HNRS 250: Astronomy Controversies of the Modern Era

Fall 2016

Meeting: Trexler 273
Instructor: Matthew C. Fleenor
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Time: MWF 1.10-2.1Op (Block 5)
Office: Trexler 2660
Office Hours: R 1-2.30p
W 2.15-4p, or by appt.

Required Readings (you need to purchase):

Galileo's Daughter (GO), Dava Sobel
The Trial of Galileo, Reacting to the Past Series (RTP), M. Carnes & F. Purcell
Miss Leavitt's Stars (MLS), George Johnson
Heart of Darkness (HoD), Ostriker & Mitton
Any used copy of an introductory astronomy textbook

Required Readings (excerpts I will provide):

Skywatchers (S), A. Aveni
Does Copernicus Owe a Debt to Aristarchus?, 0. Gingerich
The Assayer, Galilee
Posterior Analytics, Aristotle

Components of Learning

There are several factors that make a course "good" (by good, I mean a healthy combination of the intellectual and the affective). Good courses are also clear about their essential components. Below is an attempt to be clear about how will I operate within HNRS 250, as well as my expectations of a student who is enrolled in HNRS 250.

Descriptions

Aspiration: How do the scientific processes of observation, measurement, and theorizing help to create and resolve controversy within the sciences? Is it healthy to maintain controversy regarding theories and models in the sciences; i.e., do the sciences thrive on controversy? How is controversy received and interpreted by the larger society and culture? By examining some well-known controversies within the astronomical sciences, we will explore both the quantitative arguments and the historical contexts in answering the above questions. Since physics is the proper background for astronomical studies, the course will also focus on the physical concepts and processes associated with astronomical objects. You will also take measurements, observe astronomical objects with telescopes, and interpret graphically-presented data through a required weekly night lab. The aspiration is that you will better understand the process of carrying out science and determine what makes 'good science.'

Goals & Objectives: Remember, you are primarily enrolled in the Controversies class because it satisfies the lab-science component of your liberal arts, general education program. All sections of HNRS 250 share a common set of learning outcomes related to the skills students will develop in this course. These outcomes are as follows:

1. Students will be able to describe and apply scientific methodologies appropriate for the courses discipline and topic, including the ability to design and conduct simple experiments and to draw conclusions based upon data.
2. Students will be able to write about course topics clearly and effectively.

3. Students will be able to interpret quantitative information related to the course topic.
4. Students will connect course content to their lives and to communities beyond the classroom.

An outcome is a newer term in education and represents what people traditionally think of as a goal or an objective. In the 'Controversies' section of HNRS 250, the common outcomes above will be developed in specific assignments tied to specific outcomes. A specific list of outcomes for this specific course is found under "Course Learner Outcomes" beginning on page 4.

Attendance: I will aspire to track daily attendance, and the following modes of learning also highlight a student's presence or absence: group work, discussion, and quizzes within the class hour. You are allowed a total of 3 absences (either un/excused) for which I do not require a note, but only an email ahead of time forewarning me of your absence (if possible). At the third un/excused absence, I will request a meeting with you and send an email to you, your Advisor, and the Registrar alerting them of the situation. After the fourth absence, you will be dropped (forcibly, with a "DF" or "DP," or willingly with a "W" before the ninth week) from the class. Late arrivals greater than 10 minutes will constitute an official absence.

As is the case for all Roanoke College classes, the time spent on this course will constitute at least 12 hours a week. This includes class, lab, reading, and any homework or writing assignments.

Office Hours: Besides the normal class hours, my office door is open to each student (at least) three more hours each week. If these times conflict with your schedule, please seek me out to set a time that meets your needs.

Inquire (NQR): The information found within the NQR environment is an essential component to the course itself. Notes, announcements, readings, web links, and course documents will all be placed within the course NQR. Please do NOT forget to check NQR before you come to class or if you have a question about previous assignments.

Academic Integrity (AI): All freedoms imply responsibility, and your responsibility to the RC AI policy ensures your academic freedom. I want to foster a mutual respect for the classroom hours that we have together, and AI is primarily about mutual respect (because responsibility and accountability accord). In light of this, please silence cell phones, electronic devices, etc. before class and come prepared (e.g., book, paper, and pencil). Classroom computers are designed for academic learning and should be used in this manner during class; i.e., no email exchanges and/or surfing during class.

Reading, reflection, and research all involve the activity of recognizing the good thinking of others. Plagiarism exists when someone takes personal credit for another's creative (usually written) work. Hacker's A Writing Reference gives very clear examples for citing the work of others from a broad spectrum of sources (including the internet). Please use this guide when citing work during the writing that you will complete in the course. Lastly, please be advised that the RC AI policy will be upheld within this course as detailed online at-
http://roanoke.edu/A-Lindex/Registrar/Policies_and_Jnformation/Aeademic Integrity.htm
Included here is an explanation of how violations of the College's academic integrity policy are handled.

A Word about Late Work: Please note that for all assignments a total of 50% will be deducted after one week past the due date. After two weeks past the originally-assigned due date, no credit will be awarded for the assignment.

