AST 381, Computational Astrophysics
Unique No. 46660, Spring 2019

CLASS MEETS: TTh 2-3:30pm in PMA(RLM) 15.216B
INSTRUCTOR: Prof. Volker Bromm
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Email: vbromm@astro.as.utexas.edu
Office Hours: by appointment

COURSE WEBSITE:
https://canvas.utexas.edu/

IMPORTANT NOTE:
A climate conducive to learning and creating knowledge is the right of every person in our community. Bias, harassment, and discrimination of any sort have no place here. If you notice an incident that causes concern, please contact the Professor and the Campus Climate Response Team
(http://diversity.utexas.edu/ccrt).

COURSE OBJECTIVES: Computational astrophysics is a fantastic subject. It is also extremely important, wherever your research and career will lead you. Our focus throughout will be on a core set of basic principles and techniques. We will approach our subject first in a "bottom-up" fashion, where you will gain mastery of the key concepts in idealized, scaled-down settings. Here, you will write your own code from scratch (with Python, say). After a brief introduction into parallel computing, we will then turn to a "top-down" approach. In this part, we will get to know the popular GIZMO simulation code. With it, we will address key problems in computational astrophysics: N-body simulations, hydrodynamics, and radiative transfer. The course will have two equally important elements: we will gain a firm conceptual understanding of the important techniques and algorithms, and you will see them unfold in practice with lots of hands-on coding and analysis exercises.

TEXTS:

Currently, there is no one good textbook on this subject. Thus, we don't have an `official' required text.

However, you might find useful (some copies in the UT library system):

- Bodenheimer et al., Numerical Methods in Astrophysics, Taylor & Francis

- Pacheco, Parallel Programming with MPI, Morgan Kaufmann Publishers

GRADING: The final grade will be based on a point system:

6 Problem Sets	60
2 Group Projects	20
In-class Activities	10
Oral Exam	10

The following grading scheme will be used:

A = 90 - 100
A- = 85 - 89
B+ = 82 - 84
B = 72 - 81
B- = 70 - 71
C+ = 68 - 69
C = 62 - 67
C- = 60 - 61
D = 50 - 59
Any score below 50 is failing.

PROGRAMMING LANGUAGES:
For Part I, you can in principle use whatever language you are already familiar with, but by default, I recommend Python.
In Part II, we will work with MPI. The GIZMO code for Part III is written in (ANSI) C and MPI.

QUIZZES:
We will have frequent in-class quizzes, where you will team up with one or two of your classmates to work out order-of-magnitude answers to questions that will illustrate our course material.

MINI-PRESENTATIONS:
You will get reading assignments, where your job is to try to understand the material ahead of class time. You should bring up all your questions, via e-mail or in person, for clarifications. After you have had the chance to raise all your questions, I will randomly select a student to explain the material in the reading assignment to the class.

NOTE: In-class ACTIVITIES = Quizzes + Mini-Presentations.

GROUP PROJECTS:
In groups of 2 (or 3), you will complete two extendeded coding and analysis projects. As final product, you will write up a brief, succinct report, and you will give a brief presentation in a conversation with me (in my office). Your grade for this

part will reflect both the quality of the report and the presentation.

COURSE CONTENTS:

1) Introduction

2) Basic Principles and Techniques (from the `bottom-up')

- Time Integration
- Introducing PDEs: Advection
- Shocks
- Transport: Monte-Carlo (MC) Methods

3) Parallel Computing

4) High-Performance Computing (from the `top-down')
[--> GIZMO]

- N-body Solvers
- Hydro Solvers
- Radiative Transfer