

IS 212. Early Modern Science Spring 2020

Instructors: Ewa Atanassow; Katalin Makkai; Ross Shields; Aaron Tugendhaft; Michael Weinman

Guest Lecturers: Faysal Bibi; Noa Levin; Gabe Pihás

Course Times: Tuesdays and Thursdays, 10:45–12:15

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Office Hours: Set by individual instructors

Description

What is science? When and how did it come to be considered the royal road to truth? This course examines the meaning and history of modern science by looking closely at its beginnings and evolution in the early modern period. Retracing the developments that defined the principles, methods and frameworks of natural science as it exists today, we shall explore its philosophical foundations, practical procedures and their political and cultural ramifications.

Our efforts will be divided into four units, organized in two pairs. The first pair examines the emergence of the so-called scientific method. Here, we have two foci: first, we contextualize this debate within the longer intellectual horizon from which it arose, through a discussion of the reception of classical, especially Aristotelian natural philosophy in medieval Arabic thought. Next, through Bacon and Descartes, we discuss the intellectual debate between the positions that solidified as “rationalism” and “empiricism,” examining the material culture of the emergent scientific method and focusing on scientific instruments and the experimental method. In the second pair of units, we examine the emergence of modern disciplinary scientific knowledge: first, focusing on Galileo, we concentrate on the new understanding of space, matter, and motion, which derive from the cosmologies and mechanical theories of this era and form the basis of modern physics. Finally, in the closing unit, we consider how the phenomenon of life presents a challenge to Galilean-Newtonian mechanical natural philosophy provided, focusing on Goethe’s work in botany.

Throughout the course, we will also attend to theoretical debates regarding the relationship between philosophy, science, and their histories: the connection between experience, experiment, and knowledge; the unity or plurality of the sciences themselves; and the historical development of such seemingly straightforward terms and practices as ‘observation’, ‘description’, and ‘fact.’ Included in the course are special sessions and visits to exhibitions and collections in Berlin, which will help us ponder the preconditions of scientific inquiry, and the extent to which scientific practices are necessarily embedded in a particular political and cultural horizon and/or physical reality.

Readings

Bacon. 2000. *The New Organon*. Cambridge University Press. (ISBN: 9780521564830)

Descartes, R. 1999. *Discourse on the Method*. Hackett Publishing. (ISBN: 9780872204225)

Galileo. 2001. *Dialogue Concerning Two Chief World Systems*. Modern Library. (9780375757662)

Goethe. 2009. *The Metamorphosis of Plants*. MIT Press. (ISBN: 9780262013093)

Wollstonecraft Shelley. 2012. *Frankenstein: Or the Modern Prometheus*. (ISBN: 9780393927931)

Course Reader (printed edition)

Library and Book Purchase Policies

Students must have a hard copy of all required texts. A limited number of the required books are available from the library; students on financial aid have priority. Other readings will be in the reader.

Requirements

Seminar Attendance and Preparation

Regular attendance and class preparation are essential to the success of this course. Preparing for class means reading thoughtfully and engaging with the course materials, for instance, by taking notes while reading and thinking through the argument in a particular reading assignment, or by looking over in advance the description of an exhibition we will visit. To aid your preparatory effort, this syllabus includes short blurbs and study questions for the course readings. Do read and use them! **Please note: coming late or leaving in the middle of the sessions will count as absence. Absences beyond two will reduce your seminar grade for the second rotation by a letter grade (e.g., from B+ to B).**

Writing Assignments (see also “Essay Deadlines” and “Grade Breakdown”)

You will write one substantial final essay (ca. 2500 words in length) at the end of semester. In order to help you “build up to” this substantial reflection on the course material, you will be required to keep a “learning journal” throughout the semester. This document will be your space to record your immediate reactions to the reading assignments and the seminar conversations. It should consist of 1-2 dated entries (up to 300 words) per week. Included within this journal will be a series of “field reports.” Each of these will call for giving an account of how you did something: for instance, how you came to understand an argument in a guest lecture; how you saw something in a practicum; what you observed in a practical session or exhibition visit. The journal will be collected four times throughout the semester. You will also be expected to meet with your seminar leader in Week 13 or 14 to discuss your final essay.

Academic Integrity

Bard College Berlin maintains the staunchest regard for academic integrity and expects good academic practice from students in their studies. As such, instances in which students fail to meet the expected standards of academic integrity will be dealt with under the Code of Student Conduct, Section 14.3 (Academic Misconduct) in the Student Handbook.

