

## **Year I: Location: St. Johns College**

### **Motion and Natural Law in a Philosophical and Political World**

**Day 1:** “Science, Wholeness, and Beauty: the Classical Mathematical Cosmos.”

This session will introduce participants to the idea of the liberal arts, the ordering of knowledge, and the tensions between a purely rational analysis of the cosmos and the demands of observation. This section also brings to the fore the importance of aesthetic criteria in scientific understanding.

**Morning:** Platonic Cosmology: Selection from **Plato**, *Republic*, Books VII 524a to 530 e. (Any edition is fine, Bloom’s preferable; Plato on the ordering of the Liberal Arts); Plato, *Timaeus*, Kalkavage translation 27a-47e2; 53c-56e; 86b1-92c9.

**Afternoon:** Mathematics as a Way to Truth: **Euclid**, *Elements*, Greenlion edition: Book I, Definitions, Common Notions, Propositions 1,4,5. Book V, Definitions 1-13; enunciations of Props. 1-2; Book VI, Definitions, Prop. 1, 2, Book VII, Defs 1-5, 20 only

**Laboratory, 7:30 PM:** A laboratory visit to a planetarium at St. John’s will demonstrate the observed motions of the planets and the heavens.

**Day 2:** “Saving the Phenomena”: Making Rational Explanation Account for Appearances

This section brings to the fore the problem of experience and its analysis. We open with Aristotle’s opposition to the Platonic mode of treating experience in order to illustrate the way in which nature can also be approached through a qualitative “physical” analysis of nature that gives primacy to sensory experience. The second session then illustrates the way Ptolemy’s Hellenistic astronomical treatise represents a synthesis of the approaches of Plato, Euclid, and Aristotle to create an exact predictive mathematical model of the heavens. We see Ptolemy’s attempt to take into account the claims of experience, Aristotle’s physical assumptions about motion and rest, and the idealizing mathematical treatment of phenomena of Plato and Euclid.

**Morning:** The Aristotelian approach to nature: Readings, all in McKeon edition: **Aristotle**, *Physics*, Book II. chps. 3-4 (194b16-196b 10); chp. 7, 8 (198a12-199b33); *De Caelo*, Book I, chps. 1-2 (268a 1-269b.18); Book II, chps. 13-14 (293a15-298a20); Book III chp. 2; (300a 20-301b35); Book IV, chp. 1 (307b 30-310a 15); *Metaphysics*, Book 12, chps. 7-9, (1072a20-1075a5).

**Afternoon:** Integration: Ptolemy’s system of the World: Readings, **Ptolemy** *Almagest*, opening discourse and Book I (as found in Crowe, 42-65); Selections from Book III, iii. We will work through the geometrical demonstration of the equivalence of the eccentric and epicycle-deferent systems to allow participants to see exactly how Ptolemy is using Euclid to generate a system in which the exact observational “phenomena” can be saved.

**Laboratory 8:30:** Leave St. John’s for laboratory on naked eye astronomy in the evening. Back by 10:00. The crescent moon; Jupiter, the zodiac.

Utterly optional laboratory at 4:30 AM. This naked-eye observation may allow us to see Mercury precede Venus into the morning sky before sunrise. Mars also will be visible.

**Day 3:** “Cosmology, Theology and Poetry: Dante’s Cosmos”

This day will be entirely devoted to **Dante**’s *Divine Comedy* as a work of literature, theology, and scientific cosmology displaying the integration of these elements in the great epic of the high middle ages, illustrating how the cosmology of Aristotle, with some aspects of Ptolemaic astronomy, are used as a framework for developing this great medieval epic.

**Morning:** *Inferno* Cantos 1-2, 34; *Purgatorio* Canto 1; *Paradiso* Cantos 1-6 (Allen Mandelbaum trans.)

**Afternoon:** *Paradiso* Cantos 10,13, 18-20, 21, 27, 30-33.

**Day 4:** “Transforming Natural Philosophy I: Reordering the Heavens”

This section focuses on the conceptual restructuring of the heavens by Copernicanism and the wider implications of these changes for literary thought and theology.

**Morning:** readings in **Copernicus**, *On the Revolutions of the Heavenly Spheres*; read all as found in Crowe anthology: 100-133. Possible supplementary reading: Book III, Chapter 15: Copernicus’ equivalency proofs.

