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Stable Orbits in the Didymos Binary Asteroid System – Useful Platforms for Exploration

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We have analyzed particle motion in binary asteroid systems to search for stable orbits.

In particular, we studied the motion of particles near the asteroid 1996 GT (Didymos), proposed as a target for the AIDA mission.

The combined gravity fields of the odd-shaped rotating objects moving about each other are complex. In addition, orbiting spacecraft or dust particles are affected by radiation pressure, possibly exceeding the faint gravitational forces.

For the numerical integrations, we adopt parameters for size, shape, and rotation from telescopic observations. To simulate the effect of radiation pressure during a spacecraft mission, we apply a spacecraft wing-box shape model. Integrations were carried out beginning in near-circular orbits over 11 days, during which the motion of the particles were examined.

Most orbits are unstable with particles escaping quickly or colliding with the asteroid bodies.

However, with carefully chosen initial positions, we found stable motion (in the orbiting plane of the secondary) associated with the Lagrangian points (L4 and L5), in addition to horseshoe orbits, where particles move from one of the Lagrangian point to the other. Finally, we examined orbits in 1:2 resonances with the motion of the orbital period of the secondary. Stable conditions depend strongly on season caused by the inclination of the mutual orbit plane with respect to Didymos solar orbit. At larger distance from the asteroid pair, we find the well-known terminator orbits where gravitational attraction is balanced against radiation pressure.

Stable orbits and long motion arcs are useful for long tracking runs by radio or Laser instruments and are well-suited for modelling of the ephemerides of the asteroid pair and gravity field mapping. Furthermore, these orbits may be useful as observing posts or as platforms for approach. These orbits may also represent traps for dust particles, an opportunity for dust collection – or possibly a hazard to spacecraft operation.