HAVERFORD COLLEGE

Department of Astronomy

COSMOLOGY

Textbook: *Introduction to Cosmology by* Barbara Ryden

Course Description:

Even though striving to understand the cosmos is one of the oldest scholarly endeavors, for millennia the observational evidence was so scarce that cosmology consisted primarily of simple models created to account for a few observational facts accompanied by a great deal of speculation. Consequently, fifty or sixty years ago, an undergraduate astronomy or physics course in cosmology would have been frowned upon. In the first half of the 20^{th} century Einstein's general theory of relativity and Hubble's discovery of the expansion of the universe provided a theoretical and observational basis for describing the large scale structure of the universe, i.e., the birth of modern cosmology. Even so, the relative lack of observational evidence led many physicists and astronomers to doubt that cosmology was a proper scientific discipline. All this began to change in the last half of the century, slowly at first and then at an increasing rate following the explosion of technology and the accompanying new instrumentation. Now, most physicists and astronomers consider cosmology to be, indeed, a proper science. The current, admittedly simple, "standard model" seems capable of explaining most of the current observations as well as making predictions that will be tested in the coming decades.

Barbara Ryden's text, only a few years out of date, provides an excellent snapshot of the current state of cosmology. Although the treatment is necessarily simplified for consumption by advanced undergraduates, it contains enough technical details to prepare students for more advanced, graduate treatments and should make it possible for them to be able to consume some of the current literature in the field (see below). To be sure, there remain parts of cosmology that are extremely speculative, e.g., the inflationary epoch of the Big Bang. This is to be expected because of its all encompassing nature, from the highest energies possible at the beginning of the Big Bang to distances beyond what we can ever observe, i.e., beyond our "horizon". Ryden includes discussions of these speculations while admitting that they may well be (and probably are) wrong.

Ryden's text is terse but extremely well written and I'm sure you will find it delightful to study. One might wonder why you even need me to guide you through this subject. Never-the-less, that's what I'll be, your guide, and I hope you will find me useful in this capacity. Ryden's text is only 230 (medium sized) pages long and we'll cover all of it. I will give you modest reading assignments prior to each class and request that you complete them in advance. This will allow for a much more useful and interactive classroom experience, which will be a mix of lecture, discussion, and workshop.

Assignments, Exams, and Special Assignment:

There will be on the order of 7 bi-weekly homework assignments with most of the problems coming from those at the end of the chapters of Ryden's text. There aren't many end of the chapter problems and I urge you to look at all of them, including those that are not assigned on the homework. There will be two exams, a midterm and a final. Both of these will be open book, open note, untimed exams. Finally, there will be a special assignment that consists of reading a current cosmology research paper of your choosing, giving a short in-class talk on the topic, as well as writing a report on it. I'll request that you identify a tentative paper the week after Spring Break. It shouldn't be a problem if this paper deals with material that we have not yet covered. You can always read ahead. The course grade will be determined from the exams (~50%) and weekly and special assignments (~50%).

Tentative Course Outline

	Topic	**Reading**
Week 1	Hubble Expansion and Other Observations	Chapters 1 and 2
Week 2	Curved Space-Time; Dynamics	Chapters 3 and 4
Week 3	Friedman Equation	Chapter 4
Week 4	Simple Models of the Universe	Chapter 5
Week 5	More Complicated Models	Chapter 6
Week 6	Cosmological Parameters	Chapter 7

Week 7	Review and Midterm Exam	
Week 8	Spring Break	
Week 9	Dark Matter and begin Special Assignment	Chapter 8
Week 10	Cosmic Microwave Background	Chapter 9
Week 11	Nucleosynthesis	Chapter 10
Week 12	Epoch of Inflation	Chapter 11
Week 13	Structure Formation	Chapter 12
Week 14	Structure Formation	Chapter 12
Week 15	Review and Special Assignment	