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Nongravitational effects in the motion of sunskirting comets

V. Emel'yanenko
Institute of Astronomy of the Russian Academy of Sciences, Moscow, Russia (vvemel@inasan.ru / Fax: +7-495-9515557)

Abstract

The orbits of multiple-apparition sunskirting comets 321P, 322P, 323P and 342P have been studied in order to ascertain the significance of nongravitational effects. We assert that nongravitational forces are definitely detectable in the motions of these comets. The nongravitational forces are irregular. There are strong nongravitational accelerations normal to the orbit planes.

1. Introduction

Many of the sunskirting comets with perihelion distances ~ 0.05 au have been observed in several apparitions [1]. In particular, comets 321P, 322P, 323P have been observed in five apparitions, and 342P has been observed in four apparitions. This allows us to study their orbits and to estimate nongravitational effects in their motions.

2. Methods

We determined the orbits of 321P, 322P, 323P and 342P using observations in all the apparitions. The gravitational attractions of all the planets were taken into account, and relativistic terms were included in the equations of motion. From consecutive pairs of the apparitions, we obtained four representations of the observations for 321P, 322P, 323P and three representations of the observations for 342P.

3. Nongravitational effects

From a comparison of the different values for the times of perihelion passage in orbits calculated from different pairs of apparitions, we can detect nongravitational effects in the motion. Nongravitational changes were estimated in 2001, 2004 and 2008 for 321P, in 2003, 2007 and 2011 for 322P, in 2004, 2008 and 2012 for 323P, in 2005 and 2011 for 342P. These computations show that there are nongravitational forces acting on the sunskirting comets. The nongravitational forces are irregular. Differences in the values of orientational elements provide evidence that nongravitational components perpendicular to the orbital planes are substantial. Table 1 shows an example of nongravitational changes for 323P near the perihelion passage in 2012.

Table 1: Changes of the orbital elements (the semimajor axis a, the eccentricity e, the inclination i, the argument of perihelion ω, the longitude of the ascending node Ω, the mean anomaly M) for 323P near the perihelion passage in 2012

Δa, au	0.000049±0.000389
Δe	0.000153±0.000040
Δi, deg	-0.1488±0.0528
$\Delta\omega$, deg	0.7023±0.2179
$\Delta\Omega$, deg	-1.3008±0.2192
ΔM, deg	0.0008±0.0004

Potential interpretations of detected nongravitational variations are discussed. In particular, comparisons are made with the results obtained in [2] for the Kreutz sungrazing system's dwarf comets.

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References

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