Inventing Reality: The Human Search for Truth
Spring 2001, Hampshire College

Lecture Time: M 1:30 - 2:20; W,F 1:00 - 2:20
Stargazing and Extended Discussion: M 8:00 - 9:30 PM
Place: Room 333, Cole Science Center
Instructor: Douglas Leonard
Office: Room 212, Cole Science Center
Email: dleonard@hampshire.edu
Course Website: http://helios.hampshire.edu/~dclNS/inventingreality/
Telephone and Office Hours: TBA!

Course Description

Creating order out of our universe has been a perennial human pastime. Accepted truths have had a history of transience, with the models of each age yielding to the paradigm shifts of the next. Here we examine this continuing human dialogue, tracing a crooked line from ancient Babylonia to the present, accompanied along the way by such powerful thinkers as Aristotle, Aquinas, Newton, and Einstein. We will explore the physical world on all scales, from the fundamental constituents of matter to the origin, evolution, and fate of the universe. Though the focus will be on astronomy, related topics in classical physics, quantum mechanics, religion, music, art, and philosophy will not be avoided.

No prior background in astronomy or physics is assumed, and math will be limited to high school algebra and geometry. Students will directly confront the original writings of the philosophers, scientists, and theologians studied, and there will be frequent short writing assignments in addition to one longer paper. Class will meet three times a week for one hour and 20 minutes, with one session held in the evening to allow astronomical observations.

References

Required Text:

Wolf, F. 1989, *Taking the Quantum Leap: The New Physics for Non-Scientists* (Harper & Row: New York).

The story of how we struggled, resisted, and ultimately accepted the modern view of physical reality is beautifully told in this readable account of 20th century physics. We'll use this book primarily in the last third of the course, though the first two chapters will be covered earlier.

Other *recommended* texts are given in the Reader.

Syllabus

Week 1 (Jan. 31 - Feb. 2): *Observing Nature*

Topics covered: Introduction/overview; fundamental reality and the role of a Diety.
Readings and activities: Lucretius and Plato handout.

Week 2 (Feb. 5-9): *Inventing Nature's Language*

Topics covered: Prehistoric attitudes towards nature; beginnings of science in Egypt and Mesopotamia; Ancient Greece -- the world of Homer, Hesiod, and the rise of philosophy; the Ionian School and the question of ultimate reality; unity behind diversity -- numbers (Pythagoras) or atoms (Democritus); love, strife, and the problem of change (Zeno's paradoxes); Brief introduction to Epicurean philosophy; notion of free-will vs. determinism; the validity of the senses.
Readings and activities: Reader: Hesiod, Lucretius, Heraclitus, Empedocles; Wolf: p. 9-20. Nighttime stargazing, understanding the basic astronomical observations that any theory must explain.

Week 3 (Feb. 12-16): *A Theory of Everything*

Topics covered: Plato's forms and Eudoxus' spheres; Aristotle's philosophy of nature: cosmology, change, motion and fundamental causes, role of the senses, nature of the soul; the problem of the planets.
Readings and activities: Reader: Plato, Aristotle; Wolf: p. 20-23.

Week 4 (Feb. 19-23): *The Power of Prediction*

Topics covered: Euclid's deductive reasoning; the Euclidean proofs of Aristarchus and Archimedes; heliocentric considerations; Ptolemy's epicyclic Universe.
Readings and activities: Reader: Euclid, Aristarchus, Archimedes, Ptolemy.

Week 5 (Feb. 26 - March 2 (no class Wednesday)): *Setting the Stage*

Topics covered: Astrology in the Middle Ages; encyclopedists of the Middle Ages -- Pliny the Elder, Martianus Capella; the rise of Christianity; brief introduction to Islamic science; recovery of Greek science; rise of radical Aristotelianism; the Copernican thoughts of Nicole Oresme.
Readings and activities: Reader: Ptolemy, Pliny, Capella, St. Augustine, St. Thomas Aquinas, Boethius of Dacia, Nicole Oresme.

Week 6 (March 5-9): *Revolution*

Topics covered: Copernicus -- the timid Canon, heliocentric hypothesis, the last Aristotelian; Tycho's schemes and observations; Kepler smashes the circle -- the ellipse, and the Harmony of the Worlds.
Readings and activities: Reader: Copernicus, Kepler; Wolf, p. 25-29.

Week 7 (March 12-16): *Newton's Giants*

Topics covered: Kepler's Laws; Bruno and the church; Descartes' quest for certainty; Galileo's world-view -- falling bodies, vacuums, telescopes, and the nature of science.
Readings and activities: Reader: Kepler, Bruno, Galileo; Wolf: p. 29-37.
→First paper (book review) due Wed., March 14.

Week 8 (March 19-23): *Spring Break*

Topics covered: Matter at rest.

Week 9 (March 26-30): *Newton's New Language – The End of Explanation*

Topics covered: The world of genius -- introduction to Isaac Newton; Newton's laws, the *Principia*, the secret life of an alchemist, the search for truth and his fundamental reality, theory of light, the immutable nature of time, theology and spiritualism.
Readings and activities: Reader: Galileo, Newton; Telescopic viewing of sunspots; Wolf: p. 37-46.

Week 10 (April 2-6): *Beyond the Planets*

Topics covered: Newton's legacy -- Laplace's ''nightmare of determinism''; Speculations on the nature of the nebulae: Kant, Herschel, Messier; the science of spectroscopy -- Kirchoff's Laws and the fingerprints of the elements; the Doppler effect; time's mushy arrow; Foucault's pendulum and proof of Earth's motion.
Readings and activities: Reader: Laplace, Abell.

Week 11 (April 9-13): *Smashing Certainty*

Topics covered: The controversy rages -- the Shapley-Curtis debates and the size of our Universe; return to the fundamental nature of light -- Young's experiment, Maxwell's equations, the search for the ether; Planck's reluctant explanation; Einstein draws a picture, the photon is born.
Readings and activities: Selected Abell readings. Wolf: p. 46-71.

Week 12 (April 16-20): *Inventing a New Language*

Topics covered: Bohr takes a quantum leap; a Prince imagines a wave; the end of pictures -- Schroedinger's unimaginable world; God's dice and uncertainty; a new look at spectroscopy.
Readings and activities: Selected Abell readings. Wolf: p. 72-124.

Week 13 (April 23-27): *Finding Our Place in the Universe*

Topics covered: The debate ends -- Hubble discovers a law, the expanding universe; looking back to the Big Bang, shadows of creation; the unity of physics and cosmology. The nature of observation; Einstein's hidden orders.
Readings and activities: Selected Abell readings. Wolf: p. 124-151.

Week 14 (April 30 - May 4): *The End*

Topics covered: Supernovae and dark energy; Sisyphean nightmares and happiness.
Readings and activities: Reader: Albert Camus.
→Final paper due by Wed., May 2.