First Semester Report

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Ph.D. Thesis title: Stability Analysis and Modeling of Dynamical Systems

1 Introduction

The object of the research is the stability analysis of a family of periodic solutions of the gravitational n-body problem called Elliptic Relative Equilibria (ERE) solutions. From a mathematical point of view, the motivation is to understand how stability analysis works in a non-trivial, but relatively simple system. The main question of the stability analysis is that, once an arbitrary but small initial perturbation is added to the initial conditions, would the new perturbed trajectories oscillate around the original base solution, or is the dynamics going to be entirely different? The first step to tackle this problem is to study the linear stability of the base solution. However, if a linearized system shows stability, it does not necessarily mean that the original non-linear system obeys the same stability criteria. The linear stability technique used is the Floquet analysis, which is the linear stability method for periodic systems. The research aims to sketch the linear stability diagrams of certain ERE solutions, and afterwards to verify by numerical simulations of the original n-body system if the linear and non-linear stability criteria are the same or not.

2 Description of research work carried out in current semester

By the end of the passed semester I have finished the python code implementing the all the Floquet stability analysis and numerical n-body simulations used for verification. All data processing and examinations are planned to be finished by August (linear stability diagrams, and numerical simulations for verification).

3 Publications & Conferences in current semester

I have already started writing the draft of the article. That paper writing process will be on focus in August when all my results are ready.
My short talk was accepted for presentation at *The Ninth International Meeting on Celestial Mechanics* (CELMEC IX), which will be held in Italy from 14 to 18 September 2026. The goal is to upload the paper to arXiv before the conference and submit it for publication shortly after the conference.

I participated in two summer schools in it the topic of celestial mechanics:

- 15th CELTA-Cortina Advanced Study Institute (ASI), Dynamic Solar Systems: The Exploration of Exoplanetary and Solar System Bodies.
- CIME summer school, New Challenges in Celestial Mechanics (organized by the Italain mathematics institute *ondazione C.I.M.E. Centro Internazionale Matematico Estivo*)

4 Studies in current semester

- FIZ/3/017E: Physics of environmental flows – grade 5
- VTN-099:133: Rowing (BEAC training) - grade: 5

5 Grants

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