

First Semester Report

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

1 Introduction

The object of the current 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 current 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

In the past year, I have formulated the linear stability analysis formalism for the ERE solutions by applying Floquet analysis. We (the code implementation of the linear stability diagrams was partly done by Botond Osváth) have constructed the linear stability diagrams of five different ERE solutions. Some of these are new and unpublished results. The current step is to verify by numerical simulation of the original n n-body equations whether the linear stability criteria are equivalent or not equivalent to the non-linear stability conditions. Besides code implementation and data processing, I have spent time learning the relevant stability analysis literature.

3 Publications

An article on the ERE project is planned to be submitted by 31 March 2026 to apply to the conference CELMEC IX (The Ninth International Meeting on Celestial Mechanics).

4 Studies in current semester

- FIZ/5/053: Chapters from modern celestial mechanics - grade: 5
- FIZ/3/075E: Extremes, Records, and Order-Statistics in Nature - grade: no grade

5 Conferences in current semester

- The Art of the Invisible Force: The Dynamics of Equilibria Near and Far, Scientific Conference in Honor of Bálint Érdi, June 2 – 4, 2025

Talk: *Stability analysis of elliptic relative equilibrium solutions*

- Assembly of Hungarian Astronomers, Sept. 5, 2025

Poster: *Linear Stability Analysis Method for Elliptic Relative Equilibrium Solutions*

6 Professional activities

I have proposed a task for the 2026 Rudolf Ortvy Competition.