About Astronomia Nova

Astronomia Nova is a work of astonishing originality, and it stands, with Copernicus's *De Revolutionibus* and Newton's *Principia,* as one of the founding texts of the scientific revolution. When Kepler boldly chose the words *Astronomia Nova* for his title, he must have had some sense of how apt they were. Although the book is not lacking in historical antecedents (as Kepler himself was keenly aware), it is in most respects quite unlike anything that had appeared before. Astronomy is no longer seen as a deductive science, founded mainly upon geometry, whose aim is to construct an ideal system that matches the appearances of the celestial motions as closely as possible. Instead, it is an adventure in which the human being uses all the means at his disposal to explore the creation in which God has placed him as His image. Error is no longer equated with failure, but is seen as an indication of the way to the truth. Thus the rules of the game are no longer fixed, but are to be discovered in the playing. And so the hypotheses of the ancients, the uniform circular motions previously thought to be indispensable to astronomy, were tested, found wanting, and rejected. The question was no longer "How can the appearances be accounted for?" but "How does God make things move?"

In undertaking to subvert more than two thousand years of astronomical theory and tradition, Kepler knew he had set himself quite a challenge. Had he just presented his principles and theories in magisterial style, in the manner of Copernicus and Ptolemy, he would have appeared to be just another innovator, in the same cast as Bruno and Patrizi, whom he despised. Instead, he chose the profoundly rhetorical approach of taking us through a step-by-step account (heavily edited and dramatized, to be sure) of his "battle with Mars," aimed at convincing us that no conclusion other than his was possible. In the course of his tale, he sprinkles in images from literature and daily life: meat being squeezed in a sausage casing, a chaste maiden walking the streets behind a prostitute, pretzels, battles being fought on many fronts, ferryboats on the Danube, amusement park rides, biblical scenes,

and lines from Horace and Virgil. Clearly, this is no ordinary astronomical treatise!

In the course of this adventure, Kepler shows us that the old geometrical principle of uniformity has to go: it was, he says, a geometrical approximation of a physical principle, according to which planetary speeds are governed by their distance from the sun, the source of driving power. Here we see the origin of what we now know as "Kepler's Second Law," which Kepler soon converts into the more familiar area/time formulation for the sake of easier computation. He then uses this physical principle to explore the shape of Mars's orbit: the planet takes more time over the parts where the distances and areas are greater. This leads to the discovery that the orbit must be squeezed in at the sides: it has to be an oval. But what sort of oval? There was no reason to suppose that it would be some neat curve, such as an ellipse; rather, Kepler expected it to be a complex shape resulting from the independent efforts of the solar whirling force and the planet's own striving towards and away from the sun. In the end, he shows, using both mathematics and physical causes, that the resulting curve could be nothing else but the ellipse itself, a form that had been ready at hand all along.

Kepler is remembered today chiefly for the mathematical laws of planetary motion that bear his name. His idiosyncratic physics has not stood the test of time. Nevertheless, his fundamental idea—one might call it his faith—that planetary astronomy must be based upon physics led ultimately to Newton's great synthesis of terrestrial and celestial motions.