MASTERS OF SCIENCE AND INVENTION

BY

FLOYD L. DARROW

AUTHOR OF "BOYS' OWN BOOK OF GREAT INVENTIONS,"
"BOYS' OWN BOOK OF SCIENCE," ETC.

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PREFACE

Masters of Science and Invention offers to the lay reader a simple account in biographical form of the development of scientific achievement from early times to the present day. No knowledge of the laws of science and their manifold applications is even approximately complete without acquaintance with the outstanding figures who have made possible the age in which we live. But the busy reader does not have time to peruse long and often tedious volumes, to obtain this information. Many readers do not know how and where to find it. Even if the names are known, an encyclopedia will give only a bare recital of facts. The human interest features are all omitted. The romance of science and invention is lacking.

This volume not only attempts to humanize science, but gives an accurate and comprehensive outline of its salient features. Each chapter is an essay in itself, and while the chapters follow in general the chronological sequence of events, they may be read in any order. No single story will require more than thirty minutes for its reading. The book is preëminently the general reader's guide to the historical development of scientific fact and theory.

FLOYD L. DARROW.

Brooklyn, N. Y.

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MASTERS OF SCIENCE AND INVENTION

CHAPTER I

GALILEO AND HIS PREDECESSORS

First among the masters of science and invention to catch the true spirit of modern research was the Italian, Galileo Galilei. The supreme purpose of his life was to discover the truth about Nature and her laws. He cared nothing about theory which could not be demonstrated by experiment and observation. Thus we find him, when little more than a youth, disproving from the Leaning Tower of Pisa Aristotle's century-old myth concerning the time of a falling body. But to understand this man and his work we must silhouette him, so to speak, against the background of the ages.

Particularly did Galileo distinguish himself in the field of astronomy, the oldest and most beautiful of the sciences. Even when the curtain rises on the early civilization of the Nile valley, we find the ancient Egyptians following the movements of the heavenly bodies and reckoning time by observation of the sun. The coming of the Nile floods, without which agriculture would be impossible in Egypt, coincides with the summer solstice. So striking a circumstance did not fail to challenge the attention of these observers. The first linking up of astronomical events with the natural phenomena of the earth determined

the length of the Egyptian year, which from the earliest records that have come down to us, dates from the summer solstice. Even the pyramids, those mighty monuments to the mechanical genius of this early people, were arranged with definite regard to the point at which the sun rises on this most important day of the year. The Egyptians constructed theories of the universe, too, crude products of ignorance and superstition, as befits an infant race making the first tiny explorations of the infinite depths of space.

The Babylonians, extending the knowledge of those pioneer observers of the Nile valley, gave us the week of seven days, the division of the day into hours and the year into months. Just as the sun had been the chief object of interest to the Egyptians, so was the moon to the Babylonians. Its circuit of the heavens gave them their month, and twelve of these they called a year. The Chaldean shepherds, watching their flocks by night and gazing at the stars as a pastime, discovered those wanderers of the heavens, named for that reason planets. Why planets change their positions with reference to the other stars, why the light coming from them does not twinkle, the shepherds could not tell. They saw the nightly rising and setting of the moon and stars, and in common with the view that prevailed for centuries, they regarded the earth as the center of the universe, with the other heavenly bodies at no great distance away and revolving around it once in each twenty-four hours. A natural view, this, and just the one that we ourselves should have taken had we been living at that time.

Our superior wisdom of today is due to our rich heritage from the past.

The Greeks, that intellectual race of philosophers who carried the learning of the East to the western world, made contributions to this earliest of the sciences, astronomy. They gave to the world Aristarchus, the first notable astronomer of antiquity. Although it is probable that Pythagoras before him had expressed the opinion that the earth is round and revolves about the sun, it remained for this really great Greek astronomer to put forth such a theory, based upon actual observations. Seventeen centuries before the time of Copernicus, Aristarchus proposed a theory of our solar system practically identical with that of today. By sound geometrical methods, he had measured the relative sizes of the sun, earth, and moon. Although his numbers were inaccurate, he saw that the sun was many times larger than the earth and at a great distance from it. For the first time in history, he pointed out the absurdity of making the sun revolve about the earth and traverse such an immense orbit in twenty-four hours. This "Copernicus of antiquity" also taught that the moon shines by reflected light and revolves about the earth. Unfortunately, Hipparchus, his successor, although contributing much to our knowledge of the heavens, rejected this new theory of the solar system, and the world had to wait nearly two thousand years for Galileo to prove its truth.

