Author: L. DELL'ELCE
INRIA (France)
Title: *"Optimal Low-Thrust Orbital Transfer by Averaging Multiple Frequencies"*
Abstract. When the state of an Hamiltonian system can be decomposed into slow and fast oscillatory components, averaging the equations of motion over the instantaneous period of the fast variables is a valuable practice to simplify the dynamics of the system and gain understanding of the long-term evolution of the flow. The perturbed Kepler problem belongs to this category. Hence, averaging techniques were exploited in astrodynamics since the early space age to develop efficient analytic or semi-analytic orbital propagators. More recent contributions in optimal control were addressed to the study of extremal flow of low-thrust orbital transfers in energy and time minimization.

Averaging the controlled system facilitates the challenging task of providing a reliable initial guess to shooting algorithms. The quality of this guess can be possibly enhanced if multiple fast-oscillating perturbations are accounted for, e.g., sectorial gravitational harmonics or third-body perturbations. Nonetheless, available results in control consider a single fast variable, namely the angular position of the satellite on a slow-varying orbit.

In this talk, we discuss the orbital transfer problem in the presence of multiple fast-oscillating perturbations. Although the enhancement of the realism of the model is appealing, averaging multiple frequencies is only mathematically sound when the instantaneous frequencies are non commensurable. However, important applications exist where near-resonant regions are crossed or even targeted. For example, geosynchronous orbits exhibit a one-to-one resonance between the orbital and the Earth rotation periods. In this case, averaging over the two variables independently lacks a rigorous justification. A preliminary step is to use frequency map analysis to gain insight into this problem.

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