Policy on Late Submission of Papers

Please note the following policy from the Student Handbook on the submission of essays: essays that are up to 24 hours late will be downgraded one full grade (from B+ to C+, for example). Instructors are not obliged to accept essays that are more than 24 hours late. Where an instructor agrees to accept a late essay, it must be submitted within four weeks of the deadline and cannot receive a grade of higher than C. Thereafter, the student will receive a failing grade for the assignment.

Grade Breakdown

Learning journal (4 x 10%): 40%; Final essay (ca. 2500 words): 30%; Seminar grade: 30%.

Submission Deadlines, at a glance

Journal submission deadlines: 1) Friday, 14 February; 2) Friday, 13 March; 3) Friday, 3 April; 4) Friday, 1 May
Final Essay deadline: Thursday, 14 May

Course Overview, with study questions

1. Method in Aristotle and Abrahamic Aristotelianism

Our goal in this course is to try to tell ourselves a consistent story about what has been called “early modern science” or more provocatively and problematically “the scientific revolution.” In this first unit, we take our first steps toward this goal by exploring the sort of scientific knowledge that existed before the rise of early modern science and the epistemological and metaphysical commitments that came along with this old Aristotelian model, through a particular focus on the “Abrahamic Aristotelianism” of the medieval period, here represented primarily in the figures of Ibn Rushd (Averroes) and Moses Ben Maimon (Maimonides).

Study Questions:

- What was the essence of the old Aristotelian model of scientific knowledge? What counted as “scientific knowledge” according to this model and what were its limits?
- What, precisely, is at stake in the debate about the putative “incoherence” of natural philosophy between al-Ghazali and Ibn Rushd?
- What error or confusion does Maimonides see in the queries posed to him by the Rabbinate in Provence?
- What similarities or differences do we see in the sort of prudence operative in the way that Ibn Rushd and Maimonides speak to their respective audiences?

2. Modern “Scientific Method”: Empiricism and/or Rationalism

Following upon our engagement with the Aristotelianism that had become orthodox science in the late medieval period, we turn to examine the ways in which the concept of “science” changed with the rise of early modern thought and how thinkers such as Bacon and Descartes believed it was possible to arrive at “scientific facts” or truth. We will be especially interested in the epistemological and metaphysical commitments on which their approaches rested. We will study these questions by comparing and contrasting the old Aristotelian science, as it was received, preserved, and extended in the medieval period, with the two new scientific models as put forth by Bacon and Descartes.

Study Questions:

- What are the precise differences between this old scientific model compared to the new models found in Bacon and Descartes? What was it about these new ways of thinking that made the tremendous advances in scientific knowledge possible in the second half of the 16th and first half of the 17th century?
- How do Descartes and Bacon importantly agree? Where do they meaningfully differ?
- What relationship does Descartes posit between humans and nature in the *Discourse*? How does this relationship appear in his more “technical” discussion of how science ought to proceed?
- How do Descartes and Bacon align their observations with theoretical commitments?

3. Galileo: The “First Modern Scientist”?

The second unit begins with a discussion about the geocentric worldview and its usefulness independently from the astronomic developments. Our primary source is Galileo’s defense of heliocentrism and terrestrial motion in the cosmological *Dialogue Concerning the Two Chief World Systems* (1632). We will discuss his attitude towards the Ptolemaic-Aristotelian

worldview and assess three aspects of the Copernican debate: the mathematical, the physical (or natural philosophical) and the theological-scriptural. One meeting will be dedicated to Galileo's famous Inquisition trial and condemnation, in particular to the early-modern mechanisms of censure and control as well as to the early-modern conflict between religious orthodoxy and natural inquiry.

Study Questions:

- What is the historical context of Galileo's Inquisition trial and condemnation?
- How did cosmology and practical knowledge relate in the early modern period?
- What were the main challenges of the Copernican "revolution" in planetary theory? What was Galileo's attitude toward tradition and natural inquiry?
- What lessons does about individual and institutional supporters of scientific work can be gleaned from the letters written by and around Galileo? How or why does this matter?

4. Observing Living Things: The (In)Sufficiency of Efficient Causation

Finally, we turn to the phenomenon of life and the challenge it presents to the mathematical and mechanistic explanations that are often associated or even equated with science in the contemporary sense. We begin with Leibniz's influential attempt to resurrect a key feature of Aristotelian natural philosophy over against the dominant Cartesian natural philosophy of his day: the role of the final cause, independent from merely efficient causality. From there, we move on to a discussion of Goethe's work in botany, which was criticized by his contemporaries for likewise reintroducing final causes. Following Goethe's suggestion that nature should be observed under an open sky, and not reproduced in a laboratory, we will visit the Botanical Garden and Museum, where we will attempt to put his theory into practice. We conclude the unit with Wollstonecraft Shelley's *Frankenstein*, which raises fundamental questions about identity and diversity while highlighting the political consequences of the opinions proffered in natural philosophy—all in the context of exploration, colonization and imperial domination. This text provides an occasion to reflect on the course as a whole, prompting us to ask how it is possible to communicate scientific knowledge along with the material conditions—individual, and institutional, political and economic—that are necessary to support it.

