Astronomy 102: Black Holes, Time Warps, and the Large-Scale Structure of the Universe

Fall 2009

In Astronomy 102 we present a physical and astronomical (but mostly non-mathematical) picture of the workings of Einstein's theory of relativity, and its application to black holes and the Big Bang. Black holes turn out really to occur in nature; the origin and expansion of the Universe turns out to have a lot in common with black holes; and all of this is connected with relativity in a manner that is a lot less mysterious than one might think. As we explore the connections we will find many good examples of the processes by which scientific theories are conceived and advanced in general.

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For more information, see the separate handouts to be distributed during recitation.

Web site: http://www.pas.rochester.edu/~dmw/ast102 . This is the main reference for the course. In these pages one can find complete lecture presentations; the electronic homework, practice exams and real exams; and many other useful resources, even a copy of this document.

Lectures: Tuesdays and Thursdays, 2:00-3:15 PM, in Hoyt Auditorium, conducted by Dan Watson. All of material for each lecture will be available, for you to browse or to download in a form suitable for taking additional notes, on our Web site, about a week before the lecture is actually delivered. Note that about a third of the material we will introduce in lecture is *not* found in the textbooks. In lectures we use the Interwrite **Personal Response System** (PRS) for real-time student feedback and participation. Each student needs his/her own PRS transmitter. These devices are available at the UR Bookstore.

Required textbook: Only one, Kip Thorne's *Black Holes and Time Warps: Einstein's Outrageous Legacy* (Norton, 1995). Our treatment of relativity, and the theory of black holes and wormholes, is based on this book.

Recommended textbooks, that you should not feel compelled to buy: Michael A. Seeds, *Foundations of Astronomy*, tenth edition (Thomson Brooks/Cole, 2008), Stephen Hawking, *A Brief History of Time* (Bantam, 1988), and Joseph Silk, *The Big Bang*, third edition (Freeman, 2005). The book by Seeds is also used as the text in Astronomy 104, 105 and 106, three classes that belong to many of the same clusters as Astronomy 102, so there are lots of copies of it around: mostly of the ninth edition, but that would be fine. The book by Silk has recently gone out of print, but there are still many used copies around. All of these books are on reserve in the Physics-Optics-Astronomy (POA) Library, 374 Bausch and Lomb Hall.

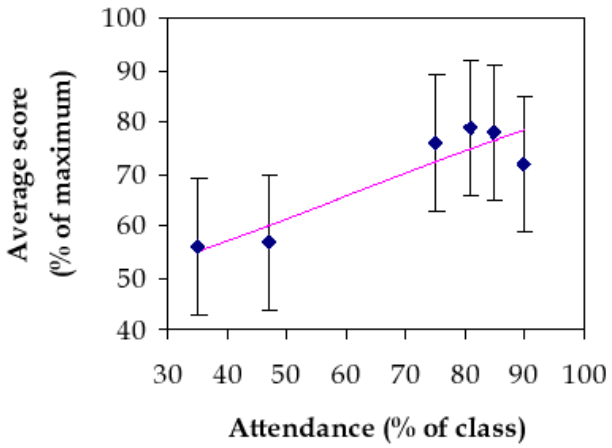
Recitations: Mondays, 2-3:15 PM, in 525 Morey; Tuesdays, 3:25-4:40 PM, in 269 Bausch and Lomb; Wednesdays, 3:25-4:40 PM, in 315 Bausch and Lomb and 4:50-6:05 PM, in 502 Morey; Thursdays, 4:50-6:05 PM, in 101 Hylan; and Fridays, 4:15-5:30 PM, in 310 Gavett. They begin **the second week of classes.** Brian DeCesare and Jae Song will conduct the recitations. You may attend any or all but you must register for one. The recitations will be where and when we show the…

Films and clips: a few short movies elaborating on or illuminating crucial aspects of the material introduced in lectures or textbooks; and some TV clips, and most of one feature-length Hollywood movie -- Disney's *The Black Hole* (1979) -- as exhibits of Bad Astrophysics in the Mass Media. The Bad Astrophysics exhibits will help you learn to detect the frequent, unintentionally humorous, mistakes

made by filmmakers when they refer to astronomy or other sciences. Each film or clip will be followed by thorough discussions, led by the teaching assistants. They will be showing, in recitation, throughout the semester; screenings will be listed on the Contacts and Calendar page of the AST 102 Web site. You should see each film and clip at least once; the Bad Astrophysics material will appear on Exams #2 and #3.

