IDS 2935: Stars and Nuclear Arms Race

Quest 2

I. General Information

Class Meetings

- Summer B 2025
- Course Format: Classroom; Enrollment Capacity: 138
- Lectures: Monday, Wednesday,Friday, 2:00 – 3:15 pm, at Turlington L005
- Group discussions with TAs: Tuesday, Thursday 2:00-3:15 and 3:30 – 4:45,
- at LEI0104, FLI0101 and LIT0127.

Instructor

- Dr. Avrajit Bandyopadhyay
- 217 Bryant Space Science Center
- Office hours: Mondays 11:30 – 12:30 pm
- abandyopadhyay@ufl.edu

Teaching Assistant(s)

(Delete this section if inapplicable)

- Alyssa Bulatek
- 304 Bryant Space Science Center
- Wednesdays
- Contact: abulatek@ufl.edu
- Ehsan Mahdavi
- 405 Bryant Space Science Center
- Mondays 1:00 – 2:00 pm
- Contact: ehsan.mahdavi@ufl.edu
- Matthew Reinhard
- physics building NPB 2111
- Fridays 4:00 – 5:00 pm
- Contact: matt.reinhard@ufl.edu

Course Description

How do astronomical events that occurred 10 billion years ago, or thousands of light years away, impact humanity today? This course introduces students to the astronomical events that astronomers identify to be the sites of formation of the heaviest elements in the periodic table, including the radioactive element Uranium. Uranium (U, Z=92) is an infamous element that is one of the heaviest and rarest elements on Earth. It is originally forged via the oldest stars in the Universe, and pro-

duced by a process called the r(apid) neutron capture process nucleosynthesis event. It also has a rich and complex history on Earth. This course invites students to explore connections between the heavy elements (particularly U) forged in ancient stars and the nuclear weapons that have shaped global politics and local environmental policy over the last few generations. It will allow students to explore how ancient stardust became the key ingredient in the nuclear arms race since the 20th century, and how this story might impact our expectations on the search for extraterrestrial life.

Quest and General Education Credit

- Quest 2
- Physical Sciences

Primary Gen Ed Designation: Physical Sciences (P)

Physical science courses provide instruction in the basic concepts, theories and terms of the scientific method in the context of the physical sciences. Courses focus on major scientific developments and their impacts on society, science and the environment, and the relevant processes that govern physical systems. Students will formulate empirically-testable hypotheses derived from the study of physical processes, apply logical reasoning skills through scientific criticism and argument, and apply techniques of discovery and critical thinking to evaluate outcomes of experiments. This course accomplishes the Quest and General Education objectives of the subject areas listed above. A minimum grade of C is required for Quest and General Education credit. Courses intended to satisfy Quest and General Education requirements cannot be taken S-U.

Required Readings and Works

- Online reading:

1. DOE Handbook: “Department of Energy Fundamentals Handbook, Nuclear Physics and Reactor Theory, Volume 1 of 2”. January, 1993. https://www.standards.doe.gov/standards-documents/1000/1019-bhdbk-1993-v1
2. Online reading set “A”: - Blog: http://blog.sdss.org/2017/01/09/origin-of-the-elements-in-the-solar-system
3. Online reading set “B”: - Wikipedia: “Nucleosynthesis”
   - Wikipedia: “r-process”
4. Online reading set “C”: - Wikipedia: “Drake Equation” (sections “equation,” “usefulness,” and “estimates” only)
   - Canvas: fermiparadox.pdf
   - Canvas: howclose.pdf

II- Articles:

1. New York Times articles: (PDFs will be posted on Canvas)
   - *“When Uranium Outshines Gold”*

- *“Now I Am Become Death’: The Legacy of the First Nuclear Bomb Test”*
- *“Why they call it the Manhattan Project”*

2.Science Magazine article: (PDF will be posted on Canvas)
- *“Some dead stars may harbor enough uranium to set off a thermonuclear bomb”*

