Metodos numericos en Astronomia Teorica, lecture 1

Dominik Schleicher

Universidad de Concepciòn,
Departamento de Astronomía

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Important

- This is not a programming class. The class assumes that you know about programming.
- If you are not sure about programming, I strongly recommend to fresh it up, with a Python or Fortran tutorial.
- There will be some exercises on programming, on the level of "Programación Astronómica", for refreshing your programming skills.

How will we organize this class? (1)

- This will be a somewhat experimental class to teach numerical methods for astrophysics.
- The class will have different components, videos with explanations on numerical methods, and also reading material to be studied at home.
- Also slides will also be available online for students who cannot watch videos.
- We may also have live components to allow for questions and discussions.
- The first two weeks, we will have the "marcha blanca" to adjust the modality of the class if needed. There are no exams during that time.

How will we organize this class? (2)

- Part of the class will be based on the book "Numerical methods in Astrophysics. An Introduction" by Bodenheimer, Laughlin, Rozycyka and Yorke.
- In some classes, I will provide videos with introductory material on numerical methods.
- You will also regularly receive reading assignments based on the book.

Topics I will cover through videos (1))

- Numerical accuracy.
- Numerical integration
- Root finding
- Newtonś method in 1D and 2D
- Time integration
- Runge-Kutta methods
- Adaptive timesteps
- stiff equations

Topics I will cover through videos (2))

- implicit methods
- N-body dynamics
- Gravitational force calculation: tree method
- Schródinger type equations
- Numerovś method
- Shooting method
- Physical stability
- Numerical stability

Topics I will cover through videos (3))

- Smoothed Particle Hydrodynamics
- Partial Differential Equations (PDEs) - Classification
- Solving the Poisson equation
- Fourier Transformation
- The Poisson equation in 2D
- Fast Fourier Transforms
- Parabolic PDEs
- Crank-Nicolson method
- Stability of Crank-Nicolson
- Comments on modern hydrodynamics codes

Chapters we will (partly) read from the book

- Chapter 1: Basic equations
- Chapter 2: Numerical Approximations to Partial Differential Equations
- Chapter 3: N-body particle methods
- Chapter 4: Smoothed Particle Hydrodynamics
- Chapter 6: Grid-Based Hydrodynamics
- Chapter 8: Magnetohydrodynamics

How will this class be evaluated?

- There will 3 exercise sheets to implement simple numerical methods. You need to know about programming to do them.
- For each chapter we are reading, you will get one questionaire to answer.
- You need to present and work with one of the example codes from chapter 10 of the book (should be summarized on 3 pages, including figures produced from the results).

Example codes from chapter 10

- Radiation Transfer
- Stellar Evolution
- One-Dimensional Lagrangian Hydro*
- Zeus: 3D Hydrodynamics*
- N-body codes*
- Smoothed Particle Hydrodynamics*

The codes marked with * are more relevant for this class.

Time

I will circulate a doodle poll to determine the time of the first live class. This class will be organized via zoom.