Study Questions:

- What are Leibniz's motivations for reintroducing final causality? How, if at all, does he reconcile final and efficient causality?
- Does Leibniz's approach seem to add any actual knowledge about nature beyond what a mechanistic explanation can provide?
- How, if at all, does Goethe's poem contribute to his work in *Metamorphosis of Plants*?
- How does Goethe's explanation of organic form differ from Leibniz's? In what respect are they similar?
- Does the *Metamorphosis of Plants* follow the methodology proposed in "The Experiment as Mediator...?"
- What, if anything, does Frankenstein's university experience teach us about the limits of science and the questions that the phenomenon of life poses for mechanical explanation?

Course Schedule

Week o	Tuesday	Thursday
Unit 1. Method in Aristotle and Abrahamic Aristotelianism		
27 Jan	What is “modern” science? Why study its history? Arendt, “Conquest of Space and Stature of Man”	Opening Plenary Aristotle, <i>Post. An.</i> , I.2, 18, 31; II.5, 19
3 Feb	Natural philosophy and divine revelation Al-Ghazali, “Incoherence of the Philosophers”	AT Lecture: Natural philosophy/Divine revelation Rabbinate in Provence, “Queries on Astrology” Maimonides, “Letter on Astrology”
10 Feb	Emergent scientific method: Science and faith? Ibn Rushd, “Incoherence of the Incoherence”	Emergent scientific method: Science and faith? Ibn Rushd, <i>Decisive Treatise</i>
Unit 2. Modern “Scientific Method”: Empiricism and/or Rationalism		
17 Feb	Science as a Project of Reform Bacon, <i>New Atlantis</i>	Science as a Project of Reform Bacon, <i>New Organon</i> , Front matter (pp. 2-31)
24 Feb	Emergent scientific method: Empiricism? Bacon, <i>New Organon</i> , I.1-68 (pp. 33-56)	Emergent scientific method: Empiricism? Bacon, <i>New Organon</i> , I.69-end (pp. 56-101)
2 Mar	Emergent scientific method: Empiricism? Bacon, <i>New Organon</i> , II.1-21 (pp. 102-36)	Emergent scientific method: Rationalism? Descartes, <i>Discourse on Method</i> , Parts 1-2
Mar	Emergent scientific method: Rationalism? Descartes, <i>Discourse on Method</i> , Parts 3-4	Emergent scientific method: Rationalism? Descartes, <i>Discourse on Method</i> , Parts 5-6
Unit 3. Galileo: The “First Modern Scientist”?		
16 Mar	Galileo: Celestial and earthy mechanics Galileo, <i>Two World Systems</i> (pp. 3-8; 123-53)	GP Lecture: Galileo, Modernity, Math & Physics Galileo, <i>Two World Systems</i> (188-201)
23 Mar	Galileo: Celestial and earthy mechanics Galileo, <i>Two World Systems</i> (222-41)	Galilean mechanics: Pendulum experiment Galileo, Letter to del Monte Galileo, <i>Two World Systems</i> (263-8, 316-19)
30 Mar	Science and (or?) Religion: Galileo Letters: Bellarmine to Foscarini; Galileo to Castelli; Galileo to Christina	Brecht Life of Galileo Lecture Hall 7 PM Brecht, <i>Short Organum for the Theatre</i>
6 Apr	No Class; Spring Break	
Unit 4. Observing Living Things: The (In)Sufficiency of Efficient Causation		
13 Apr	NL Lecture on Vitalism and Idealism in Leibniz Leibniz, “Principles of Nature and Grace...”	Faysal Bibi Lecture on Paleontology Leibniz, <i>Protogea</i>
20 Apr	Goethe on Plants Goethe, <i>Metamorphosis of Plants</i> , (§§1-28)	Goethe on Plants Goethe, <i>Metamorphosis of Plants</i> , (§§29-83)
27 Apr	Observation Exercises in Botanical Garden Held on Saturday, 25 April Goethe, <i>Metamorphosis of Plants</i> (§§84-121)	Experiment and Knowledge of Self and World Goethe, “The Experiment as Mediator...”
4 May	The Limits of Science Wollstonecraft Shelley, <i>Frankenstein</i>	The Limits of Science Wollstonecraft Shelley, <i>Frankenstein</i>
11 May	Final Essay due Thursday 14 May	

Pink=Joint sessions; Green = Course text; Turquoise = Course Reader