CHAPTER 3

BEGINNINGS OF MODERN SCIENCE AND AGE OF THE ENLIGHTENMENT

3.1 SCIENTIFIC REVOLUTION

Modern science had its origins in the sixteenth and seventeenth century "Scientific Revolution." "The Enlightenment" was an eighteenth century movement.

Nicholas Copernicus (1473 – 1543) discovered that the earth is but one of many planets revolving around the sun and turning on its own axis to make day and night. He demonstrated that the Greek mathematician, Ptolemy, was mistaken in his idea that the earth was a stationery planet in the center of the universe.

Tycho Brahe (1546 – 1601) a Danish nobleman, built an expensive observatory and systematically pursued Copernicus' theories.

Johann Kepler (1571 – 1630) the first great Protestant scientist and assistant to Brahe, discovered that the orbits of the planets are ellipses which make their orbits in equal times. He explained the speed of the planets in their orbits and found that the planets do not move with the sun as focal point.

Galileo Galilei (1564 – 1642) was Professor of Physics and Military Engineering at the University of Padua. He was the first to use the telescope as a scientific instrument and built a powerful telescope himself.

His discoveries and use of the telescope were a great aid in the voyages of discovery and had a direct effect on navigation. He provided artillery with a means of surveying distant targets for more accurate marksmanship.

Galileo's discoveries in mechanics had far-reaching significance. He proved that all falling bodies descend with equal velocity, regardless of weight. He found that a long pendulum swing takes the same time as the short one, so that some force increases the speed of each swing by equal amounts in equal times.

Francis Bacon (1561 – 1626), Lord Chancellor of England, specified inductive method for scientific experimentation. Inductive observation, the development of hypotheses, experimentation, and organization were to be the keys to scientific inquiry.

Rene Descartes (1596 – 1650) wrote his *Discourse on Method* to build on the scientific method by using deductive analysis on scientific discoveries. He wrote that science must begin with clear and incontrovertible facts and then subdivide each problem into as many parts as necessary, following a step-by-step logical sequence in solving complex problems. Descartes was particularly a leader in mathematics and philosophy.

3.2 SCIENTIFIC SOCIETIES

Scientific societies were organized in many European countries in the 17th century. Italy began the first scientific societies in Naples, Rome, and Florence. The Royal Observatory was established at Greenwich in 1675 and the Royal Society in 1662; private donations and entrance fees from members financed the society. The French Academie des Sciences was founded in 1666. King Frederick I of Brandenburg-Prussia chartered the Berlin Academy of Sciences in 1700. Finally, Peter the Great founded the St. Petersburg Academy of Sciences in 1725.

Sir Isaac Newton (1642 – 1747) taught mathematics at Cambridge, was Master of the Royal Mint in London, and for twenty-five years was the President of the Royal Society. Most of his work was done in astronomy, the dominant science of the seventeenth century. He worked with magnification, prisms, and refraction. He used lenses with different curvature and different kinds of glass. Newton's greatest contribution, however, was in discovering his principle of universal gravitation, which he explained in *Philosophiae Naturalis Principia Mathematica*, published in 1687. He claimed to "subject the phenomena of nature to the laws of mathematics" and saw order and design throughout the entire cosmos.

Science and religion were not in conflict in the seventeenth and eighteenth centuries. Scientists universally believed they were studying and analyzing God's creation, not an autonomous phenomena known as "Nature." There was no attempt, as in the nineteenth and twentieth centuries, to secularize science. "Natural law," they believed was created by God for man's use. A tension between the natural and the supernatural simply did not exist in their world view. The question of the extent of the Creator's involvement directly or indirectly in his Creation

was an issue of the eighteenth century but there was universal agreement among scientists and philosophers as to the supernatural origin of the universe.

3.3 THE AGE OF THE ENLIGHTENMENT

For the first time in human history, the eighteenth century saw the appearance of a secular world view to capture the imagination of many intellectuals. In the past some kind of a religious perspective had always been central to western civilization. This was true of the ancient Egyptians, Hebrews, Persians, Greeks, and Romans. It was also true of medieval Catholic Christendom and of the sixteenth century Protestant Reformation. The eighteenth century philosophers, who declared themselves "enlightened," thought that "light" came from man's ability to reason. They rejected the idea that light must come from God, either through the Church (the Catholic position) or the Scriptures (the Protestant position). The Enlightenment opened the door to a secularized anthropocentric universe instead of the traditional theocentric view.

The philosophical starting point for the Enlightenment was the belief in the autonomy of man's intellect apart from God. The most basic assumption was faith in reason rather than faith in revelation. The "Enlightened" claimed for themselves, however, a rationality they were unwilling to concede to their opponents.

The Enlightenment believed in the existence of God as a rational explanation of the universe and its form, but that "god" was a deistic Creator who created the universe and then was no longer involved in its mechanistic operation; this was governed by "natural law." Enlightenment philosophers are sometimes characterized as being either basically ***rationalists*** or ***empiricists.***

3.3.1 *Rationalists*

Rationalists stressed *deductive* reasoning or mathematical logic as the basis for their epistemology (source of knowledge). They started with "self-evident truths" or postulates, from which they constructed a coherent and logical system of thought.

Rene Descartes (1596 – 1650) sought a basis for logic and thought he found it in man's ability to think. "I think; therefore, I am" was his most famous statement. That statement cannot be denied without thinking. Therefore, it must be an absolute truth that man can think. His proof depends upon logic alone.

Baruch Spinoza (1632 – 77) developed a rational pantheism in which he equated God and nature. He denied all free will and ended up with an impersonal, mechanical universe – a universe with no one there.

