

IDS 2935 - Stars and the Nuclear Arms Race

Quest 2 Syllabus

I. Course Information

Spring 2022

General Education Designation: Physical Sciences

Meeting Day/Time: Tuesday: 3:00 pm - 3:50pm, Thursday 3:00 pm - 4:55 pm

Location: Tuesday: LEI 0104, Thursday: MCCA 3194

Instructor Information

- Prof. Rana Ezzeddine – rezzeddine@ufl.edu
- Office location: 324 Bryant Space Science Center
- Office hours: Monday/Friday 2:00pm - 3:00pm (and via appointment by email)
- Phone: (352) 294-1846

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. A minimum grade of C is required for general education credit. Courses intended to satisfy the general education requirement cannot be taken S-U.

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 produced 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.

Required & Recommended Course Materials

I- 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. "A Scenario Analysis" S.D. Baum et al., Acta Astronautica, 68, 11 (2011) available at <https://arxiv.org/pdf/1104.4462v2.pdf>
Which sections do I need to read?
 - surnames A-E: 1, 2, 3, 6
 - surnames F-M: 1, 2, 5
 - surnames N-S: 1, 2, 4
 - surnames T-Z: 1, 2, 3
5. NASA website: <https://exoplanets.nasa.gov>: "Exoplanets 101" and "Habitable Worlds" and "Would Contact with Extraterrestrials Benefit or Harm Humanity?"
6. 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/>
7. "On the belated discovery of fission" Physics Today, 68, 6-40 (PDF will be posted on Canvas)

III- Videos: (Youtube link will be posted)

1. The world after Trinity (1981)

II. Coursework & Schedule

1. List of Graded Work

Assignment	Description	Requirements	Points
Written Reflections (7 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	30
Homeworks (6 in total)	Will be assigned on some weeks to reinforce skills taught in class.	Response to questions	30
Midterm Exam	Formative assessment in the form of multiple questions to assess the grasp of the course materials and identify areas that need work	Response to questions	15
Final Exam	Formative assessment in the form of multiple questions to assess final review of the topics covered in the course and your knowledge on the subject.	Response to questions	20
Participation	Consistent informed, thoughtful, and considerate class participation is expected and will be evaluated using the rubric in the appendix 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.

2. Weekly Course Schedule

Week/ Date	Activity	Topic/Assignment (Question/Subject)	Points
Week 1	Topic	Syllabus and Introduction	
	Summary	Covering the syllabus and introduction to the course	
	Readings/Works	None	
	Assignment	None	
Week 2	Topic	Introduction to atoms and spectroscopy	
	Summary	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	4.5
Week 3	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	4.5
Week 4	Topic	Nucleosynthesis, the r-process, and radioactive decay	
	Summary	Definition of nucleosynthesis and formation of chemical elements inside and via the stars, chemical enrichment events. Broader introduction to the formation of the heavy neutron-capture elements (particularly via the r-process) and their radioactive decay to stable isotopes.	
	Readings/Works	DOE Handbook, p. 22-25, 27, 30-35. Online reading set "B". Science Magazine article: <i>"Some dead stars may harbor enough uranium to set off a thermonuclear bomb"</i>	
	Assignment	Homework 3	6
Week 5	Topic	Nuclear physics and nuclear weapons	

Week/ Date	Activity	Topic/Assignment (Question/Subject)	Points
	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	
	Readings/Works	DOE Handbook, p. 17-21, 48-51, 56-62 and <i>"On the belated discovery of fission"</i>	
	Assignment	Written reflections	4.5
Week 6	Topic	Uranium in the 20th century	
	Summary	Discussion on Uranium mining and its political and geological significance for U enriching countries and the rest of the world	
	Readings/Works	Scientific American articles: article: <i>"How long will the world's uranium supplies last?"</i> , <i>"When Uranium Outshines Gold"</i> and <i>"Uranium and Geology"</i> .	
	Assignment	Written reflections	4.5
Week 7	Topic	The Manhattan Project	
	Summary	Discussion on the development of the Manhattan Project until the building of the first bomb	
	Readings/Works	NYT article: <i>"Why they call it the Manhattan Project"</i>	
	Assignment	Written reflections	4.5
	Midterm		
Week 8	Topic	The world after Trinity	
	Summary	Discussion and reflections on the movie <i>"The world after Trinity"</i> and World War II events post Hiroshima and Nagasaki	
	Readings/Works	Watch movie: <i>"The world after Trinity"</i>	
	Assignment	Homework 4	4.5
Week 9	Topic	The reactions of scientists	

