ASTRONOMY 353, ASTROPHYSICS:
Birth, Life and Death of the First Stars

Unique No. 46925, Spring 2016

CLASS MEETS: TTh 12:30-2pm in RLM 15.216B

INSTRUCTOR: Prof. Volker Bromm
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Office Hours: W 4-5pm, or by appointment

COURSE WEBSITE:
http://www.as.utexas.edu/astronomy/education/spring16/bromm/353.html

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Office Hours: TBA

REVIEW SESSION: Mon 5-6pm
Location: RLM 15.216B
Topic: Announced in class the Thursday before

COURSE OBJECTIVES: The physics of the stars is a fantastic subject! We will apply the laws of physics to understand how stars are born, evolve, and die. Specifically, we will learn the key principles by considering a question of great importance in current astrophysics and cosmology: the formation, evolution and impact of the very first stars that emerged early in cosmic history, a few hundred million years after the Big Bang. This will lead us to the frontier of knowledge, touching on topics that will likely dominate the agenda in the upcoming decade, when new telescopes are becoming available, such as the James Webb Space Telescope. You will learn to look at the physics behind these exciting phenomena, and make things as simple as possible, but still capture the important effects.

TEXTS:

There is one required text, available at the Co-op. In addition, I here suggest some optional books that you may find useful. To cover the course material, we will provide you with detailed lecture notes, available for downloading from the course website. Beyond that, there is a huge universe of relevant online tutorials, many of them are quite good. We will make specific suggestions while we go ahead.

The required text is (available at the Co-op):

- Abraham Loeb: "How did the First Stars and Galaxies form?", Princeton Univ. Press

The optional texts are (available at the PMA Library):

- Barbara Ryden: "Introduction to Cosmology", Addison Wesley

- Dan Maoz: "Astrophysics in a Nutshell", Princeton Univ. Press

- A. C. Phillips: "The Physics of Stars", Wiley

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

In-class Quizzes	10
Homework	60
2 Group Projects	2x15

We won't have any in-class exams (thus also no Final Exam).

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 (F).

HOMEWORK AND GROUP PROJECT:
The smaller problem sets and the more extended group projects will contain analytical and numerical parts. I assume that you know one high-level language (C, Python, IDL, Mathematica, ...), enabling you to solve problems numerically. Please ask if you feel you need to catch up on your computer literacy. We will be glad to suggest ways to quickly get up to speed if necessary.

QUIZZES: We will have frequent in-class, unannounced quizzes, where you will work with 1 or 2 of your colleagues to solve small problems (with a duration of about 10 mins each). The quizzes will not test your memory by asking you to remember some fact or another. Instead, the quizzes will often ask you to devise an "order-of-magnitude" (back-of-the-envelope) solution to a problem based on the material that we have introduced in class.

Quantitative Reasoning (QR) FLAG:
This course carries the Quantitative Reasoning flag. Quantitative Reasoning courses are designed to equip you with skills that are necessary for understanding the types of quantitative arguments you will regularly encounter in your adult and professional life. You should therefore expect a substantial portion of your grade to come from your use of quantitative skills to analyze real-world problems.

COURSE AND UNIVERSITY POLICIES:

- CLASS ATTENDANCE:
  It is important that you come to class. You will not be successful otherwise in following the course material. In addition, we will have unannounced quizzes. If you miss one, there will be no make-up quiz. But you are allowed to miss up to 2 quizzes without penalty; make sure to talk to me if you have to be absent from class more than 2 times, so that we can discuss your situation.

- EXAMS: There will be no in-class exams (and thus no final exam).

- PLAGIARISM: Scholastic dishonesty, in particular any plagiarism, will be prosecuted in accordance with the university guidelines. In simplest terms, plagiarism occurs if you represent as your own work any material that was obtained from another source, regardless how or where you acquired it. Please have a look at:
  http://deanofstudents.utexas.edu/sjs/scholdis_plagiarism.php

  There, you find a more detailed description of what constitutes plagiarism in its various forms. In particular, have a careful look at "paraphrasing".

- RELIGIOUS HOLIDAYS: University policy is to respect religious holidays. If you have to miss a lecture or exam because of a religious holiday, you will not be penalized. But you need to tell me ahead of time.

- NOTICE: Students with disabilities may request appropriate academic accommodations from the Division of Diversity and Community Engagement, Services for Students with Disabilities, 471-6259.

COURSE CONTENT:

- Introduction

- The Big Picture: Brief Intro to Cosmology
  -> Expanding Universe
  -> Big Bang and Inflation
  -> Cosmic dynamics: Friedmann models
  -> Dark Matter: WIMPs, axions,...

- Physics of Star Formation
  -> Gravitational Instability
  -> Building up a protostar
  -> Initial Mass Function (IMF)
  -> Binaries and clusters

- Principles of Stellar Structure and Evolution
  -> Pressure inside the stars
  -> Hydrostatic Equilibrium
  -> Energy Transport
  -> Energy Generation
  -> Stellar evolution

- Stellar Death and Remnants
  -> Final fate of stars
  -> Explosions: Supernovae, Gamma-ray bursts
  -> Stellar relics: white dwarfs, neutron stars, black holes

- Stellar Feedback
  -> Winds and outflows
  -> Chemical enrichment of the intergalactic medium

- Observational Probes
  -> Near-IR Telescopes (James Webb, GMT,...)
  -> Radio Telescopes
  -> High-energy probes

- Epilogue: The Cosmic Frontier