2 The Scientific Method

The development and establishment of the characteristic methodology of science has always been regarded as constitutive of the Scientific Revolution. A. C. Crombie tried to suggest that at least one major element of that methodology, experimentalism, could be traced back to the thirteenth century [41; 42], but the tide of historiographical consensus is definitely running against him [139: 361]. Similarly, although there were mathematical sciences throughout the medieval period, it is generally acknowledged that the period of the Scientific Revolution saw a dramatic change in conceptions of, and attitudes towards, the mathematical analysis of nature. In this chapter we will consider both of these major components of the scientific method in turn.

(i) The mathematization of the world picture

The 'mathematization of nature' which has been seen as an important element in the Scientific Revolution used to be attributed to a sea-change in the metaphysical system which underwrote all concepts of the physical world, introducing 'Platonic' or 'Pythagorean' ways of looking at the world to replace the Aristotelian metaphysics of medieval natural philosophy. Recent work has shown the inadequacy of this view on a number of grounds and has pointed to an alternative account of changing attitudes to mathematics [107; 12; 238]. To put it simply, the Scientific Revolution saw the replacement of a predominantly instrumentalist attitude to mathematical analysis with a more realist outlook. Instrumentalists believed that mathematically derived theories are put forward merely hypothetically, in order to facilitate mathematical calculations and predictions. Realists,

J. Henry, *The Scientific Revolution and the Origins of Modern Science*

by contrast, insisted that mathematical analysis reveals how things must be; if the calculations work, it must be because the proposed theory is true, or very nearly so [107: 140].

The new realism can be seen at work in the astronomy of Nicolaus Copernicus (1473–1543). Astronomy, one of the so-called 'mixed' sciences, had always consisted of a mathematical and a physical part. Essentially, what this meant was that the astronomer had to reconcile the putative mathematical structures, which provided him with his means of calculating planetary and other heavenly movements, with the demands of Aristotelian cosmology and physics. Although the great synthesizer of ancient Greek mathematical astronomy, Claudius Ptolemy (AD 90–168), was a realist, his astronomical system had been regarded increasingly throughout the Middle Ages as a hypothetical system which, while providing a basis for calculation, was incompatible with the Aristotelian system. The result was a separation of the mathematical and physical parts of astronomy [238].

Where Aristotle's cosmology was a neat homocentric nesting of heavenly spheres in which only uniform circular motion could take place, Ptolemaic mathematical astronomy had planets moving on an epicycle, whose centre inscribes a circle (the deferent) in the body of the planetary sphere, in order to account, partially, for variations in the speed and brightness of the planet, and for its retrograde motion (a period in which the planet moves in the opposite direction to its usual progress). In spite of these devices, the required fit with observations could not be achieved without also assuming that the epicycle moved with uniform motion only with respect to an eccentric point, not with respect to the centre of the deferent, or with respect to the earth. Although such uniform motions around what was called the 'equant' point could be easily defined mathematically, it was by no means clear what kind of physical mechanism could explain such motions. Indeed, it was axiomatic in Aristotelian physics that all heavenly motions were natural, unforced, motions, and that the natural tendency of heavenly bodies was to move uniformly, in perfect circles [135; 43; 60; 168].

Ptolemaic astronomy was also beset with more pragmatic difficulties. Perhaps the most embarrassingly visible of these, by the end of the fifteenth century, was its inability to accurately set a date for Easter. Copernicus was concerned to solve this