

***HIST 394: HISTORY OF ASTRONOMY AND COSMOLOGY, STONEHENGE  
TO THE SPACE AGE. Fall Term 2009***

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Classes: Tuesday and Thursday, 2-3.20pm. Education 170.

Office Hours: Monday, 1-3pm (or by appointment)



EMAIL

*Email exchanges are usually a good way to deal with very short questions or queries. However, they are generally a bad way to discuss course content. If you have questions related to course content, please arrange to meet with me during office hours or if these are not convenient, we can set up an appointment. I will be very happy to discuss content questions with you in person.*

COURSE DESCRIPTION

This course is an exploration of a variety of topics in the history of astronomy and cosmology from the earliest times to the present day, although the emphasis will be on developments in the last five hundred years. To begin, we will discuss Stonehenge and the astronomy and cosmology of early civilizations. These topics will lead into an examination of Islamic astronomy and the astronomy of the Latin West. A central theme of the rest of the course will be the changing views of astronomers on the large-scale structure and origin of the universe. In particular, we will discuss how these views have been shaped by the availability of new and different kinds of telescopes including on astronomy and cosmology pursued from space vehicles, including the astronomy of the Hubble Space Telescope.

### COURSE OBJECTIVES

- 1) To develop a broad familiarity with the major topics, themes and ideas in the history of astronomy and cosmology and to be able to relate these issues and themes to wider issues in the history of science, technology, and society.
- 2) To demonstrate on written exams, an observation journal, and a research paper, the ability to absorb, assess and analyze the information presented in class and in a variety of readings. These readings will include some 'primary sources' (that is, materials written by the historical figures we are studying).

### REQUIRED BOOKS AND COURSEPACK

There are two required books for the course. These are:

- 1) Michael Hoskin, The Cambridge Concise History of Astronomy (Cambridge University Press, 1999)
- 2) Albert Van Helden's translation of Galileo's Siderius Nuncius, or The Sidereal Messenger (Chicago University Press, 1989). Both are available in paperback from the Bookstore.

We will also be using a Coursepack and this too is available from the Bookstore. Some of the Coursepack selections will be the basis for class discussions. Please bring the Coursepack with you to each class!

Also, note that the main textbook, the volume by Michael Hoskin, contains more material than we will need. Don't panic! You do not need to learn everything in it! 'Study Guides' are attached to this Outline and list the key concepts, people, books, institutions and instruments we will focus on.

### MARKS

There will be no TA for the course. All of the marking for the exams, observation journal and term paper will be done by Professor Smith. The distribution of marks for the course is as follows:

- 1) observing journal 10%
- 2) mid-term 20%
- 3) paper 30%
- 4) final 40%

During the course, marks will be assigned to each exam and assignment. A grade on the university's letter grade scale will then be assigned on the basis of your total marks following the final exam. Grades will not be distributed according to a set curve.

Both the mid-term and the final will be closed book exams. However, for the mid-term and final I will distribute along with the exam paper, a copy of the short 'Chronology' from Michael Hoskin's The Cambridge Concise History of Astronomy. Although the final will include material from the entire course, the emphasis will be on material covered after the mid-term exam.

**The mid-term exam** will be in class on **TUESDAY OCTOBER 13**. The final exam will held at a time to be announced during the final exam period (December 5-18).

Deferred Final Exam: If students are granted a deferred final exam request, that exam will be held on MONDAY DECEMBER 21 at 10am.

Descriptor	Letter Grade	Grade Point Value
Excellent	A+	4.0
	A	4.0
	A-	3.7
Good	B+	3.3
	B	3.0
	B-	2.7
Satisfactory	C+	2.3
	C	2.0
	C-	1.7
Poor Minimal Pass	D+	1.3
	D	1.0
Failure	F or F4	0.0

### OBSERVING JOURNAL

We will discuss what is expected in the Observing Journal in class and a short description appears in the outline. The Observing Journal will be due at the start of class on **THURSDAY NOVEMBER 12**. If the Observing Journal is handed in late it will be marked down.

## PAPER

You will be required to write a paper. I will spend some time in class going over what is expected for the term paper, but here are the key points.