**Afternoon:** Readings of selections from **Galileo**, *Starry Messenger* (as found in Crowe anthology) and *Dialogues on the Two Chief World Systems* (Short handout to be distributed at seminar); Galileo “Letter to Castelli” (a short version of Letter to the Grand Duchess on science and theology, to be handed out at the seminar).

**Day 5:** “Transforming Natural Philosophy II: Ratio and the New Science of Motion.”

This unit will analyze Galileo’s novel ways of relating demonstrative mathematics and natural phenomena in his final work. It will also be intended to show the complexity of his new “experimental” discourse. At issue will be the following questions: “What does it mean for nature to be lawful?” “What does it mean for experiment to be necessarily approximate but nevertheless to “prove” a law of nature?” “What is the exact relationship between rational construct and natural phenomena?”

**Morning:** Galileo, *Two New Sciences*: from the introduction, pp. xvii-xxi; pp. 5-8, “Letter to the Reader” and “Letter of the Publisher,” First Day, pp. 61-69; 79-88; Opening discussion from “Third Day.”

**Afternoon:** Galileo, *Two New Sciences*; Third Day, “On Local Motion”; “Opening Discussion” and Definitions and Axioms. Read just enunciation of Propositions 1-6 on “Uniform Motion” and the section on “On Naturally Accelerated Motion,” through Proposition II, Theorem II (pp. 153-67); Fourth Day, just pp. 232-34.

**Laboratory 4:00 PM:** A laboratory on the Inclined Plane and Pendulum will be used to illustrate the complex ways in which rational construct and experience interact in this simple experiment from physics. (This accompanies the reading of Galileo).

**Day 6:** “Transforming Natural Philosophy III: The World as a Rationally Mastered Machine”

This Session is devoted to the larger conceptual revisions of natural philosophy taking place in the early modern period that attempt to synthesize the piecemeal transformations in cosmology, mechanics, and philosophy. In this we will see the explicit development of modern notions of “laws of nature” as distinguished from the Stoic-Medieval conception of “natural law.” The session will also explore the new ways of conceiving the relation of the world to divine action. This session will again raise in a new way the complex interaction of rational constructs and empirical experience.

**Morning:** read **Descartes**, *Discourse on Method* (Cottingham edition) (pp. 109-151); selections from *The World (Le Monde)* (pp. 81-98)

**Afternoon:** Descartes, “Author’s Letter” to the *Principles of Philosophy* and selections from Part II (pp. 223-247), IV (pp. 267-292) of the *Principles*; Selection from *Treatise on Man* (pp.99-108).

**Day 7:** Mastering the Political World: This session explores the ways the new science of Galileo and Descartes provides a framework for a reconceptualization of a new “science of politics” in the work of Thomas Hobbes.

**Morning:** read **Hobbes**, selections from *Man and Citizen* (Hackett Publishing), “Author’s Preface,”; “Liberty” chps. 1-3; “Dominion” chp. 7, 12; “Religion” chp. 15 (illustrating connection of the natural philosophy and political theory).

**Afternoon:** Reading: “Newton’s Philosophy of Nature”:

This session introduces, selectively, the powerful synthesis by Isaac **Newton** of the various strands of natural philosophy previously encountered in readings from Copernicus, Galileo, and Descartes into a comprehensive solution to the issues of celestial mechanics. With this, we will have reached the culmination of the first great break in scientific thought away from classical scientific reasoning. This session will also be concerned to illustrate the ways in which this Newtonian synthesis can be developed in practical ways into current or to-be-developed curricula of our participating institutions.

Readings: Newton, (In Cohen and Westfall, Norton Anthology) excerpts from *Principia* pp. 221-238 (preface, definitions, laws of motion)

**Laboratory 9:00 PM:** Telescopic Observations: St. John’s observatory and additional provided telescopes.

**Day 8:**

**Morning:** Readings: Newton, excerpts from *Principia* Book I, Book III (Rules, Phaenomena, Moon proof. Law of Universal Gravitation. (in Cohen and Westfall, pp. 238-246; 257-273). We might use Sloan’s commentary (emailed) on this material along with this.

**Afternoon:** Newton, General Scholium. (pp. 339-341) Queries to the *Opticks* (pp. 184-190). Literary reactions to the Scientific Revolution: **Donne**, “Anatomic of the World,” in First Anniversary, (website printout); Selections from Crowe Anthology: **Pascal**, *Pensees*; **Milton**, *Paradize Lost*; **Addison**, “Ode,” and **Young**, “Night Thoughts.”