Grades: For better and for worse, you will receive a letter grade for this course. Basic letter grades (A-F) are assigned according to the following minimum scale: "A"(92-100), "A-" (91) "B+"(88-90), "B"(83-87), "B-"(80-82), "C+"(78-79), "C"(74-77), "C-"(70-73), "0"(60-69), "F"{< 60).

Observing Lab: There is a required laboratory (WED, 7.30 – 10.30p) for the course that involves telescope observing, taking data, and drawing conclusions supported by those data. The observing lab meets at the Elizabeth Campus (EC) in Hundley Hall. Please consult the NQR site for a map to Hundley at EC. However, when the weather is poor, we may meet in TREX 273. Within the laboratory component, we will explore both astronomical observation and the physical principles supporting astronomical measurements. You must register for both the course and lab sections.

Collaboration: One stark distinctive of 21st century science is the degree of collaboration within the astronomical community. To gain some insight into this process, much time will be spent in group collaboration in/outside of class. VVe will spend some time discussing the difference between "collaboration" and "plagiarism." In short, collaboration relies on the individual strengths and contributions of each group member to produce a deeper level of understanding.

Modes of Learning

Rubric

Your grade is determined according to the following distribution.

Exams (4)	30%	Classwork/homework	10%	Public Media (3)	7%
Engagement Project	10%	Observing Lab (3)	15%	Focused Reflection (3)	8%
Reacting Essay	10%	Quizzes	10%		

Descriptions

There are several researched and proven learning methodologies that we will employ to gain a better understanding of the material and its context. Below I have listed some of them and given a brief description.

Quizzes. VVeekly written or online quizzes are completed individually and graded. Quizzes are intended to be simple and direct measures of new and cumulative knowledge that you have obtained and retained. Quizzes will only consist of a few questions, usually four or less. They could relate to the reading from the assigned selections, or these questions could be taken from the multiple choice questions at the beginning of (almost) every class. Alternatively, the quiz questions could be graphical in nature.

Public Media. Astronomy is discussed in all sorts of venues and contexts, including newspapers, television, popular science magazines, and artistic interpretation. At specific times listed on the Reading Guide, you will submit a reflection pertaining to a connection point with astronomy in the public media. Details on what makes up a worthy Public Media submission can be found explicitly on NQR. (NOTE: Almost all internet material proceeds from source material, such as articles, books, magazines, etc. For the media journal, you must cite the source material as well as the website.)

Written Reflection. Besides the Public Media reflections, there will also be three opportunities within the course to communicate about a particular concept or historical event. You will have less control on choosing the article(s) and/or reading(s) because I want to ask specific questions from you. Answers to the questions will be written in paragraph form. Your final submission will include grammar, structure, coherence, and creativity as grading criteria.

Written Lab Reports. A portion of your laboratory grade is based on written reports that you will submit one week after completing a particular "experiment" (or observation). Two of these reports will be

collaborative (group reports) and one will be individually written. The structure of a lab report is quite different than the above reflections, so we will discuss these differences during lab.

Exams. Exams (3) will cover the build-up of material through the class discussion, writing, quizzes, and laboratory investigation. These exams will contain questions of varying type: thought experiments, short essay (explanative and opinionated), and graphical interpretation. All exams will contain comprehensive material from the previous chapters, probably the most missed problems from the previous exam/quizzes. Make-up exams will only be allowed as a result of a discussion with me beforehand or an emergency note (death, hospitalization, misdemeanor, etc.) signed by a governing official (medical doctor, parent, law enforcer, etc.). The final exam is scheduled for 14 DEC (WED), 2.00- 5.00p.

Reacting Essay. The essay is based on the role-playing, debate-oriented historical reconstruction of the Trial(s) of Galileo. The reconstruction consists of an oral/written historical conversation between Galileos proponents and detractors. Although there is a debate (oral) portion to the project, and you will also be in collaboration with others during this time, the primary weight of the grade (80%) is rooted in your ability to make your role "come to life" through understanding the character you are assigned and expressing that in written form.

Engagement Project. There is one collaborative (research) project within the course, relating to a modern astronomy controversy of your choice. This will serve as your community engagement project and will result in your dissemination of your findings to the community via a poster session in Colket in December. I will provide several topics, but this provision does not preclude you choosing a different topic, so long as your collaboration and I agree on the topic. You will be working in groups toward a concerted goal of presenting both sides of the argument. There is an oral and written portion to the project, and this will involve much of your own individual creative effort.

Intended Learner Outcomes

Course-wide

Successful students will:

– Identify underlying foundational tenets that shape wrong (and right) models and theories.

– Examine datasets that lead to a re-creation of the scientific arguments and a re-calculation of results supporting both sides of the controversy.

-Analyze and interpret the personal and historical stories that shape individual science paradigms.

-Synthesize third source data and analysis to draw conclusions about a current, unresolved controversy.

Successful students will have improved their skills in:

– Identifying supporting arguments based on data versus philosophical extrapolation.

– Constructing a summative paragraph for a scientific argument.

-Constructing an informed graph and calculating the slope with its proper units.