3.Scientific American articles: (PDFs will be posted on Canvas)
- *“How long will the world's uranium supplies last?”*
- *“What happens during a Nuclear meltdown?”*
- *“Uranium and Geology”*
- *“Smarter use of Nuclear waste”*

4.Universe Today article: “What Role do Radioactive Elements Play in a Planet’s Habitability?” Available at https://www.universetoday.com/148796/what-role-do-radioactive-elements-play-in-a-planets-habitability/

5.*“On the belated discovery of fission”* Physics Today, 68, 6-40 (PDF will be posted on Canvas)

III- Videos: (Youtube link will be posted)
- *The world after Trinity (1981)*

Materials and Supplies Fees: n/a

II. Graded Work

Description of Graded Work

Grading Scale

For information on how UF assigns grade points, visit:
https://catalog.ufl.edu/UGRD/academic-regulations/grades-grading-policies/

A	94 – 100%		C	74 – 76%
A-	90 – 93%		C-	70 – 73%
B+	87 – 89%		D+	67 – 69%
B	84 – 86%		D	64 – 66%
B-	80 – 83%		D-	60 – 63%
C+	77 – 79%		E	<60

Grading Rubric(s)

Assignment	Description	Requirements	Points
Written Reflections (3 in total)	Weekly written reflections include documenting your responses to opinions, events or information taught in class, and communicating your response to thoughts on topics discussed in class.	500-750 words	21
Homeworks (3 in total)	Will be assigned on some weeks to reinforce skills taught in class.	Response to questions	21
Weekly worksheets (6 in total)	Formative assessment in the form of multiple questions to asses the grasp of the course materials and identify areas that need work	Response to questions	18
Final Exam	Formative assessment in the form of multiple questions to asses final review of the topics covered in the course and your knowledge on the subject.	Response to questions	35
Participation	Consistent informed, thoughtful, and considerate class participation is expected and will be evaluated using the rubric given below.	Attendance	5

General notes:
• Assigned readings are due the following class.
• Homework and written reflections are due one week after they have been assigned.
The course canvas site will make clear all assignment dates and deadlines, as well as exam dates. Any questions about deadlines should be directed to the Instructor, ideally through the course Discussion pages, after class or during office hours.

Participation Grading Rubric:

	High Quality	Average	Needs Improvement

Informed: Shows evidence of having read the readings and/or done the assigned work.	Has grasped all the essential material needed for discussions and participation	Has grasped the basic material but shows some importat lapses or superficial attention to materials	Shows little to no evidence of having read appropriate materials
Thoughtful: Shows evidence of having understood and considered issues raised.	Has given thought and anticipated how to contribute to the discussions and activities	Is thoughtful of responses to questions and discussions	Shows little interest in the issues raised
Considerate: Takes the perspective others into account.	Engages actively, creatively and respectfully in participating in the class	Is tolerant of the perspectives of others but doesn't show much interest or engagement in other points of view	Is disrespectful of the views of others

III. Annotated Weekly Schedule

Week/ Date	Activity	Topic/Assignment (Question/Subject)	Points
Week 1	Topic	Syllabus; Introduction to atoms and spectroscopy	
	Summary	Covering the syllabus, introduction to the course, brief Introduction to atomic structure, line absorption and emission in gas and plasmas, telescopes and spectrographs and the field of spectroscopy	
	Readings/ Works	DOE Handbook, p. 1-16	
	Assignment	Homework 1	**7**
Week 2	Topic	Chemical abundances of the elements	
	Summary	Definition of stellar atmospheres, chemical abundances and a description of how to determine them in stars.	
	Readings/ Works	Online reading set “A”	
	Assignment	Homework 2	**7**
Week 3	Topic	Nucleosynthesis and radioactive decay	
	Summary	Definition of nucleosynthesis and formation of chemical elements inside and via the stars, chemical enrichment events. Broader introduction to radioactive decay to stable isotopes.	
	Readings/ Works	DOE Handbook, p. 22-25, 27, 30-35. Online reading set “B”. Science Magazine article: *“Some dead stars may harbor enough uranium to set off a thermonuclear bomb”*	
	Assignment	Homework 3	**7**

