The Big Four of the New Astronomy

Nicolaus Copernicus

Nicolaus Copernicus was born in 1473 in Poland. He attended Krakow Academy and then travelled to Italy to study law at the University of Bologna. While he was there, he became interested in astronomy thanks to the mathematics professor, Domenico Maria Novara, with whom he was lodging. Copernicus went on to study at the Universities of Padua and Ferrara and then, in 1503, he returned to Poland. He worked as a private secretary and then took up a post as canon in Frauenburg, a position which gave him time to dedicate to his passion, astronomy. In 1514 Copernicus was called by the Catholic Church as an expert on celestial bodies and consulted on the calendar. Although Copernicus completed his work *De revolutionibus orbium caelestium* in around 1530, it was not published until the year 1543, shortly before Copernicus's death. In it, Copernicus put forward the theory that the Earth rotates on its axis and revolves around the Sun as did the other planets, refuting the long-held Ptolemaic system which placed the Earth at its centre.

Tycho Brahe

Tyge or Tycho Brahe was born in Scandinavia in 1546. He attended the universities of Copenhagen, Leipzig, Wittenberg, Rostock and Basel. He was fascinated both by alchemy and astronomy and invested in a set of astronomical instruments. In 1572 he observed a new star in Cassiopeia and published a paper about it (*De nova et nullius aevi memoria prius visa stella*) in 1573. Although Brahe did not embrace heliocentrism, this observation and that of a comet in 1577 were crucial in proving the heavens were not immutable as Aristotle had argued. He began to lecture in astronomy at the University of Copenhagen and soon received funding from King Frederick II to build an observatory on the island of Ven nearby. It was considered the finest observatory in Europe. Brahe invented new astronomical instruments and carried out observations, meticulously recording his findings. In 1597 he left Denmark and later became Imperial Mathematician at the court of Emperor Rudolph II in Prague. Here he hired the young Johannes Kepler as his assistant to calculate planetary orbits. Brahe died in Prague in 1601, leaving a wealth of data which would prove invaluable to Kepler's future work.

Galileo Galilei

Galileo Galilei was born in Italy in 1564. Abandoning his studies of medicine at the University of Pisa, he took up philosophy and mathematics and later became professor of mathematics. In 1592 he became professor at the University of Padua, where he carried out experiments regarding pendulums and the velocity of falling objects. Galileo next built his own telescope and began observing the skies. He discovered four of the moons of Jupiter, the phases of Venus and sketched the irregular surface of the moon. He was appointed court mathematician in Florence. Galileo's observations led him to support the Copernican view of the solar system, for which the Church accused him of heresy and forbade him to teach. Nevertheless, in 1632, he published his *Dialogue Concerning the Two Chief World Systems*, for which he was summoned to appear in front of the Inquisition in Rome. The Church convicted him of heresy, sentenced him to life imprisonment and demanded that he publicly renounce the heliocentric theory. Due to ill health and the support of

some important friends, Galileo was allowed to serve his sentence under house arrest in Arcetri, near Florence. He died there in 1642.

Johannes Kepler

Johannes Kepler was born in what is now Germany in 1571. He studied at the University of Tübingen, where he was introduced to the Copernican theory. He became a mathematics teacher in Graz and there wrote his defence of the Copernican system, *Mysterium cosmographicum* in 1596. He moved to Prague and began to work as assistant to Tycho Brahe, taking over as Imperial Mathematician when Brahe died in 1601. He made use of Brahe's precise recordings to calculate the orbit of the planet Mars, which he found to be elliptical and not circular, as had previously been assumed. He then applied his theories to the orbits of all the planets in the solar system, calculating their orbital paths, speeds, and distances. In 1609 he published *Astronomia nova* containing his first two laws of planetary motion. In 1619 he published *Harmonices mundi* which contains his third law. His *Epitome astronomiae copernicanae* (1618-1621) became a central work in Renaissance astronomy thanks to its systematic and exhaustive discussion of Copernican heliocentric theory. Fulfilling a lifetime dream of Brahe's, Kepler produced the *Rudolphine Tables* which provided perpetual tables for calculating planetary positions for any past or future date. He died in Regensburg in 1630. Today Kepler's findings are still considered by scientists to be accurate descriptions of the motion of any planet or satellite.

(taken from the textbook *White Spaces 1* by D. Ellis, Loescher editore, 2017)