-Manipulating simple data-taking instruments for the purpose of understanding proportions of variables.

Galileo and the Copernican Revolution

Successful students will:

– read original documents from the Galilean era that discuss science arguments and group them as supporting or opposing.

– observe differences between early models of the solar system and determine how these differences incorporate observation and/or reasoning.

-verify Kepler's third law with data from Jupiter's Galilean moons

-analyze socio-religious correspondence (e.g., Galilean era) written in response to scientific observations and identify bias and/or support.

The Great Debate of 1920

Successful students will:

– manipulate original data (Shapley GC data) to construct maps of the Milky Way that show the sun is not at the MW center.

-differentiate between measurement and inference when establishing a scientific argument, which includes identifying hidden or unstated assumptions.

Big Bang versus the Steady-State Models

Successful students will:

– extract meaningful spectroscopic results from mock observations.

– re-construct a plot of Hubble expansion (velocity vs. distance) and calculate the Hubble constant value (slope).

-read and critique personal biography (e.g., Hubble) and autobiographical correspondence (e.g., Burbidge) as it reveals underlying beliefs of particular scientists.

-utilize simple carts and timers to demonstrate that speed and acceleration are proportional.

Missing Mass, Dark Matter, and MoNO

Successful students will:

– recognize the apparent imbalance between observational measurement and theoretical prediction.

-weigh the implications of creating and/or adding to established laws and models.

-measure and calculate the rotation speed of a spiral galaxy compared with an elliptical.

Community Engagement Project

Successful students will:

-organize pre-processed data into graphical representation relating to an unresolved controversy.

– read and summarize third source material as it relates to current science topics.

-build a portfolio that contains both graphical representation of data as well as written argumentation in support of a side in a current controversy in astronomy.

Course Outline & Reading Guide

Please see the Outline in the following document for the exact dates of meeting for the course. The Outline also shows the daily activity and course content for our educational experience. If you have questions about scheduling, please refer to this Outline first. There is also a Reading Guide in the following documents to provide detailed information about the reading assignment for each class and the due date for assignments.

HNRS250 Course Outline FALL 2016

Week	Date	Controversy	Topic	Concept(s)
1	31-Aug		Introduction- What are we trying to do?	
	2-Sep	How much	Scope and Limitations of Science (Astronomy)	Inference
2	5-Sep	astronomy did	Cosmology and Maya Influence	Solar system
	7-Sep	the Maya know?	Mayan astronomy and Codices	Cyclic periodicity
	9-Sep		Sidereal and synodic measurements	Sidereal/Synodic
3	12-Sep	What killed the	Chicxulub Crater Impact: History and Science	Potential/kinetic E
	14-Sep	dinosaurs?	Alternative Ideas and Theories	Dating-Radioactive
	16-Sep		Greek Influence on Astronomy	Epicycle/circumf
4	19-Sep		Optics- Focal Length & Telescopes	Image formation
	21-Sep	For what reasons	Observations- Aristotle and Catholicism	
	23-Sep		In-class Exam 1	
5	26-Sep	did Galilee incur	Copernicus & the rise of heliocentrism	Intuition & theory
	28-Sep	persecution?		
	30-Sep			
6	3-0ct		Trial of Galileo (mini-Reacting)	
	5-0ct		see specific schedule for event order	
	7-0ct			
7	10-0ct		Kepler Jigsaw Activity	3 Kepler Laws
	12-0ct		Tycho Brahe and measurement	"error" in science
	14-0ct		In-class Exam 2	
8	17-0ct		*No* Classes -*Fall* Break	*No Is b this week*
	19-0ct			
	21-0ct			
9	24-0ct	Is there one	Nature of Light & Telescopes	photons, *elm* rad
	26-0ct	galaxy or many?	Types of stellar objects- diffuse nebulae	spectral features
	28-0ct		Cepheid Variables/ Globular Clusters	correlation
10	31-0ct		2D/3D Mapping	extinction
	2-Nov	Did the universe	Radial velocities and Distance Ladder	doppler effect
	4-Nov	have a	ps. Hubble Expansion of the Universe	
11	7-Nov	beginning?	Early Models and Theories	radio sources
	9-Nov		Evidences for the Big Bang	H-R MSTO
	11-Nov		Early Evidence of Missing Mass	conservation of E
12	14-Nov	What is the	Rotation Curves of Spiral Galaxies/21cm	spin-flip in H
	16-Nov	nature of	Baryons and other strange particles	indirect detection
	18-Nov	Dark Matter?	Stellar Evolution & Nucleosynthesis	BH evidence
13	21-Nov		In-class Exam 3	
	23-NOY		No Classes -Thanksgiving Break	*No Is b this week*
	2 '1(			
14	28-Nov	What is the	Time, Space, and the (multi-)Universe	relativity & DE
	30-N0v	Nature of	What is MoND and what's "wrong" with it?	F = rna, linear
	2-Dee	the Universe?	What does it mean to alter the laws of Nature?	
15	5-Dec			
	7-Dec		Final Controversies Project	
	9-Dec			
	14-Dec		FINAL EXAM: 2.00 – 5-.00 PM	