

AY 235 – Numerical Methods for Astrophysics

Overview:

This course covers the range of numerical methods and simulation techniques that form the basis of an effective astrophysicist's toolkit. The course is divided roughly 65-35 between astrophysical simulation techniques (text 1) and more generally applicable numerical methods (text 2). The goals are flatly practical. At the end of the class, the students should be comfortable using computers to solve the broad range of problems that crop up during their professional lives as working astronomers. There's no bias toward those with either observational or theoretical interests. The idea is to teach topics that are useful for everybody.

Texts:

(1) Bodenheimer, P., Laughlin, G., Rozyczka, M., & Yorke, H. 2007 *Numerical Methods in Astrophysics* (Boca Raton: Taylor and Francis)

(2) Press, W., Teukolsky, S., Vetterling, W., & Flannery, B. 2007 *Numerical Recipes: The Art of Scientific Computation* (3rd Edition) (Cambridge: Cambridge University Press)

(3) Supplementary articles from the literature, usually one per class.

Topics covered:

The class has historically shown some variation in topics, but a representative list is as follows:

1. Overview, Class Project Descriptions, and Basic Equations of Numerical Astrophysics (2 lectures)
2. Numerical Approximations to Partial Differential Equations (3 lectures)
3. N-body particle methods (3 lectures)
4. SPH (2 lectures)
5. Stellar Evolution Codes (1 lecture)
6. Grid-based hydrodynamics (3 lectures)
7. Poisson solvers (2 lectures)
8. Numerical MHD (1 lecture)
9. Numerical Relativity (1 lecture)
10. Radiation transport (3 lectures)
11. Statistics (2 lectures)
12. Optimization (2 lectures)
13. Modeling of data (2 lectures)
14. Databases – sorting, searching and compression
15. Digital signal processing
16. Time series analysis