- The paper should be about 2,300 words in length (that is, approximately 8 double-spaced pages in length, excluding bibliography).
- I will assign paper topics. However, if you would like to tackle a different topic from the ones assigned, I will be open to your proposals. But please arrange to meet with me to ensure your proposed topic will be acceptable. YOU MUST ALSO SUBMIT A WRITTEN REQUEST FOR A CHANGE FROM THE ASSIGNED TITLES SO THAT I HAVE A RECORD OF YOUR TOPIC. I WILL ALSO APPROVE ANY CHANGES IN WRITING.
- In completing the paper, you should follow the guidelines in the Department of History and Classics' Guidelines for Historical Essays. Copies of these documents will be distributed in class and are also available from the Department of History and Classics, 2-28 Tory Building.
- This is a history course and so the paper must be historical in nature. An essay in which, say, someone describes the various constellations in the night sky is not an historical essay.
- Your paper will be marked both on the content (coherence of argument, use of evidence, etc) and the style/presentation. The paper should be written in Standard English. This means that concentration on the topic, clarity, and seriousness of thought should be reflected in clear and concise writing. Ideas and arguments will be evaluated in terms of the manner in which they are presented. In marking papers, I will be particularly concerned with the following points:
  - Content Mastery, Synthesis/Integration and Research: An assessment of the student's ability to understand facts, concepts, and theories introduced in class and in the readings, as well as the quality of the research that has gone into the paper.
  - Communication Skills: The policy of the Faculty of Arts requires that instructors must take into account "the quality of expression in assessing written work." Hence it is very much in your interest that the papers handed in should not be a first draft. The papers should be neatly typed (double-spaced), with page numbers, and with the title, your name, and the course number and title clearly marked. It is important that you both check the spelling and proof-read your papers before you hand them in.

- The paper must be your own work. Unacknowledged use of sources--through extensive summaries or quotations--constitutes plagiarism. Also, students are not allowed to submit in any course or program of study, without both the knowledge and approval of the person to whom it is submitted, all or a substantial portion of any academic writing, essay, thesis, research report, project or assignment for which credit has previously been obtained or which has been or is being submitted in another course or program of study in the University or elsewhere. On issues of plagiarism and cheating, see also the University guidelines given later in this Outline.
- The paper will be due at the start of class on **TUESDAY NOVEMBER 24**. *I encourage everyone to hand me a one-page summary/outline of the essay at least two weeks ahead of this due date so I can provide some feedback.*
- Late papers will be marked down. Requests for extensions to a maximum of one week will only be granted in advance and for very good reason (e.g., illness, with a medical certificate). If you are ill and can't submit your essay on time, you must complete one of the Health Services medical forms, or get a letter from your family doctor. This letter or form must reach me by the essay due date; have a friend or family member contact me if you are unable to do so. The press of work in other courses is not a legitimate reasons for a late essay. To eliminate problems arising over lost assignments, please keep a photocopy of the paper and observing journal and hand in the original. For your paper, keep an electronic copy as well.

### MOODLE SITE

There will be a moodle site for HIST 394 on the Department of History and Classics website. I will explain how to access the site and what sort of material will be posted there in class (the posted material will include past final exams for the course).

### CLASSES

Classes will mostly be lecture based but there will be a number of discussions. It will not be possible to do well in this course without attending consistently.

### HOW TO GET THE MOST FROM THIS COURSE

1. If a section from the textbook, an assigned reading or handout is to be discussed, make sure you read it beforehand. Come to the class with a clear idea of what questions you need to have answered--you can do this only if you read the textbook, assignments and handouts carefully and take notes. Again, effective reading includes taking notes and reflecting upon the material covered. You are very welcome to ask questions and offer relevant comments during class sessions, and to come and talk to me about the course. You should bring the Coursepack materials to class.

**2. Remember that lectures do NOT simply duplicate the materials in the readings.** Lectures will cover a lot of ground quickly; the textbook and other readings provide background and context for the lectures and discussions. On occasion students will be guided to read and take notes on material that we will not cover in lectures.

