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SEARCH OF ASTEROID-ASTEROID ENCOUNTERS

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RESUMEN

Durante mucho tiempo los estudios relacionados con los asteroides no consideraban las interacciones entre los mismos, suponiendo en esos casos que sus masas eran despreciables. En 1966 Hertz considera por primera vez los efectos gravitacionales producidos por un asteroide sobre otro para la determinación de la masa del mismo. Para que esta acción gravitacional sea de consideración es necesario que se produzcan encuentros suficientemente efectivos. La más eficiente interacción gravitacional para asteroides es aquella que se produce en un largo intervalo de tiempo y a pequeñas distancias.

Como en general se tienen encuentros ocasionales entre asteroides, es importante saber cuándo uno de ellos es bueno para la determinación de masa. Sin embargo, es conveniente realizar en cada caso particular un análisis para determinar la factibilidad en la determinación de masa y elementos orbitales.

En el presente trabajo, hemos realizado una búsqueda de los encuentros ocurridos en el siglo XX entre los primeros 3000 asteroides numerados. De todos los encuentros que se produjeron, hemos seleccionado y analizado aquellos pares en los que un asteroide tuviera un diámetro mayor a 200 km y el otro, más pequeño, un intervalo de observación no inferior a 10 años.

ABSTRACT

Earlier studies about asteroids did not consider mutual interactions since they assume a negligible asteroid mass. In 1966 Hertz took into account for the first time the gravitational effects produced by an asteroid on another for mass determination. This gravitational action becomes relevant for enough effective encounters. The most efficient gravitational interaction is that produced in a large time interval and for small distances.

For each particular caseful it is relevant to perform a care analysis in order to determinate the feasibility in the mass determination and improved orbital elements.

In the present paper we performed a search of asteroid-asteroid encounters occurred in the twenty century for the first 3000 numbered asteroids. Of all encounters we have selected only those asteroid pairs in which one of the asteroids has a diameter larger than 200 km and the other one (the smaller) an observational interval of at least ten years.

Key Words: **SOLAR SYSTEM: MINOR PLANETS, ASTEROIDS**

1. INTRODUCTION

The mass of an asteroid is classically obtained by an analysis of its gravitational effects on the orbit of another asteroid. Currently, only for the six minor planets Ceres, Pallas, Vesta, Hygiea, Eunomia, and Interamnia, there have been results for their masses from gravitational interactions.

The object of this paper is to determine which asteroid-asteroid interactions occurring during the twenty century could be used for determining masses of asteroids greater than 200 km in diameter.

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2. INTEGRATION AND SELECTION CRITERIUM

A numerical integration of the first 3000 asteroid orbits was carried out to find asteroid encounters. The initial osculating elements of the asteroids were taken from the STAMP92. The masses of all asteroids were taken as zero for the integration. Planetary perturbations were provided by integration of the planet orbits at the same time. The initial positions and masses were taken from the DE200 ephemeris (Standish 1990). Once the integration was complete, the distances between all asteroid pair combinations were computed for each half day of integration. Those encounters of the largest asteroid that were less than 0.05 AU in distance were analyzed.

The selection criterion used to determine those encounters which could be useful to mass determination is based on the scattering angle. We can apply the formula for an asymptotic angular deflection in a restricted three-body planetocentric model as follows:

$$\tan\left(\frac{\theta}{2}\right) = \frac{GM\,(m+M)}{v^2 b M}, \tag{1}$$

where θ is the angle through which the asteroids are scattered by the encounter, M and m are the masses of the larger and smaller asteroids, respectively, b is the impact parameter, v is the relative speed of the two asteroids and G is the gravitational constant. Values for the masses are estimated from the asteroid radii. Assuming a density of 3 g/cm^3, and expressing the radius in km, the impact parameter in AU, and the relative speed in AU/day, the scattering angle becomes

$$\tan\left(\frac{\theta}{2}\right) = \frac{2 \times 10^{-21}\, r^3}{v^2 b}. \tag{2}$$

We compared the scattering angle of all encounters with the obtained for the pair Interamnia/Moultona. The encounters with a high scattering angle are the ones most likely to yield reasonable determinations of the larger asteroid's mass.

3. CONCLUSIONS

We make a different analysis of the results and we obtained:

1) A total of 130 asteroid-asteroid encounters were found which could be used to determine the masses of 23 asteroids.

2) A total of 4 possible resonances between pairs of asteroids were found.

3) A total of 5 occurrences of small asteroids interacting with more than one large asteroid were found.

REFERENCES

Hertz, H. G. 1968, Science, 160, 299

Stamp, A. P. 1992, Ephemerides of Minor Planets for 1992 Computer Version 1991. The Institute of Theoretical Astronomy, Leningrad, USSR

Standish, E. M. 1990, A&A, 233, 252