Physical Science in the XVIIth Century

Physics

MARTHA ORNSTEIN in *The Rôle of Scientific Societies in the Seventeenth Century* (Univ. of Chicago Pr.):

As regards instruments [the seventeenth century] produced the microscope, telescope, and machinery for grinding their lenses. It originated an exact time-measuring instrument in the pendulum; it brought into existence the thermometer and barometer, and the air pump. It created therefore the most fundamentally important apparatus of the modern physical laboratory.

The seventeenth century first produced the places where, and conditions under which experimentation could be carried out. There is one exception to this statement. Chemistry, i. e., alchemy, had had its laboratories, i furnaces, cooling and drying apparatus, mortars, countless glass vessels, distilling contrivances, for many preceding centuries. The apothecary had had his distilling apparatus, his furnace for chemical and pharmaceutical operations. But the conception of a physical laboratory and a non-alchemistic and non-pharmacological laboratory was the creation of the seventeenth century. To be sure the earliest laboratories were not very well equipped. The bedroom or kitchen of the scientist was often used as a place for experimentation. Newton's optical researches were made in his lodgings. Robert Boyle tested his laws of elasticity of gases in tubes along the stairs. But before the end of the century such informal workshops of scientists were in some rare instances supplanted by laboratories in the modern sense of the word, supplied with instruments of measurement and with facilities for research work. By 1700 both the chemical and physical laboratory existed in embryonic form.

The astronomical laboratory, the observatory, on account of its affiliation with astrology, existed much earlier. But the seventeenth century created the modern observatory, equipped with telescopes and fine instruments for exact research, prepared for the task of making systematic maps of the celestial regions. The seventeenth century multiplied the establishment of botanical gardens. . . . .

The subjective side of Rosenberger's statement, "that the seventeenth century introduced experiment into science," signifies, as has been said, that it produced scientists and scientific skill. The truth of this statement can best be shown perhaps, by comparing, in the various scientific fields in broad outlines, the information of a man familiar with the whole range of science in 1600—whom we shall for convenience call A—with that of a man B, in 1700, similarly instructed in the entire scientific knowledge of his time. The difference between the scientific truths in the possession of A and B will then represent, to borrow a phrase from mathematics, the "integration" of the "differential" work and skill of the many individual scientists of the century. Besides, we shall in this way gain a clearer perception of how much the seventeenth century added to the fund of scientific knowledge.

Commencing with physics, and taking up first the fundamental chapter of dynamics, A was permeated with Aristotelian ideas; B, through Galileo, Kepler, and Newton, was in many respects at the level of present-day information. The vast difference this represents may be indicated as follows:

A believed that:

1. Bodies have either a natural motion downward or upward. The former are called "heavy," the latter "positively light."
2. There are two types of motion: that of heavenly bodies is perfect, circular, unchanging; that of earthly bodies is rectilinear and requires for its maintenance a force acting continually. If the force stops, it stops.
3. Bodies fall in accelerated motion because as the body falls the air gives it speed; hence in a vacuum (if conceivable) bodies would fall with uniform velocity.
4. Heavier bodies fall more quickly than light bodies.

B knew that:

1. All bodies are subject to the force of gravitation and are "heavy."
2. Every body, celestial or terrestrial, continues in its state of rest or of uniform motion in a straight line, unless it be compelled by a force to change its state. Uniform rectilinear motion would thus continue forever unless it met resistance. "Force" is that, by means of which rest or motion of a body is changed.
3. Bodies fall in accelerated motion because of the force of gravitation; air does not accelerate but impedes motion.
4. All bodies fall with uniform acceleration.

Turning from the chapter on dynamics to pneumatics, A could not conceive of the weight of air, or of the creation of a vacuum. "Nature abhors a vacuum" would to him be an axiomatic truth. B would understand the nature of atmospheric presence (Torricelli); its variation in different weather, at varying altitudes: He would have an air pump and know most of the properties of a vacuum (Guericke and Boyle). . . .

In optics, A would know considerably more than in other fields; for ever since Roger Bacon, the focal properties of spherical mirrors had been understood. Maurylocus (1494-1575) had studied lenses. Then Della Porta's book, *Magiae naturalis,* contained a description of the *camera obscura,* even of a combination of lenses which has been claimed to be the first telescope. B, on the other hand, would be acquainted with the most minute details about the focal properties of lenses (Kepler and Descartes); he would comprehend the laws of refraction of rays passing from thinner into thicker medium (Snellius); he would even be initiated into the phenomenon of diffraction (Grimaldi). He would be aware of the nature of white light and its decomposition into the spectral colors (Newton). He would have learned of the two theories of explaining light: the corpuscular theory of Newton (then accepted), and Huygens' and Hooke's theory of undulation (now accepted).

In magnetism and electricity, A would be acquainted only with the magnet and compass and the electric properties of amber. B, although his knowledge would be much less in this than in the other branches of physics, would nevertheless comprehend the phenomena of terrestrial magnetism, magnetic declination and inclination; he also would be aware of other substances besides amber which exhibit electric properties (Gilbert and Guericke).

In no other science did the seventeenth century, starting from so little, reach so far as in physics; no other science records during the century so many pioneer experimenters.

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