What is round and Runs in Circles?
(The Five Obstacles)

Why study Greek astronomy? What about the astronomy of other ancient cultures?

Things in the sky for a culture to explain:
- sky as a sphere
- rising/setting of stars, planets, sun, moon
- celestial pole
- annual motion of the sun
- retrograde motion of planets
- phases and motion of the moon
- eclipses
- meteors
- comets

The Details:
The planets were a special problem (5 bright stars that moved & varied in brightness).
Motions were west to east, but occasionally they moved east to west–very puzzling to the ancients.

A brief chronology of Greek thinkers from a western European perspective:
- Greek Science about 1,200-100 B.C
- Pythagoras-sixth century B. C.
- Philolaus-fifth century B. C
- Herakleides-fourth century B. C.
- Aristarchus-third century B. C.
- Plato about 428-347 B.C.
- Aristotle about 384-322 B.C
- Ptolemy second century A.D. (Alexandria not Greece)

The earliest Greek science:
Humans seek explanations for things we see.
In astronomy, this desire drives us to explain things in the sky and on the Earth.
A contribution of Greek civilization to this endeavor was the development of the scientific model.

The Ionians-up to about 500 B. C.  note: astronomical contributions in bold
- earliest Greek Science  infinite universe
- geometry  crystalline spheres

Pythagoras-sixth century B. C.
- Ionian who started the Brotherhood
- often considered the founder of science
- coined many words we know such as philosophy, figures,
- measurement important-pitch depended on length
- Earth was a sphere
- Sun, Moon, Planets move around earth on wheels
- motion causes music
- the Music of the Spheres
- only the master could hear the music

Philolaus-fifth century B. C.
- taught the earth moves in space around a central fire
- Copernicus originally gave credit to Philolaus when he wrote,
  "Philolaus believed in the mobility of the Earth . . . ."
Herakleides—fourth century B.C.

taught the earth rotates
planets orbit sun which orbits the earth

Aristarchus of Samos—third century B.C.

- taught a heliocentric Universe
- all planets, including the Earth, orbit the Sun
- measured the distance to the Sun and the sizes of the Earth, Moon and Sun
- treatise On the Sizes and Distances of the Sun and Moon was a breakthrough in finding distances in the universe
  his methods were used by Hipparchus and Ptolemy and later astronomers and mathematicians through the seventeenth century
  his mathematics was well regarded
  his cosmology not so highly regarded

Plato about 428-347 B.C.

- visible world is not real hence observation useless
- heaven are perfect
- heavenly shapes must be spheres
- heavenly motion-circular at uniform speed
- any change equals degeneration

Aristotle about 384-322 B.C.

- the earth could not move
- universe has two realms—heaven and earth
- different compositions, different laws
- physics of motion was different from what we understand today
- science needed no math

Ptolemy—middle of the second century A.D.

- Egyptian (not Greek) astronomer
- devised model of universe based on the ideas of Aristotle and Plato
- geocentric with epicycles
- remained in use until the 1500s

The Five Obstacles to progress on a rational cosmology in the year 200 A.D.

1. The split universe: Heavens and Earth
   - air, water, fire, earth, 5th essence (quintessence)
   - perfect spheres, uniform circular motion, no change
2. Geocentric dogma
   - religious, philosophic and physics (incorrect) arguments in support
3. Dogma of circular motion
   - required in the perfect heavens
4. Science without math & experimentation
   - thought experiments were sufficient to obtain knowledge
5. Complete misunderstanding of motion
   - Aristotle's physics was all wrong and falsifiable with simple experiments