Astronomy 401/Physics 903
Astrophysics II: Galaxies and Cosmology
Spring 2019

Instructor: Prof. Dawn Erb
KEN 4087
erbd@uwm.edu
414-229-3654
Office hours Wednesday 11 am-12 pm or by appointment

Lectures: Tuesday and Thursday 9:30-10:45 am
KEN 1140

Course website: http://www.cgca.uwm.edu/~dawn/astron401.html

Course description: This is the second semester of a general course (the first semester was Astronomy 400) intended to introduce quantitative astronomy and astrophysics to students with a physical-sciences background. A background in calculus-based physics is required. Topics covered this semester include the Milky Way, other galaxies, galaxy formation and cosmology.

Course textbook:
Extragalactic Astronomy and Cosmology, 2nd Edition. Peter Schneider (Springer, 2014)
ISBN 978-3642540820
Price (UWM bookstore): $90.74

Additional resources (not required):
An Introduction to Modern Astrophysics, *2nd Edition*. B. W. Carroll & D. A. Ostlie (Cambridge University Press, 2017)
Galaxies in the Universe: An Introduction, *2nd Edition*. L.S. Sparke and J.S. Gallagher, III (Cambridge University Press, 2007)
Introduction to Cosmology, *2nd Edition*. Barbara Ryden (Cambridge University Press, 2016)

Evaluation:
Problem sets: 30%, lowest score dropped
Midterm exam: 20% (Thursday March 14)
Final exam: 30% (Monday May 13, 10:00 am - 12:00 pm)
Research paper and short presentation: 20%

Problem sets will be given weekly, except in weeks with exams or projects. You may discuss the problem sets with each other, but copying of others' work is not allowed. Each problem set will contain one numerical problem required only for students enrolled in Physics 903. This problem will require programming, and original code should be submitted by email along with any plots required. Sample solutions will be given in Python, and the use of Python is preferred. Since one of the goals of these problems is programming practice, the use of programs such as Mathematica is not allowed. The numerical problems will count as extra credit for students in Astronomy 401.

Exams will be closed book. The midterm will be a 75 minute in-class exam (Thursday March 14) and the final exam will be two hours (Monday May 13). A short research paper and in-class presentation on a topic of your choice (suggestions will be provided) will be due near the end of the semester.

For information on university policies such as religious observances, incompletes, discriminatory conduct, etc., see: http://www.uwm.edu/Dept/SecU/SyllabusLinks.pdf

Expected average student time investment:

Lectures	50/60 x 42 = 35 hours
Assigned reading	15 weeks x 2 hrs = 30 hours
Problem sets	9 x 6 hours = 54 hours
Research project	12 hours
Review for midterm, final	6 + 10 hours = 16 hours
Midterm	1.2 hours
Final exam	2 hours
Total	**150 hours (50 hrs/credit)**
Weekly average (15 weeks)	**10 hrs/week**

Detailed syllabus: The following is an approximate schedule of the topics which will be covered each day in class. This schedule is subject to change and will be updated on the course website. Reading assignments are given by the numbers in parentheses, which refer to sections of *Extragalactic Astronomy and Cosmology*, Second Edition, Schneider. In the cases for which the reading is different in the first edition, sections in the first edition are given in square brackets. Not all material presented in lecture will be in the textbook, so class attendance is essential.

Date	Topic and reading
Tuesday January 22	Overview of the universe, contents and structure of the Milky Way (1.2, 2.3)
Thursday January 24	Contents and structure of the Milky Way II (2.3)
Tuesday January 29	Kinematics of the Milky Way, Galactic Center (2.4, 2.6)
Thursday January 31	The Hubble sequence, overview of galaxies (3.1)
Tuesday February 5	Spiral galaxies (3.3, 3.4.1)
Thursday February 7	Elliptical galaxies (3.2, 3.4.2-3.4.4)
Tuesday February 12	Elliptical galaxies II, the luminosity function (3.2, 3.4, 3.10) [1st ed. 3.2, 3.4, 3.7]
Thursday February 14	Gas, dust and star formation (3.5, 3.7) [1st ed. 3.9, 3.10]
Tuesday February 19	Stellar populations of galaxies, galaxy spectra (3.5, 3.7) [1st ed. 3.9]
Thursday February 21	Galaxy spectra II (3.5) [1st ed. 3.9]

Tuesday February 26	Clusters and groups of galaxies (6.1, 6.2, 6.3) [1st ed. 6.1, 6.2]
Thursday February 28	Clusters and groups of galaxies II, galaxy interactions (6.4, 6.5) [1st ed. 6.3, 6.4]
Tuesday March 5	Quasars and AGN (5.1, 5.2, 5.3)
Thursday March 7	Quasars and AGN II, the intergalactic medium (5.4, 5.5, 5.7) [1st ed. 5.4, 5.5, 5.6.3]
Tuesday March 12	The extragalactic distance scale, error propagation and uncertainties, midterm review (2.2, 3.9) [1st ed. 2.2, 3.6]
Thursday March 14	MIDTERM EXAM
Tuesday March 19	SPRING BREAK
Thursday March 21	SPRING BREAK
Tuesday March 26	Expansion of the universe and Newtonian cosmology (4.1, 4.2.1, 4.2.2, 4.2.3)
Thursday March 28	Newtonian cosmology II (4.2.1, 4.2.2, 4.2.3)
Tuesday April 2	The cosmic microwave background and the thermal history of the universe (4.4)
Thursday April 4	Non-Euclidean geometry, the Robertson-Walker metric, the cosmological constant (4.2.4, 4.2.5, 4.2.6, 4.2.7)
Tuesday April 9	Cosmological distances (4.3)
Thursday April 11	Cosmological distances II (4.3)
Tuesday April 16	Observational cosmology: Type Ia supernovae (8.3)
Thursday April 18	Observational cosmology: cosmic microwave background anisotropies (8.6, 8.7)
Tuesday April 23	Structure formation (7.1, 7.2)
Thursday April 25	Structure formation II (7.1, 7.2)
Tuesday April 30	Reionization and galaxies at high redshifts (9.1-9.4, 9.6) [1st ed. 9.1, 9.2, 9.4-9.6]
Thursday May 2	Research paper due, presentations
Tuesday May 7	Presentations
Thursday May 9	Presentations, course review
Monday May 13	FINAL EXAM