Gottfried Wilhelm Leibniz (1646 – 1716) worked on symbolic logic and calculus, and invented a calculating machine. He, too, had a mechanistic world-and-life view and thought of God as a hypothetical abstraction rather than persona.

3.3.2 *Empiricists*

Empiricists stressed *inductive* observation as the basis for their epistemology, in short, the scientific method. Their emphasis was on sensory experience.

John Locke (1632 – 1704) pioneered in the empiricist approach to knowledge and stressed the importance of environment in human development. He classified knowledge as 1) according to reason; 2) contrary to reason; and 3) above reason. Locke thought reason and revelation were complementary and both from God.

David Hume (1711 – 76) was a Scottish historian and philosopher who began by emphasizing the limitations of human reasoning and later became a dogmatic skeptic.

The people of the Enlightenment believed in absolutes; they were not relativists. They believed in absolute truth, absolute ethics, and absolute natural law. And they believed optimistically that these absolutes were discoverable by man's rationality. It wasn't long, of course, before one rationalist's "absolutes" clashed with another's.

The Enlightenment believed in a *closed system* of the universe in which the supernatural was not involved in human life. This was a sharp contrast to the traditional view of an *open system* in which God, angels, and devils were very much a part of human life on this earth.

3.3.3 *The Philosophes*

The ***philosophes*** were popularizers of the Enlightenment, not professional philosophers. They were men and women "of letters," such as journalists and teachers. They frequented the salons, cafes, and discussion groups in France. They were cultured, refined, genteel intellectuals who had unbounded confidence in man's ability to improve society through sophistication and rational thought. They had a habit of criticizing everything in their path – including rationalism.

Francois-Marie Arouet (1694 – 1778) better known as Voltaire, was one of the most famous *philosophes*. He attended an upper-class Jesuit school in Paris and became well-known for his unusual wit and irreverence. His sharp tongue and "subversive" poetry led to an eleven-month imprisonment in the Bastille. Voltaire lived in England for several years and greatly admired the freedom in the relatively open English society. He accepted Deism and believed in a finite, limited God who he

thought of as the Watchmaker of the universe. Characteristically Voltaire relied on ridicule rather than reason to present his case.

Jean-Jacques Rousseau (1712 – 78) lived in Geneva until he was forced to flee to England because of what the government considered radical ideas. Rousseau thought of man in a simpler state of nature as "the noble savage" and sought to throw off the restraints of civilization. Rousseau saw autonomous freedom as the ultimate good. Later in life he decided that if a person did not want Rousseau's utopian ideas, he would be "forced to be free," an obvious contradiction in terms. Rousseau has been influential in western civilization for over two hundred years with his emphasis on freedom as a Bohemian ideal. His book on education, *Emile* (1762) is still popular, despite the fact that he left his five illegitimate children in an orphanage instead of putting his educational theories to work with his own children.

3.3.4 *Chronology*

The Enlightenment varied in emphasis from country to country; the French Enlightenment was not exactly the same as the English or German Enlightenment. Distinctions can also be made chronologically in the development of Enlightenment thought:

1) The end of the 17th and first half of the 18th century saw a reaction against "enthusiasm," or emotionalism and sought moderation and balance in a context of ordered freedom.

2) From the mid-18th century the Enlightenment moved into a skeptical, almost iconoclastic phase where it was fashionable to deride and tear down.

3) The last three decades of the 18th century were revolutionary, radical, and aggressively dogmatic in defense of various abstractions demanding a revolutionary commitment. "Love of mankind" made it one's duty to crush those who disagreed and thus impeded "progress." In short, the Enlightenment entered a utopian phase that was disastrous when it brought on the French Revolution.

3.4 THE "COUNTER-ENLIGHTENMENT"

The "Counter-Enlightenment" is a comprehensive term of diverse and even disparate groups which disagreed with the fundamental assumptions of the Enlightenment and pointed out its weaknesses. This was not a "movement," but merely a convenient category.

3.4.1 *Theistic Opposition*

German pietism, especially Count von Zinzendorf, 1700 – 60, leader of the Moravian Brethren, taught the need for a spiritual conversion and a religious experience. 18th century Methodism similarly taught the need for spiritual regeneration and a moral life that would demonstrate the reality of the conversion. Methodism was led by an Anglican minister, John Wesley, 1703 – 91. The Great Awakening in the English colonies in America in the 1730's and 1740's, led by Jonathan Edwards, had a similar result.

Roman Catholic Jansenism in France argued against the idea of an uninvolved or impersonal God. Hasidism in Eastern European Jewish communities, especially in the 1730's, stressed a joyous religious ferver in direct communion with God in sharp contrast to Deism, which was at the same time gaining adherents in England.

3.5 PHILOSOPHIC REACTION

Some philosophers questioned the fundamental assumptions of rationalist philosophy.

David Hume (1711 – 76) for example, struck at faith in natural law as well as faith in religion. He insisted that "man can accept as true only those things for which he has the evidence of factual observation." (Then why accept Hume's statement as true?) Since the *philosophes* lacked indisputable evidence for their belief in the existence of natural law, Hume believed in living with a "total suspension of judgment." (But if one must be a dogmatic skeptic, then why not be skeptical about dogmatic skepticism?)

Immanuel Kant (1724 – 1794) separated science and morality into separate branches of knowledge. He said that science could describe the natural phenomena of the material world but could not provide a guide for morality. Kant's "categorical imperative" was an intuitive instinct, implanted by God in conscience. Both the ethical sense and aesthetic appreciation in human beings are beyond the knowledge of science. Reason is a function of the mind and has no content in and of itself.