Period of Knowledge

- Greek Theory, Roman Practice
- Law, Government and Roads
- Not much Science
- Restart of Greek’s habit of questioning
- Leading to Revolution/s
Revolution

Normally history tells us:

• Copernicus astronomy was a revolution
• Galileo’s theory was a revolution
• Newton’s Laws were revolutionary.
• Einstein’s Theory was a revolution

But Revolutions do not happen over night

There is always a period (often very long) of Thinking

Before, actual “revolution”, there is always “Conceptual Revolution”
Aristotelian Physics

• Since the time of Greek, especially Aristotle
  Natural Philosophy/Physics was subordinate of meta-Physics
  Aristotelian sciences were dependent on natural philosophy or
  Physics but Physics itself was under control of meta-Physics

• Copernicus, Galileo, Newton etc. are important
  milestones in the way of the bigger revolution/s
  The revolt against Aristotelian Science
  That took about 2000 years
It started with Ptolemy when he said:
  The observational tests are possible
  
  But Aristotelian philosophy was so deep rooted that in
  next 1000 years of Roman and early ~200 years of Arab
  civilizations No one dare to think against Aristotle
• Until 1050 AD, no one raised serious question to Aristotelian Physics
• Theology took over Science.
• The conceptual revolution started with criticism on Aristotelian Astronomy and then spread over other fields.

**Aristotelian view Point about Astronomy:**
• Stationary Earth  
• Earth being center of the Universe.

**Ptolemy’s Model:**
• Still geocentric
• However, earth was not stationary

It was still a good fit with Aristotelian natural philosophy

This was acceptable to Religious authorities, since they did not see direct contradiction with their beliefs.

Beyond this point was a life-threatening at that time
Arab Astronomer started questioning Ptolemy’s model but overall they kept the Ptolemy’s model with some modifications.

al-Tusi said: “There is no mathematical way to prove if earth is rotating or at rest”

That was real revolt against Aristotelian Physics.

Putting mathematics (logic) on top rather than meta-Physics

This discussion continued over almost 3 centuries

Many different Astronomy models were presented and improved/modified

Mainly: al-Tusi, al-Urdi, al-Shirazi, al-Shatir, al-Khafîr, al-Bitruji, and many others

Averro (al-Rushd) and Alhazen also played important roles.

Qushji took very different approach:

An astronomer should not need Aristotelian Physics and infect should establish his own physical principles independent of meta-Physics
Qushji’s approach, al-Tusi’s claim that “nothing false follows from the assumption of rotating earth” and other criticisms on Aristotelian Physics formed the basis of conceptual revolution that was followed by Copernicus.

**Copernicus** (1473 to 1543, Poland) At age of 27, he was master of Medicine, Law, Mathematics and Astronomy.

Challenged Aristotle’s theory of geocentric universe.

Astronomy theory at that time seemed unnecessarily complicated to him:

- If earth rotates – explains why fixed stars revolve around the earth.
- If earth revolves around the sun – will simplify the problem of explaining the orbital motion of planets.

Surprisingly, heliocentric system had been proposed by many people earlier, even by some Greeks, but no one could prove it. Probably due to lack of mathematics and geometry.
Copernicus could not “dare” to publish due to fear of politics at that time. He delayed and delayed, until his death bed. Copy of the book was brought to him on his death day.

He was afraid what orthodox Aristotelian would say about him.

Introduction of the book wrote “his theory is only a hypothesis”

Even, introduction did not say that earth revolves around the sun once a year.

Hence the book did not produce a big “chaos” in politics as Copernicus thought.
Two feature of Aristotelian System

Copernicus carefully retained two features of Aristotelian system

1. Uniform Circular Motion
2. Natural motion of heavenly bodies

Theologians, therefore, as well as some astronomers, could not believe that nothing really very important had changed

One milestone of Conceptual Revolution was achieved

Many people after Copernicus payed important role in it

Tycho Brahe (1546-1601)– Danish, Johannes Kepler (1571-1630)
Another revolt against Aristotle

• William Gilbert (1544-1603) an Englishman played crucial role in this revolt.

• He and William Harvey (1578-1675) rediscovered the way the heart works.

  Initial work was done by Avicenna (Abu-Sina)

Gilbert was trained Physician but he also studies magnetism

He discovered that the Earth is a magnet

Gilbert suspected that the gravity and earth magnet are connected someway – although never understood how?

Gilbert was protestant and hence was supported by protestant monarch – Queen Elizabeth-I

That helped him announce his “modern” discovery
Gilbert also forcefully supported “Copernicus model. His most provocative idea was

Planets must be held in their orbits by some kind of magnetism

Its importance was not realized at that time

But that caused another revolt against Aristotelian Physics
Averroes (Ibn-Rushd) –1126 – 1198, born in Morish, Spain proposed an early version of inertia

- New central to Newtonian Physics

He wrote three comments on Aristotelian Philosophy

- He defined force “something that change the motion of a body”
- He linked rate of change of motion with magnitude of force
- Crucial: Proposed that bodies have inherent resistance against the change of motion, different from air drag and gravity

He based his idea (wrongly though) on 5th element -- Ether

Aristotle idea was “Ether exists only beyond moon” So Averroes thought, only heavenly bodies have inertia, that is why they don’t move at infinite speed

That made foundation for Galileo and Newton to work on their great ideas, caused “Industrial Revolution”

Rene Descartes played very crucial role:
“Galileo-Cartesian Revolution”