### WEBSITES

There are numerous websites devoted to the history of astronomy and cosmology, some of which are excellent and many of which are awful. One reliable and very worthwhile site is called “Starry Messenger” and is maintained by the Department of the History and Philosophy of Science at the University of Cambridge in England. This website centres on the history of astronomy up to the seventeenth century. The address for this site is:

<http://www.hps.cam.ac.uk/starry/starrymessenger.html>

For demonstrations of planetary motions as envisaged by ancient astronomers, an excellent site is <http://www.scri.fsu.edu/~dduke/models>.

Also very good is a website devoted to Galileo.

<http://galileo.rice.edu/>

For space astronomy and a remarkably wide collection of images as well as lots of information on the Hubble Space Telescope and other telescopes in space, type ‘Space Telescope Science Institute’ into your favourite search engine.

There are a number of software programs for personal computers that demonstrate the appearance and motions of the night sky. A very good one is called ‘Stellarium’ and can be downloaded for free. Type ‘Stellarium’ into your favourite search engine and you will locate this very quickly. Among the programs that can be purchased, ‘Night Sky Explorer’ is excellent. Using one of these programs is not essential for the course, but some students find these are useful aids. These programs will also be discussed in class.

### ACCOMMODATION

Students who require accommodation due to a disability involving mobility, vision, hearing, learning or mental or physical health should discuss their needs with Specialized Support and Disability Services (SUB 2-88; 492-3381 [phone]/492-7269 [TTY]).

### PLAGIARISM AND CHEATING

The University of Alberta is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Code of Student Behaviour (online at [www.ualberta.ca/secretariat/appeals.htm](http://www.ualberta.ca/secretariat/appeals.htm)) and avoid any behaviour which could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence.

Academic honesty is a serious offence and can result in suspension or expulsion from the University.

### PLANETARIUM VISIT

I hope the class will be able to visit the Planetarium at the Telus World of Science to see demonstrations of various celestial phenomena (retrograde motion, diurnal motions, etc.). I will give more details later.

### COURSE OUTLINE

Policy about course outlines can be found in Section 23.4(2) of the University Calendar.

### CALENDAR AND TENTATIVE COURSE OUTLINE

Please Note: Students will on occasion be directed to particular websites for additional 'readings' and demonstrations.

#### Week 1

September 3: Introduction to Major Themes of Course and to Motions of Stars, Sun, Moon and Planets.

#### Week 2

September 8: Megalithic Astronomy  
September 10: Extending the senses: The Telescope

Readings: Hoskin pp. 1-17. Extract from Aveni's Stairways to the Stars, pp. 12-46, in the Coursepack. [Note: The Aveni reading goes into more detail than we will need. I will note the key concepts to focus on in class]

#### Week 3

September 15: Conversation on Galileo and the invention of the telescope with Professor Albert Van Helden (Professor Van Helden will be on campus this week as a University 'Distinguished Visitor.' He is the leading world expert on the invention of the telescope as well as Galileo)  
September 17: Egyptian/Babylonian Astronomy I

Readings: Hoskin pp. 18-24. Van Helden pp. 1-24 (plus dip into Galileo's *Sierius Nuncius*).

#### Week 4

September 22: Babylonian Astronomy II/Greek Astronomy I

September 24: Greek Astronomy II and Chinese Astronomy.

Readings: Hoskin pp. 24-49. Extract from Aveni, Ancient Astronomers, pp. 75-89, on Chinese astronomy, "Ancient Asia's Stellar Bureaucracy," in Coursepack.

#### Week 5

September 29: Greek Astronomy III/Islamic Astronomy.

October 1: Islamic Astronomy II/ Medieval Universe.

Readings: Hoskin pp. 50-86. Extract from Ptolemy in Scientific Revolutions, pp. 7-12, "Saving the Appearances," in Coursepack.

#### Week 6

October 6: Copernicus puts the Earth in Motion.

October 8: A Copernican Revolution?

Readings: Hoskin pp. 86-93. Extract from Nicholas Oresme pp. 92-95, Copernicus, pp. 104-117, and Thomas Digges and Giordano Bruno, pp. 132-144, in Danielson's The Book of the Cosmos, in the Coursepack.

