The millioneth book. [Lexington, Ky.] 1963.

DIALOGO D I GALILEO GALILEI LINCEO MATEMATICO SOPRAORDINARIO DELLO STVIDIO DI PISA.

E Filosofo, e Matematico primario del SERENISSIMO GR. DVCADITOSCANA.

Doue ne i congressi di quattro giornate si discorre soprai due

MASSIMI SISTEMI DEL MONDO TOLEMAICO, E COPERNICANO; *Proponendo indeterminatamente le ragioni Filosofiche, e Naturali tanto per l'vna, quanto per l'altra parte.*

CON PRI VILEGI.

IN FlORENZA, Per Gio:Batista Landini MDCXXXII.

CON LICENZA DE' SVPERIORI.

The Millionth Book

Keepsake Number 10

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The Millionth Book in the University of Kentucky Library:

Galileo's *Dialogue* of 1632, the gift of Elsie O. and Philip D. Sang of River Forest, Illinois

Galileo Galilei has been called the father of modern science, but during his lifetime he was persecuted for his scientific beliefs. This book, entitled *Dialogue on the Two Chief Systems of the World,* published in Florence in 1632, is a monument to his teachings and to the tragedy of his life. We all know the story of Galileo and of this book. He tried to convince men, once and for all, that ours is a heliocentric system, and that the sun and the stars do not revolve around the earth. Unfortunately for Galileo, he was opposed by men of egocentric as well as geocentric viewpoints. For centuries the Church upheld the doctrine that the earth was the center of the universe, an astronomical theory or “system” developed centuries earlier by Ptolemy of Alexandria. Galileo now advocated another

"system", which accounted for the movement of the stars and of the planets in a much simpler way. This was the Copernican system, proposed by Copernicus a hundred years before Galileo. Copernicus had developed his theory by means of observations made with the naked eye and with the aid of the quadrant. His theory could not be proved, however, and this Galileo now attempted to do with the aid of a new instrument, the telescope, and by the force of common-sense argument.

Galileo was the first astronomer to use the telescope for examining heavenly bodies. With this instrument, which he himself perfected, he discovered the mountains of the moon, the four satellites of the planet Jupiter, and the peculiar appearance of the rings of Saturn. He found that the Milky Way was a mass of very faint stars, and what he saw also convinced him of the truth of the Copernican view that the earth rotates on its axis and revolves around the sun.

His ardent support of this view was the cause of his difficulties with the Church. In 1616 he was given a formal warning not to teach or advocate the new system. Publication of his astronomical findings and arguments had to be postponed. His friend Maffeo Cardinal Barberini was elected to the papal throne in 1623. It was then that Galileo became anxious to have the Copernican doctrine accepted and hoped that he might write about it. He decided to write this book, completed it late in 1630, and published it in 1632. Its appearance provoked the indignation of Church authorities, not only for its doctrines, which were considered heretical, but also for its biting satire, which was aimed at the supporters of the Ptolemaic system. For this publication, Galileo was summoned before the Inquisition. The book was suppressed and placed on the Church's *Index Expurgatorius* of prohibited books, where it remained until 1835. No one knows exactly what happened during Galileo's examination by the Inquisition. It is known that he was compelled to utter a formal recantation of his views: "I Galileo, son of the late Vincenzio Galilei, Florentine, aged seventy years, arraigned personally before this tribunal and kneeling before you ... having before my eyes and touching with my hands the Holy Gospels, swear that I have always believed, do believe, and by God's help will in the future believe all that is held, preached and taught by the Holy Catholic and Apostolic Church ... Therefore ... with sincere heart and unfeigned faith I abjure, curse, and detest the aforesaid errors and heresies and generally every other error, heresy, and sect whatsoever contrary to the Holy Church, and I swear that in future I will never again say or assert, verbally or in writing, anything that might furnish occasion for a similar suspicion ..." He was condemned by the tribunal to live in strict seclusion for the rest of his life. There is a story that, as he rose from his knees, he whispered defiantly, "Eppur si muove" ("Nevertheless it does move"), referring, of course, to the earth. This, however, is a fiction invented more than a century later.

The men who opposed Galileo were defending the status quo of their age. They were more concerned with their egocentric interests, than with the progress of science, which constituted

a threat to their security. They attempted to destroy his defiance by freezing the educational system, hoping to avoid disturbing changes in the state of knowledge. They could not understand that Galileo's work represented the beginning of mankind's greatest scientific breakthrough, the development of the *scientific method.* This plan is the foundation of the all modern science. Without it none of the scientific wonders of the modern age could have been achieved.

Prior to the development of the scientific method, man had made little progress in understanding natural phenomena. He had attained the greatest heights in art and literature. The scientific method involves three essential stages of application to the study of natural phenomena, namely, the observational, the experimental, and the theoretical. In physics the third stage is a mathematical one in which the theory developed from observation and experimentation is stated in mathematical form. A famous example of such a statement is Einstein's E=mc 2 , probably the most publicized of the atomic age. It states the equivalence of energy to mass times the square of the speed of light, a succinct explanation of nuclear energy. But the theoretical or mathematical stage of scientific discovery cannot be attained without the experimental data which provide the measurements essential to mathematical formulation.

It is to Galileo that we owe the introduction of the experimental stage of the scientific method, and it is for this reason that he is called the father of modern science. The essence of this all-important stage is the art of proposing and setting up an experiment which illustrates or embodies the phenomenon under study. The experiment must be one that can be repeated and observed by others, who can thereby satisfy themselves as to the validity of the observations and the accuracy of the measurements made. It was Galileo who first devised such experiments, and in so doing broke away from and rejected the authority of Aristotle, whose teachings had dominated scientific learning in Europe for centuries.

Much of Aristotle's science was fallacious because it was authoritarian and not based on careful testing and observation. Aristotle maintained that the time in which a body falls a given distance is proportional to its weight. Galileo devised experiments to show that this was not true, and that the acceleration of all falling bodies is constant.

Although Galileo achieved his greatest reputation as an astronomer, his chief service to modern science lay in establishing certain fundamental principles of dynamics: the law of falling bodies—the discovery that the path of projectiles is a parabola—the demonstration of the laws of equilibrium —and an account of the true principle of flotation. The extraordinary advances made by him in the field of mechanics were due to his happy method of applying mathematical analysis to physical problems. Max Born has said: “The inner logic of Galilean mechanics was so strong that Newton was able to take the great step of applying it to the motion of the stars.” The method, which was

peculiarly his, consisted of combining experiment with calculation, of transforming the concrete into the abstract. This was applied to the investigation of the laws of falling bodies, of equilibrium and motion on an inclined plane, and of the motion of a projectile.

In addition to the telescope, which he developed into the type which bears his name, Galileo also devised an elementary form of the thermometer, invented the hydrostatic balance for determining the specific gravity of solid objects, and made improvements in the construction of the microscope. Another significant discovery of his, which paved the way for the invention of the clock, was that of the pendulum. His observations indicated that the oscillations of a pendulum are made in equal times.

But it is this book, Galileo's *Dialogue on the Two Chief Systems of the World* that, more vividly than any other work of his, symbolizes his life-long struggle for freedom of science. The warfare of authoritarianism against science, like the warfare of ignorance against knowledge, has not diminished since Galileo's days. Not a few scientists and scholars in our own time have had to face powerful enemies of open-minded inquiry and of free teachings, and not always in totalitarian countries alone. This book, written by one of the world's boldest explorers into new ways of studying and thinking about the universe, stands as a reminder to all that freedom of thought and progress of science must walk hand in hand for all time.

Philip D. Sang