EPSC Abstracts
Vol. 5, EPSC2010-793, 2010
European Planetary Science Congress 2010

Non-gravitational effects and activity of comet C/2006 W3 (Christensen) and C/2008 Q3 (Garradd)

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1. Introduction

Two long-period comets: C/2008 Q3(Garradd) and C/2006 W6 (Christensen) were observed with instruments on Herschel Space Observatory on July, 2009 and November, 2009, respectively ([1], [2]). The former comet was observed close to its perihelion passage (Q) and the latter one four months after perihelion passage (Q). Both comets passed perihelion at a large distance from the Sun: C/2008 Q3 at 1.8 AU and C/2009 W6 at 3.1 AU. Nevertheless they were enough active to be perturbed by the non-gravitational effects. The orbital motion of the comets is investigated based on their positional observations. The orbital elements and the non-gravitational parameters specific for a given model are determined from the observational equations by the least squares method in an iterative process of orbit improvements. The non-gravitational perturbations in the orbital motion are considered using both isotropic and anisotropic models for outgassing. In the process of the orbit improvement the standard non-gravitational parameters (isotropic model) as well as the orientation of the nucleus, the location and size of active area (anisotropic model) are found from numerical fitting of the non-gravitational acceleration model to positional observations of a comet [3]. The non-gravitational perturbations together with the observed production rates are used to constrain the mass of comets. The observed activity of the comets is represented by: the production rates obtained from ground-based telescopes in a case of Comet Christensen (OH at Nançay and CO at IRAM), the Herschel measurements of the water production rates and the visual magnitude observations.

In the numerical calculations the equations of the orbital motion are also integrated in barycentric coordinates to derive the origin and future orbit for both purely gravitational motion and the motion perturbed by the non-gravitational effects (see Table 1).

Table 1: General characteristics of the orbital calculations. The successive columns signify: time interval of the positional observations, reciprocals of semimajor axis for osculating, original and future orbits, number of residuals, RMS of the orbital fitting for purely gravitational (g) and non-gravitational model (ng) of the orbital motion. The *original* and *future* are given in barycentric coordinates.

Time interval	1/a (AU)			No	RMS	
	osc	ori	fut	res.	"	
C/2008 Q3 (Garradd)						
q= 1.7982 AU, Perihelion time: 2009 June 23.09						
2008 Aug.27	112	263	728	1631	1.23	g
- 2010 Apr.22	173	276	726	1631	0.62	ng
C/2006 W6 (Christensen)						
q = 3.1262 AU, Perihelion time: 2009 July 6.66						
2006 Oct.29	-10	380	248	10957	0.56	g
- 2010 May 21	-1	381	264	10957	0.52	ng

2. Results

The outgassing is anisotropic for both of the comets. Comet C/2008 Q3 (Garradd) exhibits quite large non-gravitational accelerations and it was possible to derive the nucleus orientation and the location of the activity region from numerical fitting of the anisotropic model to positional observations of the comet. The spin axis orientation is: , . In this notation, is the obliquity of the orbital plane to the nucleus equator and is the solar longitude at perihelion. The center of outgassing is located at the latitude . The slightly asymmetric profile

of the production rate resulting from the parameters of the orbital solution agrees with the observed profile of the production curve. The mass of the comet is found to be about kg.

The non-gravitational orbital solutions for Comet C/2006 W6 (Christensen) prefer strongly asymmetric profile of the production rate in disagreement with the observed light curve. The level and nature of the non-gravitational perturbations are different before and after perihelion passage. It seems outgassing for the comet is not attributed to the local sublimation of exposed ice and comes from both the nucleus and the distributed sources. The mass of the comet is found to be kg. The dependence of the derived parameters on the assumed driver of the outgassing: H O and CO is discussed. The sublimation from nearly parabolic comets at a large perihelion distance is controlled by CO. Especially Comet C/2006 W6 (Christensen) exhibits large CO production rate (Q)[1].

Acknowledgements

This work was partially supported by Polish Ministry of Science and Higher Education funds (181/N-HSO/2008/0 and N N203 392734).

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