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THE HISTORY OF PHYSICS

A Very Short Introduction

OXFORD

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Introduction: the Greek way

The Superconducting Super Collider (SSC), the dream of American high-energy physicists, would have had a circumference of 87 kilometres and a price tag to match. Its proponents justified the expenditure on several grounds. On the high ground, it would probe the universe to philosophical depths and thus 'keep faith with the Greeks'. Below ground, it would advance tunnelling technique and give society perfect sewers. Congress cancelled it in 1993.

The undertaking represented by the SSC might be the way to an ultimate physics. But it is not the Greek way. In antiquity, physics was philosophy, a liberal art, the pursuit of a free man wealthy enough to do what he wished. He did not aim to improve sewers and, since he had no need of public money, did not have to claim that he would. Nor did he want apparatus, since he seldom experimented; or mathematics, since he seldom calculated. The few ancient applications of mathematics to physics constituted a mixed science devoted to the description of phenomena rather than to the search for principles.

In the tripartite division of Greek philosophy, physics stood between logic and ethics. It inquired into the principles regulating the physical world from the high heavens to the Earth's centre, and from the human soul to the life of the least of living creatures.

It thus functioned as a necessary approach to ethics, or the principles of a good life. For two millennia the main practical value of physics lay in the ethical consequences of its versions of the way the world began and persists.

Greek physics, with its eye to ethics, its indifference to mathematics and experiment, and its independence of states and courts, is sufficiently distinct from an enterprise conducted by salaried teams requiring elaborate technologies and mathematical analyses to deserve a different name. Let it be *physica* and those who cultivated it *physici*. This short book describes some of the ways by which ancient *physica* became modern physics. It does not ransack history to find items in ancient and medieval science that look like physics, but sketches the place and purpose of *physica* in the societies that supported it. Hence the primary site(s) of cultivation receive special emphasis: the independent private school (antiquity), court and library (Islam), university (later Middle Ages), court again (Renaissance), academy (late 17th and 18th centuries), university again (modernity), and university-government-industry (postmodernity). Of course, successive forms did not annihilate their predecessors. Academies of science survive, primarily as honorific societies and depositories of history, although a few flourish as national channels for funding, consultation, and outreach. The scientific advisory apparatus of government may be considered the descendant of courtly science; and the Greek schools, with their characteristic discursive style, continue in the myriad seminars in which the world's nascent science is presented and anatomized.

Chapter 1

Invention in antiquity

Tradition follows Aristotle in identifying the earliest *physici* as some gentlemen of Miletus, and in specifying half a dozen other Greek speakers as their successors. In this philo-Hellenic creation myth, no Greek *physicus* learned anything from a barbarian during the 250 years between the times of the eldest Milesian, Thales, and Aristotle. The story that Pythagoras, if he existed, did so partly in Egypt, suggests outside input; and studies of cuneiform texts reveal a natural knowledge among the Babylonians in some ways more advanced than that of the ancient Greeks. Still, the essential criterion that Aristotle used to identify his predecessors was not that they were Greek, but that they had conquered a paralysing prejudice. Despite robust contrary evidence, they believed that the natural world runs on law-like principles discoverable by the human mind and immune from interruption or cancellation by meddling gods and demons.

This bold departure underlies and circumscribes all forms of *physica*, natural philosophy, and physics. Its implications go farther even than replacing caprice by law-like behaviour. Since the gods displayed all too faithfully the behaviour of human beings, de-deifying implied (to speak Greek) de-anthropomorphizing. The progress of physics has continued to remove human quirks and qualities projected onto nature. Thus nature, or the objective world, came to lose not only benevolence, malevolence, and