4300430: Introdução à Cosmologia Física

Final Project

In the second half of the course, you will organize yourselves in groups and work on a final project about a topic in Extragalactic Astronomy or Cosmology. Each person in a group will write an individual paper. The individual paper will comprise 50% of your total grade. I recommend you start working on your Final Project around the middle of the semester, so that you have time to do a good job at the end.

Rules:

1) The paper **must** be written in LaTeX Therefore writing your problem sets in LaTeX is good practice for writing your Final paper.

2) If your paper is written in English you will get up to 0.5 extra point, depending on your proficiency.

3) If your paper includes numerical calculations and/or figures made by yourself related to your project, you will also get up to 0.5 extra point in addition.

You and your group will choose from one of the following topics for your final project:

- **Halo Model**

  You will combine results from the course Problem Sets with new computations and perform a Halo Model calculation of the non-linear matter power spectrum. You will 1) use the linear power spectrum from CAMB to compute the variance of the linear density field, 2) use this variance to compute the halo mass-function and bias, 3) compute the halo profile, 4) put it all together into the non-linear power spectrum and 5) compare your results to the non-linear spectrum provided by the halofit prescription from CAMB.

- **N-body Simulations**

  You will follow Andrey Kravtsov's notes to perform a Particle-Mesh (PM) N-Body Simulation. You will 1) set up particle initial conditions, 2) define a density field from particle positions, 3) Fourier transform this density field and obtain the potential through Poisson Equation, 4) Transform back to get the potential in real space, 5) Compute the gradient of the potential to get the force/acceleration acting on each particle, 6) Update particle velocities and positions in time, 7) Evolve the simulation from high redshifts ($z \sim 50$) to $z \sim 0$), 8) Analyse simulation outputs, 9) Make visualizations.

- **Photometric Redshifts**

  You will use a couple of photometric redshift codes to estimate photo-zs of galaxies. You will perform a statistical analysis of your results to assess the photo-z quality.

- **Modified Gravity**

  You will perform analytical and numerical computations of $f(R)$ gravity.