Week/ Date	Activity	Topic/Assignment (Question/Subject)	Points
Week 4	Topic	Nuclear physics, nuclear weapons, and Uranium in the 20th century	
	Summary	Introduction to the development of the field of nuclear physics, the discovery of Uranium and radioactivity and historical encounter of the development of nuclear weapons; Discussion on Uranium mining and its political and geological significance for U enriching countries and the rest of the world	
	Readings/ Works	DOE Handbook, p. 17-21, 48-51, 56-62 and *"On the belated discovery of fission";* Scientific American article:*"How long will the world's uranium supplies last?"*	
	Assignment	Written reflections	**7**
Week 5	Topic	The Manhattan Project, The World after Trinity	
	Summary	Discussion on the development of the Manhattan Project until the building of the first bomb; Discussion and reflections on the movie *"The world after Trinity"* and World War II events post Hiroshima and Nagasaki	
	Readings/ Works	NYT article: *"Why they call it the Manhattan Project" ;* Watch movie: "The world after Trinity"	
	Assignment	Written reflections	**7**
Week 6	Topic	The reactions of scientists and humanity	
	Summary	Discussion and historical perspective on the reaction of scientists after the events of Trinity and WWII and the push to employing policies. A reflection on whether there should be boundaries set	

Week/ Date	Activity	Topic/Assignment (Question/Subject)	Points
		on science and scientific advancement; Historical, as well as present day reaction of the world on the events of trinity and WWII events as well as the continuing U enrichment and Present Arms Race	
	Readings/ Works	SA article: *"What happens during a Nuclear meltdown?"* NYT article: *"Now I Am Become Death': The Legacy of the First Nuclear Bomb Test".*	
	Assignment	Written reflections	**7**
	Final		

IV. Student Learning Outcomes (SLOs)

At the end of this course, students will be expected to have achieved the Quest and General Education learning outcomes as follows:

Content*: Students demonstrate competence in the terminology, concepts, theories and methodologies used within the discipline(s)*.

- [Provide each course SLO for the **Content** category, place in parentheses which Quest and/or Gen Ed objective each course SLO will achieve, and list the assignments that will assess each course SLO.]

Critical Thinking: *Students carefully and logically analyze information from multiple perspectives and develop reasoned solutions to problems within the discipline(s).*

- [Provide each course SLO for the **Critical Thinking** category, place in parentheses which Quest and/or Gen Ed objective each course SLO will achieve, and list the assignments that will assess each course SLO.]

Communication: *Students communicate knowledge, ideas and reasoning clearly and effectively in written and oral forms appropriate to the discipline(s).*

- [Provide each course SLO for the **Communication** category, place in parentheses which Quest and/or **primary** Gen Ed objective each course SLO will achieve, and list the assignments that will assess each course SLO. Note: The International subject area **does not** have a Communication SLO.]

Connection: *Students connect course content with meaningful critical reflection on their intellectual, personal, and professional development at UF and beyond.*

- [Provide each course SLO for the **Connection** category, place in parentheses which Quest objective each course SLO will achieve, and list the assignments that will assess each course SLO. Note: Only Quest has a Connection SLO.]

Physical Sciences SLOs → Students will be able to…	**Quest 2 SLOs → Students will be able to…**	**This Course's SLOs → Students will be able to…**	**Assessment Student competencies will be assessed through…**
Identify, describe, and explain the basic concepts, theories and terminology of natural science and the scientific method; the major scientific discoveries and the impacts on society and the environment; and the relevant processes that govern biological and physical systems.	**Identify, describe, and explain** the cross-disciplinary dimensions of a pressing societal issue or challenge as represented by the social sciences and/or biophysical sciences incorporated into the course.	Describe the methods that astronomers use to determine what are the chemical compositions of stars.	Class participation, homework, worksheets and final exam.

