Classical Astronomy

Classical astronomy followed principles established by Aristotle. Aristotle accepted the idea that there were four physical elements – earth, water, air, and fire. He put the earth in the center of the universe and contended that these elements were below the moon, which was the closest celestial body. There were seven planets, or wandering stars, because they had a course through the zodiac in addition to traveling around the earth: the moon, Mercury, Venus, the sun, Mars, Jupiter. Beyond that were the fixed stars. The physical elements, according to Aristotle moved vertically, depending on their 'heaviness' or 'gravity'; the celestial bodies were not physical but a 'fifth element' or 'quintessence' whose nature was to move in perfect circles around the earth, making a daily rotation. Aristotle envisioned the earth as the true center of all the circles or 'orbs' carrying the heavenly bodies around it and all motion as 'uniform,' that is, unchanging.

But observers realized that the heavenly bodies did not move as Aristotle postulated. The earth was not the true center of the orbits and the motion was not uniform. The most obvious problem was that the outer planets seemed to stop, move backwards in 'retrograde' motion for a while, and then continue forwards. By the second century, when Ptolemy compiled his Almagest (this common name of Ptolemy's Syntaxis was derived from its Arabic title), astronomers had developed the concept that the orbit moves in 'epicycles' around a 'deferrent,' that is, they move like a flat heliacal coil around a circle around the earth. The earth was also off-center, on an 'eccentric,' as the heavenly bodies moved around a central point. Ptolemy added a point on a straight line opposite the eccentric, which is called the 'equalizing point' or the 'equant,' and around this point the heavenly bodies moved uniformly. Moreover, unlike the Aristotelian model, Ptolemy's Almagest did not describe a unified universe. The ancient astronomers who followed Ptolemy, however, were not concerned if his system did not describe the 'true' motions of the heavenly bodies; their concern was to 'save the phenomena,' that is, give a close approximation of where the heavenly bodies would be at a given point in time. And in an age without professional astronomers, let alone the telescope, Ptolemy did a good job plotting the courses of the heavenly bodies.

Not all Greek astronomical ideas followed this geocentric system. Pythagoreans suggested that the earth moved around a central fire (not the sun). Archimedes wrote that Aristarchus of Samos actually proposed that the earth rotated daily and revolved around the sun.[3]

During the European Middle Ages, the Islamic world was the center of astronomical thought and activity. During the ninth century several aspects of Ptolemy's solar theory were

recalculated. Ibn al-Haytham in the tenth-eleventh century wrote a scathing critique of Ptolemy's work: "Ptolemy assumed an arrangement that cannot exist, and the fact that this arrangement produces in his imagination the motions that belong to the planets does not free him from the error he committed in his assumed arrangement, for the existing motions of the planets cannot be the result of an arrangement that is impossible to exist" (quoted in Rosen 1984, 174). Swerdlow and Neugebauer (46–48) stressed that the thirteenth-century Maragha school was also important in finding errors and correcting Ptolemy: "The method of the Maragha planetary models was to break up the equant motion in Ptolemy's models into two or more components of uniform circular motion, physically the uniform rotation of spheres, that together control the direction and distance of the center of the epicycle, so that it comes to lie in nearly the same position it would have in Ptolemy's model, and always moves uniformly with respect to the equant." They found that Copernicus used devices that had been developed by the Maragha astronomers Nasir al-Din Tusi (1201-1274), Muayyad al-Din al-Urdi (d. 1266), Qutb al-Din al-Shirazi (1236-1311), and Ibn al-Shatir (1304–1375). In addition, Ragep, 2005, has shown that a theory for the inner planets presented by Regiomontanus that enabled Copernicus to convert the planets to eccentric models had been developed by the fifteenth-century, Samarqand-trained astronomer ali Qushji (1403–1474).[4]

Renaissance humanism did not necessarily promote natural philosophy, but its emphasis on mastery of classical languages and texts had the side effect of promoting the sciences. Georg Peurbach (1423–1461) and (Johannes Müller) Regiomontanus (1436–1476) studied Greek for the purpose of producing an outline of Ptolemaic astronomy. By the time Regiomontanus finished the work in 1463, it was an important commentary on the Almagest as well, pointing out, for example, that Ptolemy's lunar theory did not accord with observations. He noted that Ptolemy showed the moon to be at various times twice as far from the earth as at other times, which should make the moon appear twice as big. At the time, moreover, there was active debate over Ptolemy's deviations from Aristotle's requirement of uniform circular motion

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