1. Semester report

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PhD Thesis Title: Dynamics and morphology of protoplanetary disks and galaxies

Introduction

One of the questions that have been fascinating humanity since the dawn of history is how the Earth and other celestial bodies came into existence. Initially, the explanations were mythological, philosophical and not scientific in nature. As astronomy, physics and mathematics developed, we learnt more and more about our place in the world and how it currently works.

Newton successfully explained why planets orbit the Sun on an elliptic trajectory, but not how the Solar System came to be. The first scientific explanation was given by Kant then Laplace, who said that the Sun and planets were formed by the gravitational collapse of a nebula. The current theory is built on this idea, but it is significantly more complex. We know that gravitational collapse is not the only effect that matters, the interaction of dust particles with gas and themselves is very important, as well. This modern theory of planet formation can be attributed to Safronov. The current research is about refining his model and matching it to observational data.

The concept of (extra)galaxies is relatively recent. Besides the stars, other objects can be seen in the sky, for example “spiral nebulae”. It was an open question for some time whether they are inside the disk formed by stars, or outside of it. This was answered by Hubble, as he managed to resolve individual stars in the Andromeda nebula, as well as measure its distance. It was settled, that multiple galaxies exist and our Milky Way is only one of them. Hubble also created a classification scheme for galaxies. Since then, as technology evolved, we observed more and more galaxies with lots of different properties and measured quantities. The formation and evolution of galaxies and the connection between different properties is still an open field of study. As galaxies are complex systems, studying them with analytical calculations is almost impossible, thus we use numerical simulations.

Description of research work carried out in current semester

In this semester with my co-supervisor, Áron Süli, we examined the one-particle dust sedimentation and grain growth model in protoplanetary disks, its history and different versions. The different models usually lead to an ordinary differential equation or a coupled system of differential equations, which can be solved numerically. We compared the numerical solutions of the different models given the same initial conditions.

Publications

With my co-supervisor, Áron Süli, we plan to publish three articles in the next semester about dust sedimentation and grain growth in protoplanetary disks. Two of them would be published in Fizikai Szemle. The first one would be about the summary of the topic and he would be the first author. The second one would be about new results and I would be the first author.
The third one would be published in the A&A journal and it would be the two Hungarian articles joined.
At the moment the first article is about 80% finished.

Studies in current semester:
In the first semester I signed up for two subjects:
FIZ/5/003 Astrostatistics (lecturer: Lajos Balázs), grade: good (4)
FIZ/5/017 Chapters from modern astrophysics and cosmology (lecturer: József Vinkó), grade: TBA