**Days 9-10** Review of curricula of schools in light of curriculum discussed, here. Discussions and suggestions by all participants will focus on two issues: (1) means of integrating the texts discussed into current courses, (2) suggestions from participating institutions for developing new humanistic curricula that utilize the insights gained from the experience with these primary texts.

## **NEH “Bridging the Gap Between the Sciences and the Humanities”: A Post-Seminar Supplemental Reading List**

Colleagues:

This reading list is for this year, 2003, but it has ties other years, too. In each reading’s own way, these may provide help to you on developing your courses, pedagogies, or further

intellectual interests, including a continuation of this year's theme. The readings trace a loose historical order, with the more technical usually, but not always, preceding the more general or wide ranging. Of course, almost all of the relations expressed by the works below will be developed further in 2004 and 2005 of this project, particularly in biology, the arts, technology, and political and economic works.

The list is divided into three parts:

Primary Works that we could have attended to but didn't within the framework and topic of "Motion and Law in a Philosophical World"; there are others, as well.

Pedagogical works that elucidate the topics discussed;

Works that provide background or extend the topics discussed either more toward the present or more into other fields.

*We want the participants of these seminars to add to this list, so we will be glad to take your additions at any time. Please submit such to [jscottlee@prodigy.net](mailto:jscottlee@prodigy.net) under subject heading: NEH Supplemental Reading List.*

Primary Works that we could have attended to but didn't within the framework and topic of "Motion and Law in a Philosophical World"

Aristotle, *Physics*, Bk II, i, ii, viii, and *Metaphysics* VII, vii-ix, in conjunction with the seminar readings provides deep insight, and paths for thought, into the complex differences and similarities between nature (an internal principle of motion) and art (an external principle of motion).

Archimedes. *The Works of Archimedes* (Dover), ed. Sit Thomas Heath. A collection of Archimedes' works, including the treatises on the measurement of the circle, the equilibrium of planes, and floating bodies. These latter two topics raise interesting questions about the connection between mathematics and sensible nature.

Descartes, *Principles of Philosophy*. This has finally been translated into English in entirety (the first time in its history) The edition by Valentine and Reese Miller (Dordrecht, 1984) (9027717540) is out of print. There is also another edition listed as translated by Blair Miller that I have not seen( Lewiston: Mellen, 1988) (ISBN 0889463085) that may be in print. This Descartes considered to be his "great work" and it is the best way of seeing the connections between Cartesian and Newtonian physics.

Descartes, Rene. *Rules for the Direction of the Mind*. An unpublished (and unfinished) work, in which Descartes lays the foundations for a *mathesis universalis* and symbolic representation.

Descartes, Rene. *The Passions of the Soul*. A late work, in which Descartes seeks to account for man as a composite of mind and body. The work shows how a modern notion of body (Descartes' neurophysiology) suggests a new, scientific account of the human passions.

Galileo. *Discoveries and Opinions of Galileo*, translated by Stillman Drake, Doubleday-Anchor. Contains *The Starry Messenger*, the essay on sun spots, important letters, and *The Assayer*, which contains the famous assertion that nature is a book written in a mathematical language.

Galileo. *Dialogue Concerning the Two Chief World Systems*, translated by Stillman Drake (University of California Press). A major work, in which Galileo mounts physical arguments for the Copernican hypothesis.

Finocchiaro, Maurice *The Galileo Affair: A Documentary History* (Berkeley: U Calif Press, 1989) ISBN 0520066626 (PB). A great collection of all the relevant primary documents on the trial and controversy over Galileo. Includes the "Letter to the Grand Duchess" and the shorter "Letter to Castelli"

Hobbes, Thomas. *On Body (De Corpore)*. Fills out Hobbes' connection, drawn in this seminar, between natural law and political theory.

*The Leibniz Clark Correspondence* This contains the classic encounter between Leibniz and Newton, first published in 1717 that explores the foundations of Newtonianism.

### **Pedagogical works that elucidate the topics discussed;**

1. G. Holton and Duane Roller, *Foundations of Modern Physical Science* (Reading: Addison Wesley, 1958). A classic text written by physicist and historian of science that was used for years at Harvard for teaching physics to non-science majors. Now out of print.