Who has not heard of Ptolemy, that popularizer of ancient astronomical beliefs, and the perpetuator of

a false system which held sway for centuries? This Alexandrian astronomer so firmly established the notion of the earth as the center of our solar system that it persisted all through the Middle Ages. By an ingenious but inexplicable system of "epicycles," he accounted for the varying speeds at which the sun and planets move in different portions of their orbits. In an age when original thinking was under the ban and the authority of the past sat upon the throne, this idea of the universe satisfied every need and was handed down from century to century without challenge.

Not until the coming of Copernicus, who was born in Prussia shortly before the discovery of America, did the Western World receive the first pronouncement of the system which modern astronomy has established beyond the possibility of doubt. Harking back to the time of Aristarchus, he set forth an explanation of our solar system, which, although imperfect, was essentially the same as we understand it today.

The deep-set prejudices of an age of ignorance and superstition can not be lightly overthrown. Did not the Bible support the Ptolemaic idea of the universe? Even Luther pointed out that Joshua commanded the sun and moon, and not the earth, to stand still. How could it be possible then that the earth revolves about the sun? So great an astronomer as Tycho Brahe of Denmark did not support Copernicus. Brahe did many noteworthy things. For the first time in history he gave serious study to the comets.

He observed a new star and gave the correct explanation of its origin. He devised a simple means of determining latitude by observations of the stars. But his most important achievement was the training of Johann Kepler, the contemporary of Galileo, and the astronomer who discovered and formulated the laws that govern the motions of the planets.

And now we come to Galileo. Born in Pisa in 1564, educated in the university of his native city, succeeding to professorships in his alma mater and later at Padua and Florence, this Italian scientist loosed the fetters that bound the thinking of his fellowmen to Aristotle and the traditional past. Even as a student, his hatred of the false, and his yearning for the truth brought him into frequent conflict with his professors and the student body. His demand that the principles of natural philosophy correspond with the facts of observation led him repeatedly to challenge the authority of the past. Thus he brought upon himself unpopularity and the title of "Wrangler." Here was the first apostle of the modern laboratory method, and as usual toward men of new ideas, the world did not look upon him kindly. He disturbed men's comfort. He upset their centuries-old beliefs. He made it necessary for them to think. To Galileo a thing was not true simply because it seemed plausible. With him it must bear the test of rigid demonstration.

Aristotle had taught that a body weighing one hundred pounds would fall one hundred times as fast as a body weighing one pound. No one had thought

to challenge this statement. Aristotle had said so and that was enough. But every schoolboy knows how Galileo, dropping a half-pound weight and a hundred-pound cannon ball from the famous Leaning Tower of Pisa, proved the utter falsity of this contention. Would you not suppose that this striking demonstration of the truth would have brought fame and approval to Galileo? It did not. Reverence for Aristotle and the past was stronger than the desire to know the truth. The students and the professors of the university hissed him and accused him of being a magician. So unpopular did Galileo become that he was compelled to flee from his native city. He took refuge in Padua where he obtained a professorship in the university, and his fame as a lecturer soon brought to him students from every part of Europe.

But it is in the field of astronomy that Galileo did his greatest work. He early became a disciple of Kepler and a convert to the new theory of the heavens. About 1610 he learned of the newly-invented "Dutch telescope," a contrivance by which it was reported distant objects could be made to appear much nearer and larger. In a moment of inspiration it occurred to this philosopher of Padua that this instrument might reveal the mysteries of the stars. He set to work, and placing lenses at either end of a lead tube, soon had a telescope with which he "saw objects three times as near and nine times as large." He quickly followed this with another instrument which magnified objects nearly a thousand times and brought them thirty times nearer.

With it, Galileo swept the heavens and in so doing expanded the tiny world of the ancients to a universe of vast extent. To his amazement he discovered that he could count ten times as many stars as were visible to the unaided eye. Contrary to the common belief of that time, the stars were not all equidistant from the earth. With this first glimpse of the starry depths the imaginary celestial sphere of his predecessors vanished. Turning his " optic tube " upon the beautiful Milky Way, Galileo resolved this hazy band of mellow light into myriads of faint stars at such stupendous distances as to be indistinguishable without optical aid. Under the magic eye of this new invention worlds without end sprang into view. Venus was seen to pass through phases similar to those of our moon. Thus did he obtain convincing proof that the planets, unlike the stars, are dark bodies shining by reflected sunlight. Our own moon, the most beautiful object of the heavens, disclosed a surface scarred by rugged mountain ranges and pitted with volcanic craters. Disquieting, indeed, was this discovery to the Aristotelian idea, which held the moon and planets to be perfectly smooth spherical bodies.

