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Seminar: Analytical approximations to the restricted 3-body problem dynamics: the case of Distant Retrograde Orbits

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Abstract:
The known non-reducibility of the restricted three body problem (R3BP) by means of first integrals makes its global dynamics be necessarily approached numerically. Still, the analytical approach is feasible in the computation of relevant solutions. In particular, the R3BP has been thoroughly investigated by perturbation methods in two cases: for motion close to one primary, and in the case of motion about the libration points. Out of the Hill sphere, the analytical approach is also feasible. However, because in this last case the dynamics depends essentially on special functions, the computation of accurate analytical solutions becomes a specially difficult task.

The talk focus on the Hill problem, a limit case of the three-body problem in which two of the involved masses are very small when compared to the third, dominant mass. The fact that, after a convenient nondimensionalization of the physical units, the Hill problem does not depend on any physical parameter, endows this dynamical model with a wide generality. Besides, the simplicity of the Hill problem eases the discussion of the different cases that make the perturbation approach natural.

Thus, particular arrangements of the Hill problem equations allow to compute perturbation solutions useful in different regions of the phase space. Indeed, when the body of negligible mass evolves inside the sphere of influence of one of the primaries, the Hill problem can be viewed as a case of perturbed Keplerian motion. On the other hand, the arrangement of the Hill problem as a perturbed harmonic oscillator eases the computation of analytical solutions valid in the vicinity of the libration points. Finally, the nature of distant retrograde orbits is easily disclosed by taking the nonlinear part of the Hill problem equations as a perturbation of the linearized dynamics. In this last case, a higher order analytical solution is presented than captures the librational dynamics of this kind of co-orbital motion.