ASTR5700: Stellar Interiors (Fall 2002)
`http://jilawww.colorado.edu/~pja/stars02/`

Guidelines for final papers / projects

- **Topic**. The term paper or project is intended to provide an opportunity to research a topic that interests you in more depth than we cover in class. It must have *something* to do with stars, but with that proviso a broad range of topics are possible. Some examples of possible topics to review are listed below. I can provide references to act as starting points for most of these topics.
- **Format**. Aim for a length and format similar to one of the longer review articles in Nature or Science. These have around 5,000 words, and begin with an introduction accessible (at least in theory) to scientists in other disciplines. Nature's guidance is that reviews 'inform a broad readership about fields in which there have been recent, important advances'.
- **Computational projects**. This is an alternative to a literature review type of project. Some suggestions are given overleaf. If you do a computational project, a shorter write-up focusing solely on what you did, and what the results were, would be appropriate. Beware though that computational projects can easily soak up arbitrary amounts of *your* time as well as CPU time...
- **Workload**. The paper is worth 25% of the final grade. This suggests that you should aim to spend the equivalent of ~ 4 homeworks on it. A write-up will be due on the last day of class (Wednesday, December 11th).

Examples of possible review topics

1 Modeling the spectral evolution of galaxies using stellar population synthesis models. How reliable are these methods?

2 Chemical enrichment of the Galaxy. Which stars are responsible for polluting the ISM, and how well do we understand this process?

3 Massive star formation. Is there a real problem in forming massive stars due to their radiation pressure halting accretion? Do massive stars form from collisions instead?

4 Extrasolar planets. What are the stellar properties of stars hosting known planetary systems? What does this imply about planet formation?

5 Pre-main-sequence evolution. Critically consider solutions to the 'angular momentum problem' of star formation – why do young stars spin slowly despite having formed from disks in near Keplerian rotation.

6 Stellar winds. How are stellar winds driven? How does mass loss affect the evolution of massive stars?

7 Prospects for the astroseismology mission *Eddington*. What will this mission tell us about stellar structure?

8 The formation and evolution of the first stars. What do we know?

9 The Solar cycle. Review what we know about the 11 year cycle of Solar activity.

10 Supernovae. 'No model for a Type II SN has ever been demonstrated to explode satisfactorily'. Critically review whether recent improvements in SN simulations (especially in neutrino transport) change this gloomy conclusion.

11 Dark matter. Do old white dwarfs make a significant (baryonic) contribution to the Galactic halo?

12 The X-ray properties of the Sun and / or other stars.

13 Magnetars. Discuss the physics of neutron stars with superstrong (10^{15} G) surface magnetic fields, and the evidence that these objects power soft gamma repeaters. For enthusiasts of *really* weird physics.

Examples of possible computational projects

1 Nuclear astrophysics. Problems 1 and 3 at the end of Chapter 6 of *Hansen & Kawaler* ask you to compute helium burning and the helium shell flash. Do those problems, and write up your methods and results. Include a discussion of astrophysical implications.

2 Numerical hydrodynamics. I can provide computational hydrodynamics codes that use either a particle scheme (called SPH) or an Eulerian grid-based method (ZEUS). You would need access to a modest amount of CPU time and disk space on linux or Solaris machines to run these codes successfully. Possible calculations you could try:

- Simulate the collision of two stars to estimate how much mass is lost (relevant to the problem of the origin of blue stragglers in globular clusters).
- Simulate the interaction of a supernova blast wave with a stellar companion. How much pollution of the ejecta is expected from gas stripped from the companion?

Although I would like each person to do their own project, it would probably work best for troubleshooting etc to have more than one person using each code.