The Scientific Revolution

Speaker: Bruce Dickerson

The Scientific Revolution of the sixteenth and seventeenth centuries was an outgrowth of the new sense of intellectual inquiry that developed during the Renaissance. Europeans had uncovered a new way of looking at the world that led to the discovery of new kinds of knowledge. The scientific advances of this era were in many ways paralleled by political and economic progress as well. By the end of this period, a more established sense of order with a new view of the structure of the cosmos and new ideas about man’s place in the solar system were embraced. This new scientific view of the world continued into the eighteenth century, and with the advent of an intellectual revolution known as The Enlightenment, the modern era was underway.

The revolution in scientific inquiry that began in the sixteenth century relied upon the new scientific methods and theories that were developed. Scientists who uncovered these new discoveries were inspired by the discoveries and theories of the ancient Greeks and Romans. However, modern scientists soon realized that the ancients were actually wrong about some things.

Scientific inquiry during the Middle Ages was limited and relied almost completely upon the knowledge discovered by the ancients. Medieval science, which in some ways even took a step backward, was heavily influenced by myth and superstition, and by the ideas imposed by the religious hierarchy of Europe. Things began to change when Renaissance Humanists looked to the ancient Greeks and Romans for inspiration. However, they soon began to question their conclusions as they began to see contradictions in the teachings of individuals like Aristotle and Galen. (see Figure 11.1)

Renaissance artists, with their attempts to discover new methods of painting and new architectural techniques, also helped to popularize the belief that improvements on the accomplishments of the ancients could be made. Sixteenth century scientists realized that through the close observation of nature and with the use of mathematics, new natural laws could be revealed.

One of the first big changes came in the proposals put forward by Nicolaus Copernicus (1473–1543). This was the beginning of a revolution in astronomy. Copernicus challenged the accepted Ptolemaic geocentric view of the solar system, and with his On The Revolution of the Heavenly Spheres, he proposed instead a heliocentric, or sun-centered, solar system. Although his theory was not immediately embraced by others, it did create doubt about the Ptolemaic system. (see Figure 11.2)
The revolution in astronomy continued with the observations of a Danish nobleman, Tycho Brahe. He spent years tracking the motions of the stars and planets, and then passed on his observations to an assistant, Johannes Kepler (1571–1630). Kepler was an astronomer and a brilliant mathematician, as well as an avid astrologer, demonstrating the narrow line that still existed between science and superstition. He published his first two laws of planetary motion in 1609, and later added a third. His three laws of planetary motion helped to further the growing doubt about the Ptolemaic system. (see Figure 11.)

Figure 11.3 – Johannes Kepler
The final blow to the earth-centered view of the solar system came with the observations and writings of an Italian, Galileo Galilei (1564–1642). He invented the telescope which allowed him to make a number of remarkable discoveries. He saw mountains and craters on the moon, sunspots, four of Jupiter’s moons, and the phases of Venus. He published his findings in *The Starry Messenger* in 1610. However, Galileo soon found himself condemned by the Catholic Church. He was eventually forced to recant the Copernican thesis. Church leaders feared that any teachings that questioned the belief that the earth was the center of the universe were a threat to belief in Christ. (see Figure 11.4)

Galileo was forced to spend years in “house arrest”; however, he never completely accepted the condemnation of the church. In 1632, he published *Dialogue on the Two Chief World Systems: Ptolemaic and Copernican*, which was basically a defense of Copernicus. He was quickly condemned again by the Church and, once again, was forced to recant. Perhaps because of the opposition of the Catholic Church hierarchy to any scientific inquiry that might cause one to question Christianity, scientific leadership moved outside of Italy, to England, France, and the Netherlands.

The greatest scientist of the era was undoubtedly, Sir Isaac Newton (1642–1727). He was the Chair of Mathematics at Cambridge University in England. Among his many accomplishments was the invention of calculus. In his most important work, *Mathematical Principles of Natural Philosophy (1684 – 1686): The Principia*, Newton revealed the Three Laws of Motion, and he explained how the force of gravity kept the planets in elliptical orbits around the sun. He went even further and detailed how every object exerts an attractive force, or gravity, on every other object. With Newton’s contributions, the world could now be seen in mechanistic terms. (see Figure 11.5)

Europeans were also making discoveries in fields other than astronomy and mathematics. Advances in medicine were made as well. Medieval medical practices were dominated by the teachings of the ancient Greeks, particularly Galen. For example, the use of leeches for bleeding was a common practice in the Middle Ages.