The AST 102 Film Festival: We will also watch two feature-length Hollywood movies, *Star Trek* (2009) and *Contact* (1997). They are both good movies, rich in references to and discussion of black holes and related objects, but one of them is scientifically correct *much* more frequently than the other. They will be shown on the evenings of 17 and 18 November, in the lecture room, Hoyt Auditorium, starting at 7PM both nights. The first movie on the first night will be the second on the second night, and vice versa. Abundant refreshments will be served. You should see each of them at least once, as the material introduced thereby will appear on Exam #3.

Class participation: All members of the class are expected to attend all of the lectures, and encouraged to attend one recitation per week. This is for your own good! One might gain the impression, from the comprehensive on-line course resources we offer, that this might as well be a distance-learning class, but that would be a mistake. Students who attended AST 102 lectures during 1996-2006 did better on the exams than those who did not, as is illustrated in the graph at right.



E-mail list server: ast102@mail.rochester.edu. Messages sent to this address will be resent to everybody in the class. Obviously this provides a good way to make general announcements. We also encourage use of the list server to ask questions about readings, lectures, homework problems and the like; the rest of the class will probably also be interested in your questions and the answers you'll receive. (We will answer e-mail questions privately, too.)

Homework assignments: six problem sets, to be assigned at regular intervals during the semester. Each problem set will involve use of the **WeBWorK** system, a computer program that enables students to answer homework questions interactively, with immediate feedback and automatic grading. Your problem sets will in general be different from those of your classmates. Once assigned, your personalized problem set will be accessible on the World Wide Web. Your percentage score on each problem set will count as 1.67% of your grade in the course – that is, all six comprise 10% of your final grade.

We *strongly* encourage students to discuss the homework problems, and to work together toward their solution. We demand only that the solutions you submit be the result of your own thought and expressed in your own words.

Examinations: three tests, given on line with WeBWork during the hours 12-6 PM on 1 October, 5 November, and 10 December. One hour and fifteen minutes will be allowed to complete the exam once you begin, but you can begin at any time consistent with starting and finishing within the six-hour window. Each exam will emphasize subjects that haven't yet appeared on a test; that is, no *comprehensive* final exam will be given. You must take all three tests in order to pass the course. No "senior option" will be allowed. If you miss an exam due to illness or emergency, a makeup exam may be scheduled by appointment. ***All makeups will be oral examination***s, an hour and fifteen minutes in length,

administered and graded by Dan Watson. Your percentage score on each exam will count as 30% of your grade in the course – that is, the three exams together comprise 90% of your final grade.

The best way to study for the examinations is to do the homework, and to work out the sample exams that will appear in WeBWorK about a week before each exam.

Academic honesty: For our purposes, *cheating* consists of submission of homework or exam solutions that are not your own work, or submission of solutions under someone else's name. According to University rules, any detected act of cheating that is not the result of a simple misunderstanding must be handed over to the Board on Academic Honesty for investigation.

Grades: based 10% on the six homework assignments and 90% on the three examinations. **No extra-credit projects will be assigned, that cannot be assigned to the whole class.** Final grades will be set by an absolute scale, rather than "by the curve." In terms of the maximum possible percentage score, the grading scale will be as follows:

Percentage score	≥ 85	≥ 80	≥ 75	≥ 70	≥ 65	≥ 60	≥ 55	≥ 50	≥ 40	< 40
Final grade	A	A-	B+	B	B-	C+	C	C-	D	E

Last time Dan taught Astronomy 102 (Spring 2008), the class average percentage score was 75.3, for a class average grade of B+.

Extra help: Check out the class-meeting and office-hours calendar on the Contacts page in the Astronomy 102 Web site. Appointments can also be arranged. Please come in and see us frequently. We will also answer questions by e-mail (privately or through the list server), and will often be electronically accessible late into the night when homework due dates or exams approach. By either means we will be happy to answer any questions you have concerning the course. We will be even happier to help those who find the material or presentation sufficiently confusing that they're not even sure what to ask.

