

# Methods and Results of Ancient Astronomy

## SYLLABUS

Fall 2023, Deep Springs College, **Prof. Brian Hill**

## Overview

It is perhaps arbitrary where one might stop in the history of astronomy and astrophysics and deem whatever follows to be “modern.” For our purposes, “ancient” means anything and everything up to but not including or beyond Brahe, Kepler, and Galileo. The shift that occurred very roughly at 1600, although actually it was progressive, not sudden, was to a process of increasing exactitude that began with Brahe’s careful multi-decade observations at Uraniborg, Kepler’s painstaking analyses of these observations, and which then accelerated massively by the invention and use of the telescope.

I could not create a survey of pre-telescopic astronomy myself; my understanding of astronomy and physics starts with Kepler, Galileo, and Newton, and so I will be learning the history prior to this along with you. Our author and guide to ancient astronomy is James Evans. He is principally focused on the astronomy of the Greeks. His reasons are two-fold: (1) prior to the Greeks, astronomy was qualitative, and (2) for century after century following the Greeks, Ptolemy’s *Almagest* held sway, even as it was translated, commented on, and elaborated.

Even Copernicus in 1543, while disputing the Earth-centered universe in his *On the Revolutions of the Heavenly Spheres*, was tremendously influenced by Ptolemy. Only towards the end of our course will we get to Copernicus, and then finally leave the ancient Ptolemaic view behind with the observations and theories of Brahe and Kepler.

## Daily Schedules

Detailed daily schedules will be kept retrospectively:

- **Daily Schedule-Term 2**
- **Daily Schedule-Term 3**

## Unit Outline

### Term 2

Examine the table of contents of Evans' book that we will be using as our guide. The broad outline fits into our Term 2 as:

1. The Birth of Astronomy
2. The Celestial Sphere
3. Some Applications of Spherics (includes making Sundials!)
4. Calendars and Time Reckoning

### Term 3

And our Term 3 as:

1. Solar Theory
2. The Fixed Stars
3. Planetary Theory

Evans' **Full Table of Contents** provides further detail.

## Text

- *The History and Practice of Ancient Astronomy*, by James Evans

## Grading and Homework

- 40% submitted homework, including observational work
- 20% midterm (near the end of term 2)
- 20% final (near the end of term 3)
- 20% thorough preparation for class, leadership of class discussion, and maintenance of the course's pace and direction

The observational work will generally, but not always, be at night. Reports on apparatus and observations, just like lab reports in a regular laboratory class, will frequently be submitted or presented.

## Absences

The College's general policies on absences (and late work) are applicable. There was an email from Ryan on this September 8, 2022 in response to a flagging Spring 2022 semester. Since that email predates most of you, the essential absence / late policies are reproduced from that email here:

Whereas missed coursework affects both your classmates and professors by lowering the thinking and understanding you bring to a given class, and interrupts the course schedule that has been set up and is adjusted on an ongoing basis with substantial care. The same is true for absences — whereas a handful of absences might be “normal” at colleges with large lectures or less serious academics, at Deep Springs we expect students to miss *no classes* save for legitimate health issues or emergencies requiring also missing labor and governance obligations. For a student wishing to submit a course assignment past its required deadline, the student may request an extension on the assignment directly from the professor 48 hours in advance. Within 48 hours of the due date, the student must request an extension directly from the Dean. Exceptions will be granted by the Dean only if the student faces unforeseen and unforeseeable circumstances. A student who misses the deadline will be penalized an amount that is roughly equivalent to a letter grade for each day the assignment is late. Assignments cannot be turned in after solutions and graded assignments have been passed back, which generally happens one to two classes after they were turned in.



## ONE

### The Birth of Astronomy

- 1.1 Astronomy around 700 B.C.: Texts from Two Cultures 3
- 1.2 Outline of the Western Astronomical Tradition 11
- 1.3 Observation: The Use of the Gnomon 27
- 1.4 On the Daily Motion of the Sun 27
- 1.5 Exercise: Interpreting a Shadow Plot 31
- 1.6 The Diurnal Rotation 31
- 1.7 Observation: The Diurnal Motion of the Stars 39
- 1.8 Stars and Constellations 39
- 1.9 Earth, Sun, and Moon 44
- 1.10 The Annual Motion of the Sun 53
- 1.11 Observation: The Motion of the Moon 58
- 1.12 The Uses of Shadows 59
- 1.13 Exercise: Using Shadow Plots 63
- 1.14 The Size of the Earth 63
- 1.15 Exercise: The Size of the Earth 66
- 1.16 Observation: The Angular Size of the Moon 67
- 1.17 Aristarchus on the Sizes and Distances 67
- 1.18 Exercise: The Sizes and Distances of the Sun and Moon 73

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## TWO

### The Celestial Sphere

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- 2.4 Early Writers on the Sphere 87
- 2.5 Geminus: *Introduction to the Phenomena* 91
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- 2.7 Exercise: Telling Time at Night 99
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- 2.12 Exercise: Using the Table of Obliquity 109
- 2.13 The Risings of the Signs: A Table of Ascensions 109
- 2.14 Exercise: On Tables of Ascensions 120
- 2.15 Babylonian Arithmetical Methods in Greek Astronomy: Hypsicles on the Risings of the Signs 121
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## THREE

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