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ABSTRACTS

PLANETARY SYSTEMS

THE USE OF THE MATHEMATICA SOFTWARE IN THE STUDY OF PLANETARY DYNAMICS

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This work presents a study on how techniques provided by the algebraic manipulation software Mathematica can be used in planetary dynamics investigations. The discovery of extra-solar planets orbiting other stars has been one of the major breakthroughs in astronomy of the past decades, changing our view on the features of planetary systems, mainly drawn from the observation of the Solar System. Today, over 1000 exoplanets are known and the Kepler satellite has recently identified over 3000 additional candidates, most of them still waiting for confirmation. We have learned that exoplanets are much more diverse when compared to our own Solar System. Thus, the implementation of advanced manipulation techniques can be of great importance for the investigation of such unusual configurations of these new worlds. We chose Mathematica, a software that has been increasingly used worldwide due to its great analysis power.

The case that we focus is the 2/1 mean-motion resonance in the two-planet systems. Based on the Mathematica platform, we present animations of the orbits of the Neptune-Pluto system and exoplanets in the 2:1 mean-motion resonance over a short-period of time. The visualization of this problem can be very important to an initial understanding of dynamical proprieties of resonant planetary systems and their stability.

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A DYNAMICAL MECHANISM TO PRODUCE HIGH-INCLINATIONS TNOS

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We discuss the dynamical formation of small Solar System objects beyond Neptune. The discovery of the first trans-Neptunian object (TNO) − except for Pluto and Charon − is relatively recent ($1992QB_1$). Many unpredicted dynamical and physical features not predicted in past theoretical models and are now showing up. Among them, we note the existence of many high-inclined orbits with respect to the eclipitc plane (where all Solar System bodies supposedly have formed).

The aim of this work is to show a dynamical pathway from the primordial planetesimal disk to high inclinations orbits in the trans-Neptunian region. The main mechanism requires that scattered planetesimals are captured into some exterior mean motion resonance (MMR) with Neptune and then be trapped into the Kozai resonance as well. After that, some planetesimals may access a resonance *hibernating mode* in which the planesimal is barely locked in resonance. We show that only a few percent of all scattered planetesimals would access the hibernating mode. But, once this mechanism is active, $\sim 100\%$ of the particles would escape both resonances while Neptune is in its final migration stage (after the LHB phase).

Our results could explain at least a portion (up to 80%) of the classical *hot* population, defined by $a_{2:3} < a < a_{1:2}$, $i > 5^o$, and $q > 36au$. Previous results indicate that this mechanism is the most likely to form the *detached objects* close to MMR with Neptune as, for example, $2004XR_{190}$ (Gomes, 2011, Icarus 215, 661). We have determined the most probable regions, in the orbital elements space (a, e, i), where detached objects would form close to 2:5 and 1:3 MMRs (Brasil, Gomes & Soares, 2013 - *submitted to A&A*).

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