New medical ideas about the diagnosis and treatment of disease, considered by some a forerunner of homeopathy and holistic medicine, were proposed by Paracelsus. Andreas Vesalius developed new techniques for uncovering the inner workings of the human body in his masterpiece, *On the Fabric of the Human Body* (1543). He deviated from accepted practice by actually dissecting human corpses. William Harvey published *On the Motion of the Heart and*
Blood (1628), dealing a severe blow to Galen’s theories. Harvey’s ideas about the circulation of the blood set the stage for the modern field of physiology. (see Figure 11.6)

European women also contributed to the new field of modern science. Margaret Cavendish (1623–1673) published Observations upon Experimental Philosophy which set the grounds of Natural Philosophy and attacked rationalist and empiricist approaches to scientific knowledge. Maria Sibylla Merian was an entomologist who published The Metamorphosis of the Insects of Suriname in 1699. A number of German women also made contributions, including Maria Winkelmann who discovered a comet. (see Figure 11.7)

Interestingly, this was also an era when new contributions were made to the centuries old debate over the nature of women. Many held very negative views of the nature of women, believing they were sexual beings, insatiable in their desires, easily led astray, and prone to vice. In the seventeenth century, women joined this debate and rejected this negative view of women. Science was often used to “perpetrate old stereotypes about women.” Men used the scientific revolution to reaffirm traditional ideas about women’s nature and to perpetuate the belief that women were naturally inferior to men and best suited to following a domestic role as a nurturing mother.

With the scientific discoveries of this era, a new view of the earth and of humankind was beginning to develop. Widespread acceptance of the new scientific discoveries was popularized by the contributions of Rene Descartes and Francis Bacon. With his work, Discourse on Method (1637), Descartes revealed a more rationalistic view of the world and asserted that he could only accept those things that his own sense of reason supported as true. Descartes is perhaps most well known for his statement, “I think, therefore I am.” He is considered the father of modern rationalism. (see Figure 11.8)

The spread of scientific knowledge increased as more people began to rely upon The Scientific Method. In The Great Instauration (or The Great Restoration), Francis Bacon (1561–1626) emphasized using scientific method built on inductive principles. He proposed that one proceed from the particular to the general and that through experimentation and systematic
observations correct generalizations could be deduced. Descartes emphasized using a scientific method that relied upon deduction and mathematical logic. Newton united Bacon’s empiricism and Descartes rationalism into a single scientific methodology. (see Figure 11.9)

The new scientific discoveries and the more widespread belief in science can be seen in the widespread establishment of Scientific Societies. In Great Britain, the English Royal Society was founded; while in France, they created the French Royal Academy. These societies recognized the practical value of scientific research. Many saw that science offered new ways to exploit resources for profit. However, the royal societies soon shifted to more of a focus on theoretical work. (see Figure 11.10)

Western societies are engaged in an ongoing conflict between science and religion that in some ways began with the conflict between Galileo and the Catholic Church. While some would now insist that through science one can find the answer to everything, others continue to insist that the biggest questions can only be answered through religion. The common folk of seventeenth century Europe were very religious and were very superstitious. Meanwhile, the elites and propertied classes were beginning to recognize science’s rational superiority. It was inevitable that conflict between religion and science would unfold and continue into the modern era.

The question of science or religion was not a simple one; however, two individuals illustrated the wide diversity in the response of European intellectuals to the revolution in science. Benedict de Spinoza was a Jewish philosopher who believed that everything has a rational explanation, while Blaise Pascal was a French scientist who tried to unify science and religion. Pascal believed that Christianity was not opposed to the use of reason; however, he also refused to rely solely on reason. In his work, *Pensees*, he attempted to convert rationalists to Christianity by appealing to their emotions and their reason. He believed strongly that reason had limits. (see Figure 11.11)

The Scientific Revolution was a major turning point in European civilization. Europeans changed their perception of themselves, and many began to see humanity, and it’s role in the cosmos, in a much different light. These changes helped set the stage for the next intellectual debate, The Enlightenment.