The Night Sky: What's Up There, and How We Know

Quest University, Fall 2007

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Class hours: Typically, two hours per day *in class*. We will hold observing sessions mostly at night, and occasionally during daylight hours.

Office hours: Whenever I'm free

COURSE SITE: To be determined.

TEXTS:

- H. A. Rey, The Stars: A New Way to See Them, enlarged world-wide edition, Houghton Mifflin, 1997.
- Michael Seeds and Dana E. Backman, Perspectives on Astronomy, Brooks-Cole, 2008.

There will be several books available to you on reserve in the library, including:

- James Evans, The History and Practice of Ancient Astronomy, New York: Oxford University Press, 1998.
- Timothy Ferris, Coming of Age in the Milky Way, William Morrow and Company, 1988.
- Galileo Galilei/Albert van Helden, Siderius Nunicus, or The Sidereal Messenger, University of Chicago Press, 1989.
- Dennis Danielson, ed. The Book of the Cosmos: Imagining the Universe from Heraclitus to Hawking, Perseus, 2000.

SOFTWARE:

- *Stellarium*, available free at www.stellarium.org for Windows, Mac, and Linux. The commercial program *Starry Night* is a good alternative, but you have to pay for it, and you're on your own for technical problems. We might occasionally use the free *Celestia*, which allows you to tour the universe without having to view it from the Earth.

- *Virtual Astronomy Laboratories*, by Brooks Cole. An access code is provided with your Seeds/Backman textbook.

Course description: We all know some basic facts about the heavens: the Sun, Moon, and planets; stars and galaxies; some of us, even black holes, the Big Bang, and cosmic background radiation. But what do we *really* know, apart from what we've been told? This hands-on course involves active observing, both daytime and night-time; and will take advantage of the mathematical tools developed to explore the heavens over the millennia — with the goal of grasping not just what we know, but *how* we know. We begin by learning what we can about our cosmos simply by looking up, building an understanding similar to that of the ancient astronomers. We then turn to the telescope, exploring how Galileo's stunning new tool changes

what we see. We conclude by looking at modern tools, and experience how they once again transform dramatically the universe in which we live.

Course evaluation:

- ✏ Three short assignments 15%
- ✏ Observational programme 10%
- ✏ Your projects / presentations 30%
- ✏ Three synthesis assignments 35%
- ✏ Other participation / initiative 10%

Class structure: Given the uncertainty of clear skies, the schedule will vary quite a bit from day to day. I expect that we will meet an *average* of two hours per day in class. Also expect an average of one hour per day observing/measuring outside, either during the day or around midnight.

On nights when we have a late observing session, there will not be a class the next morning. ☺

Class schedule

This schedule depends strongly on weather conditions. ***Do not rely on it!*** Please check the course web site every day for updates. If weather interferes too much, a number of the "observing components" may have to be simulated on the computer.

The Ancient Sky

Review of trigonometry

Does the Earth move? What is its shape?
Observing component: Al-Biruni, dimensions of the Earth

Stars, the constellations, and their history
Observing component: individual presentations

The celestial sphere (equator, north pole, our latitude, seasons)
Observing component: the armillary sphere and astrolabe

Behavior of the stars; heliacal risings and settings

The Sun (how to observe; the ecliptic/zodiac; precession; solar model)
Observing component: the gnomon/lengths of seasons, Eratosthenes, the sun in the church/sundials; constellations of the zodiac

The Moon (monthly motion, parallax/distance calculation; tides; eclipses)
Observing component: phases, Ramadan

The planets (retrograde motions, variations in their motion; epicycles and the equant point)
Observing component: minor; will need to be in conjunction with software

The Enlightenment Sky

Shaky beginnings: Copernicus's heliocentric theory
- Evidence? Stellar parallax, Foucault's pendulum

How does a telescope work? What kinds are there?
Observing component: Using our telescopes

Galileo's telescope; The Starry Messenger
Observing component: Jupiter's moons, the Moon

Brahe, Kepler, and the Three Laws of planetary motion

Newton's mechanical universe; the inverse square law
- The cosmological shift (Galileo vs the church?)

Revisiting the Sun: an explanation for precession, sunspots
Observing component: sunspots

Revisiting the Moon: a new geological focus, craters
- Tides; the Moon's face lock

Observing component: observe mountains on Moon's edge…?

Revisiting the planets (eventual discovery of Uranus, Neptune)

Observing component: reproduce the discovery of Neptune

The Modern Sky

Modern observational tools
- The nature of light; spectrum/red shift
- Radioastronomy: radiation and radiotelescopes
- The Hubble space telescope

Revisiting the stars
- Stellar development/evolution (H-R diagram)
- Stellar structures; black holes (evidence for one at the center of our galaxy)

Observational component: nebulae?

Revisiting the planets
- A brief look at the switch from astronomy to geology; the Mars expeditions
- Extrasolar planets: how do we know?

Observational component: features of Mars

Revisiting the Milky way
- Galaxies, clusters (formation)

Observational component: observe different types, once they've been classified

Revisiting cosmology
- The Big Bang, cosmic background radiation, the expanding universe
- Relativity (gravitational lensing)
- Dark matter/dark energy

Topics left out (projects?): aurora borealis, sundials, binary stars, quasars, string theory, worm holes, the Flat Earth Society, the asteroids, comets, meteors, rings around planets, extinction of the dinosaurs, SETI/the Drake equation, other historical instruments (equatorial, quadrants), Pluto, the Earth's core, Jupiter's Great Red Spot, evidences for and against extraterrestrial life (Drake's equation)