#### Week 7

October 13: **MID-TERM EXAM**

October 15: Galileo I (Movie: Galileo's Battle for the Heavens)

Readings: Hoskin, pp. 111-119. Van Helden, pp. 87-113, plus skim pp. 35-86 of the Siderius Nuncius.

#### Week 8

October 20: Galileo II. The Reflecting Telescope.  
 October 22: Tycho and the Quest for Precision

Readings: Hoskin, pp. 94-103 and 125-129.

### Week 9

October 27: Kepler and Cosmic Harmony  
 October 29: The Newtonian Universe

Readings: Hoskin, pp. 103-111, 119-124, and 130-150.

### Week 10

November 3: William Herschel and the Construction of the Heavens I  
 November 5: William Herschel and the Construction of the Heavens II

Readings: Hoskin, pp. 196-215, plus William Herschel on “The Construction of the Heavens” pp. 175-183, from Scientific Revolutions.

### Week 11

November 10: **NO CLASS. FALL TERM CLASS BREAK.**  
 November 12: Precision Astronomy and the Discovery of Neptune. **OBSERVING JOURNAL DUE**

Readings: Hoskin, pp. 162-5 and 186-9.

### Week 12

November 17: The Rise of Astrophysics  
 November 19: Big Telescopes, Organizing Astronomy, and Organizing the Stars

Readings: Hoskin pp. 224-8, 233-5, 252-7, and pp. 215-8, 259-260. Extract from Crowe Modern Theories of the Universe from Herschel to Hubble, pp. 178-189, in Coursepack. Extract from Ronan The Practical Astronomer, “Fraunhofer Lines and their Meaning,” pp. 38-9.

### Week 13

November 24: Extra-terrestrial Life? **PAPER DUE**

November 26: The Nature of the Galaxy and other Galaxies

Readings: Hoskin, pp. 245-6. Extract from Scientific Revolutions by Percival Lowell on “Martian Engineers,” in Coursepack. Hoskin, pp. 273-282, 284-294. Extract from Crowe Modern Theories of the Universe from Herschel to Hubble pp. 214-225 in Coursepack [this is a short extract from a book by Agnes Clerke written in 1905]

### Week 14

December 1: The Expanding Universe

December 3: Astronomy from Space and the Hubble Space Telescope

Readings Extract from Ronan The Practical Astronomer, “The Expanding Universe,” pp. 190-1, and Fred Hoyle, pp. 411-415, and Steven Weinberg, pp. 433-437 in Danielson’s The Book of the Cosmos, in the Coursepack. Hoskin, pp. 311-319.

**HIST 394: HISTORY OF**  
**ASTRONOMY AND**  
**COSMOLOGY, STONEHENGE**  
**TO THE SPACE AGE. Fall Term**  
**2009**

**STUDY GUIDE I**

**This 'Study Guide' lists the main concepts, people, ideas and observations covered in the first part of the course. As we go along there might be a few additions to or deletions from this list.**

Newgrange  
 Stonehenge  
 Mayan calendar  
 Babylonian astronomy  
 Zodiac  
 Enuma Anu Enlil  
 Greek astronomy  
 Geocentric universe  
 Aristotelian natural philosophy  
 Ptolemaic astronomy  
 saving the appearances  
 eccentric  
 ecliptic  
 epicycle  
 equant  
 heliocentric universe  
 celestial spheres  
 sublunary region  
 quintessence  
 Chinese astronomy  
 Lifa  
 Tianwen  
 Tian  
 Islamic astronomy  
 Zij  
 Qibla  
 astrolabe  
 medieval universe  
 heliocentric universe  
 Wittenberg interpretation

Plato  
 Aristotle  
 Eudoxus  
 Aristarchus  
 Hipparchus  
 Ptolemy  
Almagest  
Planetary Hypotheses  
 Ibn al-Shatir  
 Nasir al-Din al-Tusi  
 Maragha Observatory  
 Nicholas Oresme  
 Peurbach  
 Rheticus  
 Copernicus  
Commentariolus  
On the Revolutions of the Heavenly Spheres  
 (De Revolutionibus...)

