



# 11020ASTR660000 Computational Astrophysics 計算天文物理

# Syllabus

### Instructor

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**Teaching assistant (TA)** TBA

Class Web page TBA

**Class schedule** Lectures on Thursday from 14:20 - 17:20 General building II, R501

## Preface

This course does not require previous programming experience but with little knowledge on compiled languages and/or python is recommended. A Unix-like system (e.g. Linux, Mac OS X, or Windows 10 subsystem for Linux) is required. Students are required to bring a laptop to class.

### Homework assignments

We will have a few homework assignments during the semester. Each assignment contains written problems and/or numerical exercises. All homework assignments are required to typed using Latex. We will use Google classroom to announce and collect homework assignments. You are encouraged to ask questions or discuss with your classmates in Google classroom as well.



## **Final project**

Depending on students' need and interests, the final project could have several forms, including

- 1. Design a "new" numerical technique (tool/library/application) that is related to their own research project.
- 2. Attack an interesting astrophysical problem that involve numerical techniques we covered in class.
- 3. Reproduce scientific numerical results in existing published journals.

#### Evaluation

Grades will be determined by homework assignments (70%), and the final project (30%). Extra bonus points from class participation will be added.

#### **Tentative topics**

Topics

- 1 Course overview / basic tools
- 2 Basic programming
- 3 Linear systems
- 4 Non-linear equations
- 5 Initial value problems (celestial movement)
- 6 Boundary value problem (stellar Interior)
- 7 PDE: hyperbolic systems
- 8 PDE: elliptical systems (gravity)
- 9 PDE: astrophysical fluids
- 10 PDE: magneto-hydrodynamics
- 11 Parallel programming

### **Recommended textbooks**

- 1. "Numerical Recipe", by Press, W.H. (http://www.nr.com)
- 2. "Numerical Methods in Astrophysics", by Bodenheimer, P. et al.
- 3. "Scientific Computing: An introductory survey", by Michael Heath
- 4. "Introduction to Computational Astrophysical Hydrodynamics", by Zingale, M. (https://github.com/python-hydro/hydro\_examples)
- 5. "The C Programming Language", by Kernigan, B.W.
- 6. "Finite Volume Methods for Hyperbolic Problems", by Leveque, R. J.
- 7. "Parallel Programming with MPI", by Pacheco P.