Innumerable wonders seemed to lie within the uncanny vision of this simple astronomer. The heavens appeared as an open book. The crude speculations of ignorance and superstition disappeared as the mist before the sun. The world grew in mental stature.

But a still greater discovery remained. One evening, as Galileo pointed his telescope toward the planet Jupiter, he brought to view a miniature solar system.

Here was a huge planet and near by were four tiny "stars." Galileo watched these "stars" from night to night and learned that they circled about the planet, exactly as our moon circles about the earth. But more than that, the revelation gave striking confirmation of the truth of the Copernican theory. Did not the planets revolve about the sun, just as these moons revolve about Jupiter? The phases of Venus had proved this to be true for one planet, and now the last lingering doubt as to the motion of the others disappeared from Galileo's mind.

Not content with these explorations of the nighttime skies, Galileo turned his attention to the sun itself. His observation was rewarded by the detection of a dark spot, a seeming blemish, upon the surface of that giant luminary. He noticed that it changed shape, suggesting changes in the substance of the sun itself. Continued observation showed that the spot returned after a period of twenty-four days, thus proving that the sun rotates on its axis. Here we have the first telescopic discovery of a sunspot, one of those gigantic whirlpools of solar activity so intimately associated with electrical disturbances upon the earth, but still presenting much of mystery.

But Galileo lived in the day of the Inquisition. The superstitions that beclouded the minds of men could not be dispelled as easily as were the astronomical mysteries under the spell of his magic tube. The Church still clung to the ancient Ptolemaic belief. The Bible was thought to teach that the earth is immovably fixed in the center of the universe. Giordano

Bruno, in the year 1600, had been burned at the stake for teaching contrary views. Galileo was warned to keep silent. Still he prepared his famous work, setting forth in the form of a dialogue the overwhelming proof of the Copernican theory. True, Galileo faithfully presented both sides, but the ancient system of Ptolemy completely disappeared before the irresistible logic of the new discoveries.

Angered at this bold attack upon the citadel of religious authority, the Pope summoned Galileo to Rome. He was now an old man, nearly seventy. Sick and feeble, he made the journey with great difficulty. Arrived at the Holy City, this prophet of a new age was treated with the utmost consideration. But the respect was for the man, not for his doctrine. Under threat of physical torture, he was forced to renounce his heretical belief in the earth's motion. His book was suppressed, but too late to prevent the new knowledge from spreading throughout Europe. His purpose has been accomplished. He knew that truth could not long be stifled, and in implicit faith that the new astronomy would very soon vanquish all opposition, he devoted the remaining years of his life to another field of discovery.

To his credit, Galileo attacked the problems of mechanics with the laboratory method. Using inclined planes to diminish velocity, he worked out the laws of falling bodies. For the first time he demonstrated that the path of a projectile is a parabolic curve. With wonderful clearness, he saw the truth of the fundamental laws of motion and came very near to stating

them. Sitting in a cathedral, he chanced to observe the regular swinging of a chandelier, and as a result of experimentation formulated the laws of the pendulum's motion. He made the first thermometer and attempted to measure the velocity of light.

A many-sided man was the simple scientist of Pisa, Padua, and Florence. Musician, scholar, teacher, mathematician, physicist, inventor, and astronomer, he stands forth now, after a lapse of three centuries, as one of the intellectual leaders of all time. We are today but carrying on the work that he began. When, with each new and more powerful telescope, we push back the frontiers of the universe by a few billions of miles, we thereby only add luster to the accomplishments of this master of the Italian hills.

CHAPTER II

NEWTON AND EINSTEIN

Bridging the gap from the age of Galileo to the beginnings of modern science, stand the life and work of Sir Isaac Newton. Although two centuries have passed since the time of this astronomer of the British Isles, his name will in future be linked with that of the new genius of science, Albert Einstein. Men have not yet ceased to marvel at the revolutionary ideas of gravitation, space, and time that Einstein has so recently set forth. Yet Einstein only supplements Newton. He does not overthrow him. He gives us new viewpoints. He sharpens our intellects. He makes predictions which the scientists verify with startling accuracy. He explains century-old mysteries. Still, within the limits of our solar system, the laws of Newton are as valid as ever. Whether gravitation be regarded as a mere force, or a "warp in space," the consequences of a fall from the Woolworth Building or the Eiffel Tower will be just as disastrous, whichever viewpoint you take. According to Einstein's own theory, it is all a matter of "relativity" anyway, an idea which we shall make clear a little later.

Newton

Born in 1642, the year of Galileo's death, frail and sickly as a child, Sir Isaac Newton gave no promise