Dynamics of a satellite and normalization around Lagrangian points in the Neptune-Triton system

T. Yokoyama (1), T. J. Stuchi (2), C. R. Solórzano (3), A. A. Corrêa (3), A. F. B. A. Prado (3), O. C. Winter (4), S. M. G. Winter (4) and D. M. Sanchez (1)

(1) Universidade Estadual Paulista-Rio Claro, (2) Universidade Federal do Rio de Janeiro-R.J., (3) Instituto Nacional de Pesquisas Espaciais-S. J. Campos, (4) Universidade Estadual Paulista-Guaratinguetá

Since a mission to Pluto-Charon is in progress, a similar mission to Neptune-Triton system, probably is just a matter of time. Besides the interesting items listed in the Hammel's proposal to explore Neptune (Hammel et al 2002), there are others very interesting points : Triton is a very large satellite with $M_T/M_N \approx 2.09 \times 10^{-4}$ where M_T and M_N are the masses of Triton and Neptune respectively. Its current inclination with respect to Neptune's equator is about 157.345^0. This unusual high and retrograde inclination for a very large inner satellite, makes this problem unique in our solar system. Hammel et al (2002) also propose that a top priority in this mission should be a Neptune-Triton orbiter (not just a flyby tour). Therefore, assuming a massless spacecraft orbiting Neptune-Triton system, basically the system can be stated in terms of the classical restricted three body problem. The new ingredient is the Neptune oblateness and the retrograde motion of Triton. With some slight displacements, the lagrangian equilibria points still exist, as well as many of the properties of the classical problem. In this work we first give an extensive numerical exploration in the case when the spacecraft orbits Triton, considering Sun , Neptune and its oblateness as disturbers. In the plane ($a \times I$) where **a** is the semi major axis and I is the inclination of the orbiter, we give a plot of the stable regions where the massless can survive for thousand of years. Retrograde and direct inclinations were considered and as usual, the region of stability is much more significant for the retrograde inclinations. Next we explore the solutions in the neighbourhood of the lagrangian points. The problem is written in terms of an Hamiltonian system and Birkhoff normalization is constructed, for elliptic and hyperbolic points. For the last case the reduction to the central manifold is performed. Periodic and quasi periodic orbits are obtained. Therefore, the planar Lyapunov family of orbits emanating from L_1 and L_2 and three-dimensional Halo orbits can also be obtained. These family of periodic orbits are very important especially the Halo orbits since they can be used to host space orbital station. The Lyapunov orbits surrounds one or two primaries and therefore, among many other important applications, they are very useful in the case of transfer of orbits in space missions when the question of fuel cost is involved.