PHY 4905 – MODERN ASTROPHYSICS – FALL 2019

INSTRUCTOR: Prof. Imre Bartos
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OFFICE HOURS: Fridays 3pm-4pm or by appointment.

COURSE WEBSITE: http://phys.ufl.edu/courses/phy4905/fall2019/

TEXTBOOKS: No required textbook. Recommended:
http://iopscience.iop.org/book/978-0-7503-1369-8.pdf

PREREQUISITE KNOWLEDGE AND SKILLS: PHY2049 or equivalent; PHY3101 or equivalent. The course will be informational rather than analytical. No previous astrophysics background is required. We will introduce all relevant information during the course. This course satisfies the 4000 level physics elective requirement for Physics BS majors.

PURPOSE OF COURSE: To introduce students to open questions in astrophysics and current research and observational efforts to address these questions. The students will become familiar with research areas that will help them keep track of new developments and, for majors, select the most relevant research topics in the future.

TOPICS COVERED: Today's astrophysics largely focuses on extreme cosmic processes whose observations recently became available due to modern, large-scale facilities such as the LIGO gravitational wave observatory, the Large Synoptic Survey Telescope, or the IceCube Neutrino Observatory. The course will focus on (i) compact objects such as black holes and neutron stars, (ii) emission processes by these objects, as well as (iii) relevant modern observational strategies and observatories. Topics include core-collapse supernovae, astrophysical particle acceleration, gamma-ray bursts, gravitational-wave emission, kilonovae, and multimessenger observations.

COURSE GOALS AND OBJECTIVES: The course will give you an understanding of some of the main, actively researched topics in astrophysics. It will give you an understanding of the frontiers, where the field is going, as well as some of the modern observational tools. Additionally, the

course's objective is to prepare you for absorbing and communicating scientific work as researchers encounter it.

COURSE EVALUATION: Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

COURSE SCHEDULE:

Week 1. **Stars' end** (possible ends of stellar life cycles, including white dwarfs, core collapse, and disintegration)

Week 2. **Neutron Stars** (what neutron stars are, how they are formed, and their properties. Neutron star equation of state)

Week 3. **Black holes** (what black holes are, how they are formed, and their properties. Schwarzschild radius, spin, charge, mass, hair)

Week 4. **Supernovae** (types, explosion mechanisms, emission properties, remnants)

Week 5. **Accretion** (gas accretion onto black holes or neutron stars. Origin of accreted gas, geometry (Bondi/disk))

Week 6. **Astrophysical particle acceleration** (relativistic outflows, their formation, and how they accelerate particles. Cosmic rays, gamma rays, high-energy neutrinos)

Week 7. **Gamma-ray bursts** (history, properties, populations)

Week 8. **Afterglow emission** (origin, properties)

Week 9. **High-energy observatories** (most important observatories that detect cosmic rays, gamma rays, and high-energy neutrinos; observation principles)

Week 10. **The high-energy Universe** (what has been observed, observational techniques, open questions. Cosmic rays, gamma rays, high-energy neutrinos)

Week 11. **Gravitational waves** (definition, detection, astrophysical production)

Week 12. **Compact binaries** (formation channels, properties, eccentricity)

Week 13. **Searching for gravitational waves** (search techniques, challenges)

Week 14. **Kilonovae** (and other emission from compact binary mergers)

Week 15. **Cosmology with gravitational waves**

Week 16. **Multimessenger astrophysics and open questions**

DISCLAIMER: This syllabus represents the Prof. Bartos' current plans and objectives. As we go through the semester, those plans may need to change to enhance the class learning opportunity. Such changes, communicated clearly, are not unusual and should be expected.

COURSE POLICIES

ATTENDANCE POLICY: Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies that can be found at: https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/.

GRADING: The final grade will be based on homework (30%) and a final presentation on an agreed-upon topic relevant to the course material (70%). See also UF grading policy at https://catalog.ufl.edu/UGRD/academic-regulations/grades-grading-policies/.

MATERIALS AND SUPPLIES FEES: None.

UF POLICIES

UNIVERSITY POLICY ON ACCOMMODATING STUDENTS WITH DISABILITIES: Students requesting accommodation for disabilities must first register with the Dean of Students Office (http://www.dso.ufl.edu/drc). The Dean of Students Office will provide documentation to the student who must then provide this documentation to the course professor when requesting accommodation. You must submit this documentation prior to submitting assignments or taking the quizzes or exams. Accommodations are not retroactive, therefore, students should contact the office as soon as possible in the term for which they are seeking accommodations.

UNIVERSITY POLICY ON ACADEMIC MISCONDUCT: Academic honesty and integrity are fundamental values of the University community. Students should be sure that they understand

the UF Student Honor and Student Conduct Code at https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/.

COMMUNICATION COURTESY: All members of the class are expected to follow rules of common courtesy in all emails, conversations, discussions, and chats. See http://teach.ufl.edu/wp-content/uploads/2012/08/NetiquetteGuideforOnlineCourses.pdf.

STUDENT COMPLAINTS PROCESS: UF has information on the complaints processes for residential students (see https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf) and for distance learning students (see http://www.distance.ufl.edu/student-complaint-process).

GETTING HELP

Resources are available at http://www.distance.ufl.edu/getting-help for:

- Counseling and Wellness resources
- Disability resources
- Resources for handling student concerns and complaints
- Library Help Desk support

Should you have any complaints with your experience in this course please visit http://www.distance.ufl.edu/student-complaints to submit a complaint.