THE VESTA ASTEROID FAMILY: STUDY OF THE FAMILY AND CLOSE ENCOUNTERS WITH TERRESTRIAL PLANETS (II). D. Souami[1,2] , M. Galiazzo[3,4], S. Eggl[4], J. Souchay[2] and D. Bancelin[5], [1] Université Pierre & Marie Curie, 75252 Paris cedex 5, France (damya.souami@obspm.fr), [2] SYRTE, Observatoire de Paris, CNRS UMR 8630, UPMC, 61 avenue de l'Observatoire, 75014 Paris, France), [3] Department of Lithospheric Research, Univ. of Vienna, Austria (mattia.galiazzo@univie.ac.at), [4] Department of Astronomy of Vienna, [5] IMCCE, Paris Observatory, CNRS, UPMC, 77, Av. Denfert-Rochereau, 75014 Paris, France.

Introduction: The Vesta family is the largest asteroidal family known in the inner asteroid belt. Most of the identified members belonging to this family are V-type asteroids and are regarded as a source for Near-Earth Asteroids (NEAs). They are also thought to be the source of the HED (Howardite Eucrite Diogenite) meteorites. In particular, these are supposed to come from the crust of the asteroid (4) Vesta [2]. We first confirm their membership, using the AstDys data base of proper elements provided by [9] and by using the classical HCM algorithm [15]. By long-term numerical integrations, we study the chaotic diffusion of the family induced by the the Yarkovsky effect [14], and compare the results to our previous results where only gravitational effects were taken into account.

Method: We give the borders of the family in osculating elements with respect to both the mean ecliptic of the epoch J2000.0 and the invariable plane [13]. By taking a sample of 350 numbered asteroids belonging to the family, we study its diffusion over 50 Myrs taking into account non-gravitational effects such as the Yarkovsky effect [14]. In addition to the real sample we consider a fictious population with a random distribution, within the limits of the Vesta family and close to the J3:1 Mean Motion Resonance (MMR) with Jupiter (similar to [10]) and the ν_6 Secular Resonance (SR) with Saturn.

For both a synthetic and a real sample, we investigate the diffusion due to non–gravitational effects and compare the results to those obtained under gravitational forces and repeated close encouters with Ceres and Vesta [5],[6]. In particular we consider the three following cases: - a simplified planetary system (Sun, and Venus to Neptune) [5] – a system taking into account the gravitational effects of the Sun, the planets (Venus to Saturn) as well as the dwarf planet (1) Ceres and the asteroid Vesta [6], as multiple close encounters with Vesta are observed [1],[3],[6]. We isolate in particular the gravitational effects of Ceres and Vesta in the evolution of the family, and study the close encounters and potential impacts with Mars, the Earth and Venus, as well as with Ceres and Vesta.

We compute the angle of deflection, the encounter velocities, the possible dimension of the craters and the energy releases in the case of impacts [10],[11], as it was done for Hungarias [4]. We compare for the Vesta family and for Hungarias, the frequencies of encounters with the terrestrial planets and probabilities of impact are also investigated.

Finally, we deepen the analysis by introducing the Yarkovsky effect and proceed to an integration over 50 Myrs, using the Radau and Lie integrators [7],[8]. At last, we isolate the effect due to the Yarkovsky thermal forces, in particular we compare the semi-major axis drift due to repeated close encounters with both Ceres and Vesta [3],[5],[6], to the one induced by the Yarkowsky effect [1],[3].

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