Week/ Date	Activity	Topic/Assignment (Question/Subject)	Points
	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 on science and scientific advancement.	
	Readings/Works	SA article: <i>"What happens during a Nuclear meltdown?"</i>	
	Assignment	Written reflections	4.5
Week 10	Topic	The reactions of humanity	
	Summary	A discussion on the 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	NYT article: <i>"Now I Am Become Death": The Legacy of the First Nuclear Bomb Test</i> ". SA article: <i>"Smarter use of Nuclear waste"</i>	
	Assignment	Written reflections	4.5
Week 11	Topic	Exoplanets	
	Summary	Definition of exoplanets and the current status of the field and exoplanet habitability	
	Readings/Works	NASA webpages	
	Assignment	Homework 5	6
Week 12	Topic	The Drake Equation	
	Summary	Definition of the Drake equation and discussion on the quest of the search of extra-terrestrial life	
	Readings/Works	Online reading set "C"	
	Assignment	Written reflections	3
Week 13	Topic	Contact scenarios	
	Summary	Discussion on possibility of detection and contact with extra-terrestrial life and its significance to human life on Earth	
	Readings/Works	Baum et al. paper - <i>"A Scenario Analysis"</i> (note: required reading per last name)	

Week/ Date	Activity	Topic/Assignment (Question/Subject)	Points
	Assignment	Written reflections	4.5
Week 14	Topic	Uranium is everywhere; course reflections	
	Summary	Discussion of the recent results on the importance of Uranium detection in exoplanets for habitability. Class conclusions and reflections.	
	Readings/Works	"What Role do Radioactive Elements Play in a Planet's Habitability"	
	Assignment	Homework 6	4.5
	Final		

***Note: Total homework points add up to 30 points.**

Total written reflection points add up to 30 points.

III. Grading

1. Statement on Attendance and Participation

Attendance and Participation:

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/>

- Participation: Consistent informed, thoughtful, and considerate class participation is expected and will be evaluated using the rubric below. The instructor will inform you of your participation grade to date when mid-term exams are returned and schedule a conference if you are earning below 70% of the possible points.
- NOTE: If you have personal issues that prohibit you from joining freely in class discussion, e.g., shyness, language barriers, etc., see the instructor as soon as possible to discuss alternative modes of participation.

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 important 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

3. Grading Scale

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

A	94 – 100% of possible points	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

IV. Quest Learning Experiences

1. 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.
- *Coherence and Style*: Demonstrating control of the conventions with essentially no errors, even with sophisticated language.

V. General Education and Quest Objectives & SLOs

1. This Course's Objectives — Physics (P) and Quest

Physical Sciences Objectives →	Quest 2 Objectives →	This Course's Objectives → (This course will....)	Objectives will be Accomplished By: (This course will accomplish the objective in the box at left by...)
Physical science courses provide instruction in the basic concepts, theories and terms of the scientific method in the context of the physical sciences.	Quest 2 courses provide instruction in the history, key themes, principles, terminologies, theories, or methodologies of various social or biophysical science disciplines that enable us to address pressing questions and challenges about human society and/or the state of our planet.	Expose students to the basic principles of atoms, nuclear reactions and nucleosynthesis in stars, concepts of stellar generations and chemical evolution in the Universe, explore the mineral and chemical properties of uranium on Earth and its discovery by humans.	Exploring the lifecycle of stars and chemical element production inside and via the stars, and delving into the significance and importance of the infamous uranium as an element and its mining on Earth.
Courses focus on major scientific developments and their impacts on society, science and the environment, and the relevant processes that govern physical systems.	Students learn to identify and analyze different social or biophysical science methods and theories and consider how their biases and influences shape pressing questions about human society and/or the state of our planet.	Evaluate and critique the history of the nuclear power, The Manhattan Project, as well as public policies regarding uranium and nuclear weapons during the Cold War and today.	Discussing the historical significance of nuclear power and and humanity's reaction to the 20th century catastrophic nuclear events and their environmental effects, the rise to nuclear arms race.

Physical Sciences Objectives →	Quest 2 Objectives →	This Course's Objectives → (This course will....)	Objectives will be Accomplished By: (This course will accomplish the objective in the box at left by...)
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.	These courses emphasize clear and effective analysis and evaluation of qualitative or quantitative data relevant to pressing questions concerning human society and/or the state of our planet.	Enhance critical communication skills	Discussing public attitudes, potential scientific, political and societal solutions towards nuclear weapons.
	Students reflect on the ways in which the social or the biophysical sciences impact individuals, societies, and their own intellectual, personal, and professional development.	Explore the implications of uranium's ubiquity in the Galaxy on the search for life in the Universe.	Exploring the role of uranium in formation of extra-Solar planets on their habitability and the potential presence of life.

2. This Course's Student Learning Outcomes (SLOs) — Physics (P) and Quest

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, midterm and final exam.
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, midterm 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...
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, midterm and final exam
	Connect course content with critical reflection on their intellectual, personal, and professional development at UF and beyond.	Summarize and describe the key individuals and events in the 20th century that led to the development and proliferation of nuclear weapons	Class participation, written reflections, midterm and final exam

Required Policies

1. 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.

2. 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 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/>.

3. 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. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

4. Counseling and Wellness Center

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

5. 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.

6. Policy on Recordings

Our class sessions may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a

profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.