SHORT TIME LYAPOUNOV INDICATORS IN THE CASE OF A SUN-JUPITER-SATURN-ASTEROID SYSTEM WITH A SPECIAL CARE FOR THE NEGHBOURHOOD OF THE 2:1 AND 3:2 RESONANCES

Róbert Ferenc Balla

Eötvös Loránd University,
1117 Budapest, Pázmány Péter sétány 1/A, Hungary. E-mail: brobi@innin.elte.hu

In our previous papers (Sándor ae al., Rom. Astron. J., 1999; Sándor et al., Cel. Mech and Dyn. Astron., 2000) we have discussed the application of the short time indicators in the planar circular Restricted Three Body Problem (RTBP) and in the Elliptic Restricted Three-Body problem (ERTBP) in order to distinguish between chaotic and regular domains of the phase space in these problems. The method of stretching numbers was introduced by Voglis and Contopoulos (1994). This method allows a quick distinction between ordered and chaotic regions in Hamiltonian systems of 2 or 3 degrees of freedom, or in 2D and 4D symplectic mappings. Comparing our results with the corresponding Poincaré's surface of section shows this method to be useful for a quick separation between regular and chaotic domains of the phase space. We showed that this method of short-time indicators is very efficient and it needs only 20 iterations per orbit. We also applied the method of stretching numbers to the elliptic restricted three-body problem. As an extension of our investigation, we applied the method of stretching numbers to a realistic Sun-Jupiter-Saturn-Asteroid (SJSA) problem. We represented the structure of the phase-space in the $a-e$ plane, where a is the semimajor axis and e is the eccentricity. For an individual $<s>_N$ curve, where $<s>_N$ is the average value of stretching numbers, the values of the semimajor axis have been taken from the interval $[3.2, 5.2]$ (AU) for a fixed value of the eccentricity of the test particle between $e=0$ and $e=0.4$. For a good visualization of the regular and chaotic regions in the $a-e$ plane we have processed the curves of average values calculating the absolut value of their "derivative" $|\frac{\Delta<s>_N}{\Delta a}|$, where $\Delta a = a_{i+1} - a_i$ is the difference between two consecutive initial semimajor axis and $\Delta <s>_N$ is the corresponding change of the average value of stretching numbers. If this derivative is larger than a certain value (in our ! case 0.002), the corresponding region between two neighbouring initial conditions is classified as chaotic. Of course, this method is very empirical, and not necessarily gives reliable results. Its usefulness is based on the very fast and effective way how it approximates the location and size of the regular and chaotic regions. We have found that the structure of the phase-space is very similar in the RTBP and in the ERTB but there is a significant difference in the case of the SJSA. It seems that with the method of stretching numbers we can have a quick distinction between ordered and chaotic domanins in the case of the SJSA too. Using this method I also analised the structure of the $a-e$ plane in the neighbourhood of the $2:1$ and $3:2$ resonances.

The numerical calculations were done by the computer system of the Depatrment of Astronomy, Eötvös University granted partially by the Physics Program of the PhD School of the Eötvös University. The grant OTKA F030147 of the National Research Foundation are also acknowledged. The research was partially sponsored by Ericsson Hungary Ltd..