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ASTEROID CLOSE ENCOUNTERS WITH (704) INTERAMNIA

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Abstract.Interamnia is the seventh largest known asteroid with an estimated diameter larger than 300 km and was discovered (surprisingly late for such a large object) on October 2, 1910 by Vincenzo Cerulli. The technique of asteroid mass determination from perturbation during close approach requires as many as possibledifferent close approaches in order to derive reliable mass of a perturber. Here is presented list of newlyfound close encounters with the asteroid (704) Interamnia which could be used for its mass determination..

1. INTRODUCTION

The number of papers devoted to mass determinations of large asteroids is raising in recent years.There are several facts that influenced such a determination-the discovery of satellites of asteroids (e.g. [1, 2]), measurements by space probes that visited asteroids [3] and growing number of astrometrical measurements with increased precision [4].

As is well known, the method of minor planet mass determination that considers gravitational perturbations produced by asteroid on other bodies during mutual close encounter was developed first.

The aim of this paper is to introduce close encounters suitable for mass determination of seventh largest asteroid (704) Interamnia by astrometric methods.

2. SELECTION PROCESS

The initial osculating orbital elements for epoch JD 2451600.5, were taken from E. Bowell database (http://www.lowell.edu/users/elgb/). Perturbations due to all planets, Moon and seven largest main belt asteroids were taken into account. The

numerical integration of differential equations of motion of perturbed bodies is carried out by Everhart code.

The close encounters between (704) Interamnia and 12970 numbered main-belt asteroids for the period 1996-2054 were investigated. For searching of the close encounters a multistep selection procedure was applied that consists in the following:

- by means of a simple geometrical consideration the minimum possible distances between pairs of asteroid orbits were found
- by using two-body dynamics it was checked for a given pair whether such an approach might occur within the given period.
- a numerical integration in the framework of a dynamical model which include major planets and four largest asteroids was performed to determine the parameters of the close encounters.

Each of this steps significantly reduces the number of potential interesting cases of close encounters

3. RESULTS AND DISCUSSION

As a result of our procedure, we found 8 perturbed asteroids due to gravitational influence of the mass of (704) Interamnia. In order to calculate dynamical characteristics of close encounters we used its estimated (based on IRAS data) mass $2.40 \cdot 10^{-11}$ M sun . Geometrical and kinematical parameters of these close encounters between perturbing body Interamnia (Ast. 1) and perturbed (Ast. 2) asteroids are given in Table 1, where:

JD - the moment of the closest encounter
ρ - the minimum distance
Vr - the relative velocity
θ - the angle of deflection
ΔV_2 - the velocity change of the perturbed body

Table 1.: Geometrical and kinematical parameters of close encounters.

Ast.1	Ast. 2	JD	ρ[AU]	V_r [kms^{-1}]	θ["]	ΔV_2 [kms^{-1} x 10^{-9}]
704	651	2457499.0	0.005434	6.808	0.04	1170
704	977	2453653.8	0.009134	9.545	0.01	497
704	1467	2451214.0	0.006471	4.687	0.06	1427
704	1484	2458351.4	0.006955	11.854	0.01	524
704	6001	2450621.3	0.009895	6.327	0.02	691
704	7152	2461553.5	0.008935	6.002	0.03	807
704	7461	2450599.5	0.007481	5.300	0.04	1092
704	10034	2451851.2	0.008073	3.497	0.09	1533

The close encounters that occurred between the seventh largest body in main asteroid belt and recorded asteroids have some common characteristics.

The relative velocities are particularly high (greater than 5kmsec^{-1}) implying that these close encounters are not long lasting. As can be seen from Table

1, the minimum distances are small (lower than 0.01 AU). Consequently, gravitational influence (Table 2) of (704) Interamnia on these perturbed asteroids is not significant.

However, it could be seen that its close encounter with (1467) Mashona exhibits significant gravitational effects.

Table 2.: Dynamical parameters of close encounters. Absolute values of gravitational effects for all selected close encounters in right ascensions ($\Delta\alpha$) and declinations ($\Delta\delta$).

Ast.1	Ast. 2	$\Delta\alpha$ ["]	$\Delta\delta$ ["]
704	651	2.50	1.25
704	977	1.00	0.40
704	1467	6.05	3.24
704	1484	0.68	0.50
704	6001	0.30	0.10
704	7152	1.80	0.70
704	7461	1.04	0.35
704	10034	2.00	1.00

The relative velocity is low. Combining this fact with small value for minimum distance it was not surprising that gravitational influence is significant. Among found perturbed bodies, the four of them are high numbered. Namely, their designation is larger than 5000. It means they are relatively faint objects.

4. CONCLUSION

The most suitable geometrical, kinematical and dynamical parameters are exhibited in the case of close encounter with (1467) Mashona. It could be useful for mass determination of (704) Interamnia.

The cases of close approaches with bodies (6001), (7452), (7461) and (10034) indicate the existence of other close encounters of Interamnia with faint objects with similar dynamical characteristics, which could be observed by ESA astrometric mission GAIA during the next decade. Using faint objects will provide an enlargement of the number of close encounters and perturbed asteroids suitable for asteroid mass determination.

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