Stellar Physics

PLAnetary DYnamics and Stellar Evolution

SUMMARY.

Stellar evolution for stars of low and intermediate masses after the end of the Main Sequence (MS), is a period of drastic changes both for the star itself but also for its circumstellar environment. During the journey from the Red Giant (RG) to the White Dwarf (WD) phases, a significant amount of the stellar material is expelled with mass loss rates reaching values up to $10^{-4}\,M_{\odot}\,\mathrm{yr}^{-1}$ in extreme cases. The dynamics of planets and small bodies around the central star will be deeply modified by the interaction with the circumstellar environment. Several non gravitational effects have to be considered and included in the dynamical equations such as frictional forces, interaction of the planet with its own wake, accretion and evaporation etc. . . , in order to understand their influences on the fate of a planetary system in the late stages of stellar evolution.

OBJECTIVES

The students will study the planetary orbits and small bodies motion during the late phases of stellar evolution. Several non gravitational effects caused by the changing characteristics of the central star and the interaction with the circumstellar environment resulting from the mass loss, must be included. The students will be introduced to the theory of stellar winds and the related non-gravitational mechanisms involved.

- Students will be able to model gravitational and non-gravitational forces in N body problems
- Students will learn about stellar winds

PREREQUISITES

Fundamental courses linked/coming in support to this METEOR :
Stellar Physics; Dynamics and Planetology in particular orbits computation), Numerical methods (in particular: ODE integration, fixed and variable step integrators)
The student should know Python and/or C language

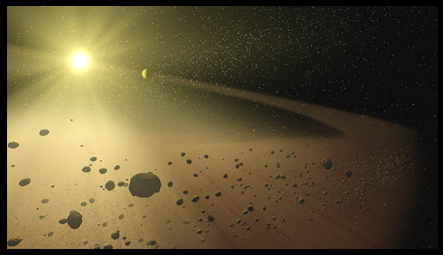
THEORY

by Ph. Bendjoya & G. Niccolini

Restricted three body problem. N body problem (N small). Non gravitational forces : friction, wake , mass loss, Yarkovsky. . . Introduction to stellar winds (isothermal, polytropic, dust driven, . . .)

APPLICATIONS

by Ph. Bendjoya & G. Niccolini



MAIN PROGRESSION STEPS

- First half of the period : theoretical courses : Winds , reviewing 2 body and restricted 3 body problem.
- First half of the period : Numerical exercises. Introduction of different non-gravitational effetcs.
- Second half of the period : numerical projects: application to the student selected problem. Qualitative and quantitative exploitation
- Last week : preparation of the final oral presentation.

EVALUATION

- Type of examinations: written exam, reports on the exercises and personal projects.
- 50% exam 50% report.
- The student will be evaluated on the autonomy, critical thinking, quantity and quality of their work, exploitation of the results

BIBLIOGRAPHY & RESSOURCES

ask to the coordinator

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