## **STUDY GUIDE 2**

**This 'Study Guide' lists the main concepts, people, ideas and observations covered in the second part of the course. As we go along there might be a few additions to or deletions from this list.**

Tychonic System (geoheliocentric system)  
 Uraniborg  
 Nova of 1572  
 Comet of 1577  
 Kepler's First and Second Laws  
 Elliptical orbits  
 Regular solids  
 Rudolphine tables  
 Telescope  
 Refracting telescope  
 Galilean telescope  
 Keplerian telescope  
 Spherical aberration  
 Chromatic aberration  
 Achromatic telescope  
 Jupiter's satellites  
 Lunar mountains and craters  
 Milky Way  
 Phases of Venus  
 Universal gravitation  
 Reflecting telescope  
 Achromatic telescopes  
 Halley's comet  
 Nebulae  
 Star clusters  
 Galaxies  
 Island universes  
 Star 'gaging'  
 Natural history of the heavens  
 Construction of the heavens  
 Discovery of Uranus

Tycho Brahe  
 Johannes Kepler  
Cosmic Mystery  
Astronomia Nova (A New Astronomy)  
Rudolphine Tables  
 Galileo  
Starry Messenger(Sidereus Nuncius)  
Dialogue on the Two Chief World Systems  
 Johannes Hevelius  
 Thomas Digges  
 Rene Descartes  
 Isaac Newton  
 Edmond Halley  
Principia...(Mathematical Principles of  
Natural Philosophy)  
 Thomas Wright  
 William Herschel  
 Caroline Herschel

### **STUDY GUIDE 3**

**This 'Study Guide' lists the main concepts, people, ideas and observations covered in the third part of the course. As we go along there might be a few additions to or deletions from this list.**

Stellar parallax	J.C. Adams
Discovery of Neptune	U.J.J. Le Verrier
Bode's Law	F.W. Bessel
Spectroscope	Lord Rosse
Spectra	Leviathan of Parsonstown
Continuous spectra	William Huggins
Absorption spectra	Annie Jump Cannon
Bright line spectra	V.M. Slipher
Doppler Shift	Mount Wilson Observaory
Energy of the Sun	Mt Wilson 100-inch telescope
Plurality of worlds (extraterrestrial life debate)	Percival Lowell
Martian canals	Henrietta Leavitt
Cepheid variable stars	Harlow Shapley
Galaxies	Edwin Hubble
'The Big Galaxy'	Albert Einstein
Redshifts	Georges Lemaitre
Redshift-distance relation (Hubble's Law)	Hubble Space Telescope
Big Bang Cosmology	
Steady-State Theory	
Invisible astronomy	
Space astronomy	

**HIST 394. HISTORY OF ASTRONOMY AND COSMOLOGY. FALL  
2009. OBSERVING JOURNAL ASSIGNMENT**

Every member of the class is required to keep an *Observing Journal*. The aim of this is to make you more familiar with the night sky, particularly some of the features that were well known to astronomers even before the invention of the telescope. The only apparatus you will need for these observations are your eyes, paper, and a pencil. The *Observing Journal* is worth 10% of the marks, and should be **handed in at the start of class on November 12**. If the observing journal is handed in late, it will be marked down. You can keep the Observing Journal in the form of loose letter sized sheets (stapled together) or you can use a bound notebook. Your name must be indicated clearly on the front of either the set of loose sheets or the notebook. The date and time of each observation should be clearly shown.

**Moon** Observe the Moon on at least six occasions at different times over an extended period and describe your observations in your *Observation Journal*. Between early September and November 12, the Moon will be visible at different times of the day and night and will exhibit various phases. What do you notice about its phases? Is the surface featureless or can you see shades of light and dark? Try to reproduce the appearance of the surface as accurately as you can in the drawings. Note the position of the Moon. If your schedule permits, try to make a couple of observations at the same time at the same spot on successive days or evenings. Try also to observe the Moon a couple of times on the same evening or day a few hours apart. Note down in the *Observing Journal* what you notice about the Moon's motion. If you observe the Moon during the day and compare it with its appearance at night, do you notice any differences?

Given the vagaries of the weather, it does not pay to wait until the last week or two before the due date to start your observations.

**Begin making your observations early!**