APPLICATION OF CHAOS CONTROL

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Orbital resonances are ubiquitous in the Solar system. They play a decisive role in the Long term dynamics and in some cases the physical evolution of the planets and of their natural satellites, as well as the evolution of small bodies (including dust) in the planetary system. The few-body gravitational problem of hierarchical planetary-type systems allows for a complex range of dynamical timescales, from the fast orbital periods to the very slow orbit precession rates. The interaction of fast and slow degrees of freedom produces a rich diversity of resonance phenomena (Malhotra, 1994).

Chirikov (1979) has shown how to make an approximate map for some problems. He emphasized that large class of resonance problems can be approximated by a pendulum - like Hamiltonian. This was for example, demonstrated above for the spin-orbit problem near synchronous rotation. Chirikov demonstrated that if neighbouring resonances are of comparable strengths than the qualitative behavior in the resonance region of the phase space can be expected to be similar to that of the "Standard map" of the plane into itself.

Wisdom (1982, 1983) used the same principle to construct an approximate map for motion near mean-motion commensurability. The terms with highest frequency and the orbital frequency are removed by averaging. Now the approximate map has only resonant and secular terms. New high frequency terms are added in such a way that periodic delta functions are formed. The new equations can be integrated across the delta function and between them, giving a map of the phase space onto itself.

Champenois and Vienne (1999) have studied the chaos and secondary resonances in the Mimas-Tethys system by taking third order resonances into account.

The main objective of studies in this thesis is to study the control of chaos in Mimas-Tethys system partially by considering the effects of tidal terms in Newtonian system on the line shown by Champenois and Vienne (1999) and in the Hamiltonian system we have followed the Tittemore and Wisdom's "Ecentric-inclined model" (1990) by taking third order resonances (Champenois and Vienne, 1999) into account. The whole study has been divided into four chapters:

Chapter one comprises with ten sections. Section one deals with the development of Applied Mathematics, Mechanics and Celestial Mechanics together with extensive reviews of the concerned works. Section two is about the disturbing function . Section three is about their commensurability conditions. Section four deals with the resonance in various systems. The next section is about solar system dynamics. The sixth section contains the chaos and chaos in solar system. The seventh is about averaging principle. Eighth section is about the development of pendulum model. In the ninth section we have defined some technical terms used in this thesis and in last section we have given the objective of the present work.

In chapter two we have studied the irregular and chaotic evolution in Mimas-Tethys system. This chapter contains four sections. Section one is introductory. While section two contains derivation of equation of motion. In section three, we have obtained disturbing function of various resonant arguments and the result is discussed in section four by the help of the graph of different disturbing functions, Poincare surface of section and time series plots at different eccentricities.

Chapter three has been divided into three sections. Section one reveals a brief introduction. Hamiltonian function has been determined in the second section. In section three, we have derived the averaged Hamiltonian of third order resonances in the Jacobian coordinates of the three body problem of Saturn, Mimas and Tethys system.

In chapter four we have discussed the role of primary third order resonances on Mimas-Tethys system. This chapter contains four sections in which the first one is the brief introduction. In section two equation of motion is derived and its result has been discussed in section three of this chapter. Fourth section contains the tables of different values which have been used in drawing the graph of the Hamiltonian.