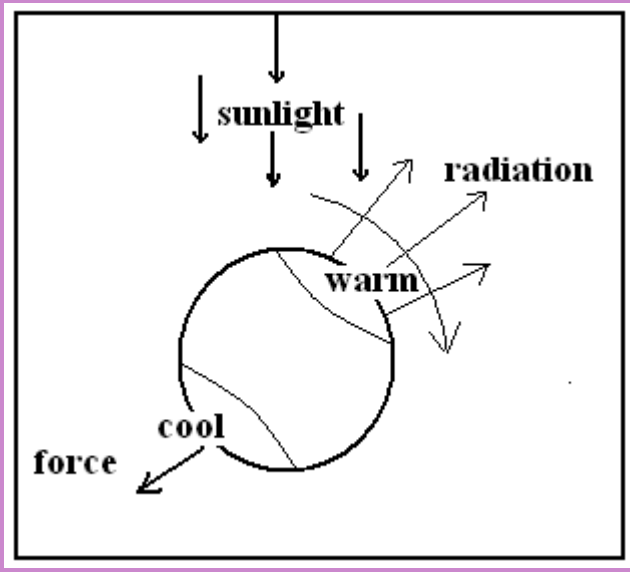
A dramatic proof of this pressure is the way a comet's tail swings away from the sun. Interplanetary space travel fueled by light pressure, on giant 'reflecting sails' has also been imagined. Scientists in Finland, Czech Republic, USA and Ukraine have reported this week that the sun's light has set an asteroid spinning, in an equally dramatic way!

Yarovsky and YORP

The Russian civil engineer Ivan Osipovich Yarovsky suggested in the year 1900 that the day and night heating of a small, rotating object in space, like an asteroid, could result in a minute force that would become significant over long periods. A related effect would be in the change of heating over the seasons, in an object that is not rotating. YORP is the Yarkovsky-O'Keefe-Radzievskii-Paddack effect – a variation of the Yarovsky effect, which would set an object spinning.

For a rotating and illuminated object, like the earth, the surface is warmer in the afternoon and early evening and cooler just before dawn and in the early morning. As warm surfaces radiate heat, in the form of photons that have momentum, the object feels a light force, from the warm side to the cool side.

Depending on the sense of rotation, the object could then be forced to slow down or speed up in its revolution around the sun. The object would thus spiral in or away from the sun!



In the case of an uneven, rotating object, the net effect of light pressure would not be just a force pushing the object forward or back, but would effectively turn the object around. The effect would be like the force of wind that turns the wanes of a windmill.

Asteroid 1862 Apollo

The Apollo class of asteroids are near-earth asteroids, some of which can get quite close to the earth's orbit. The class gets its name from 1862 Apollo, the first one discovered. 1862 Apollo was the first asteroid found to cross the orbit of the earth and it also crosses the orbits of Mars and Venus. It measures a little more than a kilometer across and even has a small satellite.

The YORP effect had so far been indirectly observed only through the clustering of the direction of rotation in asteroid families. But now the scientists report direct measurement of a significant rotating force, explained by YORP, experienced by the asteroid 1862 Apollo.

Detecting rotation

An object just 1 km across and in orbit the solar system is scarcely visible in a telescpope. But what is visible and even accurately measureable is the amount of light that it reflects at any moment. Watching this quantity of light and plotting it on a graph yields a picture of a rising and falling pattern that shows how fast the object is rotating - provided it is uneven and the reflected light varies as it rotates.

The scientists used extensive data of such light collection from the asteroid, over its appearances in 1980, 1982, 1998 and 2005 and have found that the speed of rotation of the asteroid is increasing at the rate of one extra turn every 40 years! This is fairly large, in the scale of astronomical objects and is significant in an object as large as 1.4 km across.

The results confirm that the YORP effect plays a significant part in the dynamical evolution of asteroids.