2. Alex Hahn, *Calculus From Archimedes to Newton: Its Role in Science* (New York: Springer, 1998) (ISBN 038794606-3). A new mathematics textbook, developed for the Arts and Letters-Science College Honors Program at Notre Dame. This uses a historical approach with discussions of Euclid, Galileo, Newton, and other major figures. It could be used effectively along with primary source readings.

Sam Lilley. *Discovering Relativity for Yourself*. Oxford UP, 1980. What happens to our concepts of space, time, mass, and motion when we discover that the velocity of light does not change with respect to the motion of its source. Actually teaches the mathematics of relativity, special and general, to adult continuing education students; it really works and anybody can use it. Some terrific pedagogical devices.

Works that provide background or extend the topics discussed either more toward the present or more into other fields.

Heath, Sir Thomas. *Greek Mathematics* (Dover). A good summary of Greek mathematical thought from the Pythagoreans to Theon and Diophantus.

Klein, Jacob. *Greek Mathematical Thought and the Origin of Algebra* (Dover). This text is essential to an understanding of the profound differences that underlie ancient and modern mathematical thought. Klein discusses the importance of number in Pythagorean thought, Plato, Aristotle, Diophantus, Viete, and Descartes.

E. McMullin (ed.) *Galileo: Man of Science* (New York: Basic Books, 1967). This is the papers from a conference held at Notre Dame with many fundamental articles. The hardback (but not the paperback) has a magnificent bibliography.

Fantoli, Annabale *Galileo: For Copernicanism and for the Church* (Notre Dame: UND Press, 1994) ISBN 0268010293

Richard Westfall, *Force in Newton's Physics: The Science of Dynamics in the Seventeenth Century* (New York: Elsevier, 1971). A classic study on mechanics between Descartes and Newton.

Koyre, Alexandre *From the Closed World to the Infinite Universe* (New York: Harper, 1957). Popular lectures on the Copernican and Newtonian revolution.

Nicholson, Marjorie Hope. *Newton Demands the Muse: Newton's Opticks and the Eighteenth Century Poets* (Westport, 1979) ISBN 0313210446. A classic study, published first in 1946, that traces the impact of the *Opticks* on literature.

Dijksterhuis, E. J. *The Mechanization of the World Picture* (Oxford: Clarendon, 1961) now reprinted by Princeton University Press. A classic study that is still valuable. A good level of detail that keeps the main issues in view.

Feynmann, Richard. *QED*. A set of four lectures specifically written for humanists about quantum electro-dynamics, from one of the foremost physicists of the 20<sup>th</sup> Century. This is understandable, interesting, and intelligible fourth-year undergraduate, first-year graduate physics, without the math.

Kuhn, Thomas S. *The Copernican Revolution* (Harvard). A clear, useful historical account of astronomy from the early Greeks to Copernicus.

Thomas Kuhn, *The Structures of Scientific Revolutions*, 3rd ed. (Chicago: U Chicago Press). Kuhn's classic work that essentially grew out of his *Copernican Revolution* study of 1957 that applied the conclusions of the latter to a general picture of the development of the history of science.

Cohen, H. Floris. *The Scientific Revolution: a Historiographical Inquiry* (Chicago: UC Press) ISBN 0226112802 (PB). A major survey of all the main positions on the causes and interpretation of the scientific revolution.

Heidegger, Martin. *The Question Concerning Technology*. Contains a deeply interesting discussion of the difference between ancient and modern ideas of causality.

Husserl, Edmund. *The Crisis of European Sciences*. A deep inquiry into the failure of modern science to understand its own foundations, and an attempt to provide a genuinely philosophic grounding of the sciences.

Buchanan, Scott. *Poetry and Mathematics*. A spirited, wide ranging essay on analogies between poetry on the one hand and number and figure on the other.

Isacoff, Stuart. *Temperament* (2001). This recent popular work is an entertaining introduction to the history of tuning from the ancient Greeks to the present. It shows very clearly how mathematical problem solving and the physics of vibration are deeply connected with ideas of beauty and the cosmic order.

Jonas, Hans. *The Phenomenon of Life: Toward a Philosophic Biology*. A wealth of fascinating essays, including "Is God a Mathematician?", in which Jonas explores the tension between a mathematical conception of nature and the phenomenon of the living organism.