Physical Sciences SLOs → Students will be able to…	**Quest 2 SLOs → Students will be able to…**	**This Course's SLOs → Students will be able to…**	**Assessment Student competencies will be assessed through…**
Formulate empirically-testable hypotheses derived from the study of physical processes or living things; apply logical reasoning skills effectively through scientific criticism and argument; and apply techniques of discovery and critical thinking effectively to solve scientific problems and to evaluate outcomes.	**Critically analyze** quantitative or qualitative data appropriate for informing an approach, policy, or praxis that addresses some dimension of an important societal issue or challenge.	Explain the basic mechanics of how stars produce heavy elements and how they were transported to Earth's crust.	Class participation, homework, written reflection, worksheets and final exam.
Communicate scientific knowledge, thoughts, and reasoning clearly and effectively.	**Develop and present**, in terms accessible to an educated public, clear and effective responses to proposed approaches, policies, or practices that address important societal issues or challenges.	List the basic properties of protons, neutrons, and electrons; the principle of radioactivity; and the process of nuclear fission.	Class participation, homework, worksheets and final exam
	Connect course content with critical reflection on their intellectual, personal, and professional development at UF and	Summarize and describe the key individuals and events in the 20th century that led to the development and	Class participation, written reflections, worksheets and final exam

Physical Sciences SLOs → Students will be able to…	Quest 2 SLOs → Students will be able to…	This Course's SLOs → Students will be able to…	Assessment Student competencies will be assessed through…
	beyond.	proliferation of nuclear weapons	

V. Quest Learning Experiences

1. Details of Experiential Learning Component

This course will incorporate an experiential-learning component through in-class simulations and collaborative role-playing exercises that place students in historically and scientifically significant scenarios related to the development of nuclear technology and the evolution of our understanding of production of elements in stars. For example, students will participate in a simulation of a Cold War-era policy debate, where they will take on the roles of scientists and scientific advisors to grapple with the scientific, ethical, and humanitarian dimensions of nuclear arms development. In another activity, students will work in teams to understand stellar spectra and classify stars based on real astronomical data, mirroring the investigative methods used by astrophysicists.

These activities are designed to immerse students in the decision-making, collaboration, and interpretive work that are central to both scientific discovery and global developments of nuclear arms. They will also help students appreciate the societal impact of science in both constructive and destructive contexts. All activities will be conducted during class time under worksheets to ensure equal access.

2. Details of Self-Reflection Component

Written reflections will be assigned most weeks during the class which offers you the opportunity to consider how your experiences and observations during the class have shaped your thinking, and allows you to explore and express your own ideas about the content discussed in class. Reflective writing can also help you improve your analytical skills because it requires you to express what you think, and more significantly, how and why you think that way on a particular topic.

Reflective writing will be evaluated based on fulfilling the following four criteria:

- *Depth of reflection:* Demonstrating a conscious and thorough understanding of the scenario and the subject matter.
- *Use of textual evidence and historical context:* Using specific and convincing examples from events to support claims in your own writing, and making insightful and applicable connections between issues.
- *Language use:* Using language that is precise and engaging, with notable sense of voice, awareness of audience and purpose, and varied sentence structure.

VI. Required 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/ugrad/current/regulations/info/attendance.aspx

Students Requiring Accommodation

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

UF Evaluations Process

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online. Students can complete
evaluations in three ways: 1. The email they receive from GatorEvals, 2. Their Canvas course
menu under GatorEvals, or 3. The central portal at https://my-ufl.bluera.com Guidance on how to provide constructive feedback is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code

(https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. See the UF Conduct Code website for more information. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Counseling and Wellness Center

Contact information for the Counseling and Wellness Center: http://www.counseling.ufl.edu/ , 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

The Writing Studio

The writing studio is committed to helping University of Florida students meet their academic and professional goals by becoming better writers. Visit the writing studio online at http://writing.ufl.edu/writing-studio/ or in 2215 Turlington Hall for one-on-one consultations and workshops.

In-Class Recordings

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.