Biographical Encyclopedia of Astronomers

Descartes, René

Born La Haye, (Indre-et-Loire), France, 31 March 1596

Died Stockholm, Sweden, 11 February 1650

Besides his contributions to philosophy (which he completely reshaped), René Descartes produced major results in mathematics (the development of analytic geometry), optics (discovery of the sine law of refraction), and physiology (the discovery of reflex action), and he was a key figure in the development of 17th-century cosmology

Descartes was the third surviving child of Joachim Descartes and Jeanne Brochard. He was educated at the Jesuit College at La Flèche from 1606 to 1614 and studied civil and canon law at the University of Poitiers from 1614 to 1616. After two years in Paris, he joined the army of Prince Maurice of Nassau in 1618, leaving it for that of Maximilian of Bavaria the following year. By this time he had developed an intense interest in mathematics and optics, and after various travels between 1620 and 1625, Descartes settled in Paris, where he worked primarily in optics. At the end of 1628, he left for the Netherlands, where he was to remain for the next 20 years. Early in 1649, Descartes moved to the court of Queen Christina of Sweden

In his *Principles of Philosophy* of 1644 (and in his posthumously published manuscript *The World* of 1663), Descartes formulated the first comprehensive physical heliocentric cosmology; that is to say, he provided the first heliocentric system that accounted for the structure of the cosmos in physical terms. The model he set out was one in which the cosmos contains one kind of matter and no empty spaces. Matter, for Descartes, was purely extension. With no voids, any motion implied that matter would be moved and other matter would immediately replace it. Motion could occur only through contact, so that matter must be pushed. This vision of matter, together with a set of dynamical rules that govern collisions of particles, laid the groundwork for the "mechanical philosophy of nature," in contrast to the Neoplatonism of Johannes Kepler

When God imparted motion to the Universe at the beginning, extension was broken into three forms of matter: a third element, which made up gross bodies; spherical second element particles that filled the interstices of third element matter and the space between stars and planets; and a finer first element that formed the stars and ensured no voids between particles of the other elements. The initial motion in this material plenum caused many circular displacements resulting eventually in huge vortices, carrying planets around stars.

Such a view implied that the Universe must be infinite and that a plurality of worlds was a natural consequence of Descartes's physics. This was a clear break from his contemporaries' thoughts.

Heavier bodies, such as planets, are projected radially outward from the center of the vortices Descartes treated weight as a function of the amount of matter coherent and of the internal motion of its parts, and adopted a notion of centrifugal force whereby heavier bodies are projected radially outward from the center as a direct effect of rotation; the heavier the body, the greater the force acting upon it. However, since this occurs in a plenum, and indeed within a region bounded by several other similar rotating regions, the heavier corpuscles cannot be pushed out indefinitely, but come to reach bands in which the centrifugal forces pushing them onward and the swiftly rotating heavier matter beyond them hold them in stable orbits. Much of the lighter matter is squeezed into the center in the process, and Descartes argued that this lighter matter, because of its very high degree of agitation, is responsible for light and heat. What this means is that these rotating systems have light, hot matter at their centers that, because it rotates, radiates light and heat radially from its surface in all directions. It is what we call a star or a Sun, and each such Sun or star lies at the center of its own Solar System, which takes the form of a vortex.

The next stage after the formation of solar systems is the formation of planets. The surface of the Sun at the center of a vortex can, over time, become occluded by a buildup of less active agglutinated matter, and this phenomenon, familiar in our own Solar System in the form of sunspots, can ultimately lead to the Solar System's insufficient agitation to withstand pressures from contiguous vortices, resulting in the ultimate collapse of that system. When this happens, the occluded star passes into the vortex into which its own has now collapsed, but because it is occluded, it has formed a hard surface around its central core. If the body is massive enough, it will have sufficient force to move from system to system, and it will become a comet Otherwise, it is captured by the vortex into which it has been introduced as a result of the collapse of its own vortex, and it becomes a planet or, more rarely, a satellite. Planets are carried around by the fluid in which they are embedded, the stability of each planetary orbit being ensured by the fact that the planet is only in equilibrium in that orbit and cannot move either away from or toward the center. If the planet were to move away from the center, it would encounter larger, slower particles that would decrease its speed and cause it to fall back toward the center, whereas if it were to move toward the center, it would encounter smaller, faster particles that would augment its force and push it away from the center. Satellites, which have the same density as the planets they orbit but a greater degree of agitation, are carried around the planet in a mini-vortex, whose physical properties are the same as those of full vortices.

Descartes' interest lies in the basic physical principles underlying the structure of the cosmos, and he is not concerned with astronomical detail. He is prepared to allow that planetary orbits might not be perfectly circular, indicating that they might be elliptical because the precise shape of the vortex will be determined by the pressure exerted on it by contiguous vortices, but his concern is not with a true ellipse but rather with a stretched circle that still has only one center. However, Descartes does make some effort to account for discrepancies in planetary speeds

Other things being equal, in Descartes' system the further from the center of the vortex a body is, the more quickly it moves. However, he knew that Mercury revolves more quickly than Saturn. To save the appearances here, he postulates an artificial augmentation of the speed of the globules that fill up the regions between planets and stars in the region between the Sun and Saturn, caused by the rotation of the Sun. This results in those bodies contiguous to its surface rotating more rapidly, accelerating those contiguous to these as well, but to a slightly lesser degree, and so on out to Saturn, where the effect finally peters out.

A second problem is that sunspots move more slowly than any of the planets, which seems to contradict the theory that the Sun rotates so rapidly that it accelerates the fluid surrounding it. Descartes' response to this is to postulate the existence of a solar atmosphere that slows down the spots and extends as far as Mercury

Descartes abandoned plans to publish *The World* on hearing of the condemnation of Galileo Galilei by the Roman Inquisition in 1633, but he reworked his cosmological system in his *Principles of Philosophy*, and extended the vortex theory—which already covered the production and transmission of light, the formation and collapse of solar systems, the formation of planets and their satellites, the stability of planetary orbits, the tides, and the behavior of comets—to provide an account of gravity, magnetism, and (very briefly) static electricity. The aim of the vortex theory at the most general level was to account for all these phenomena purely in terms of contact forces, and its success in this respect appealed to generations of natural philosophers, from his immediate followers such as Jacques Rohault and Pierre Régis, up to Johann Bernoulli, Leonhard Euler, and Bernard de Fontenelle. Isaac Newton went to great trouble in the *Principia*, principally in Book II, to refute the idea that planetary orbits can be accounted for in terms of planets being carried around in fluids, arguing in detail that fluids offered resistance to the motion of bodies.

Stephen Gaukroger

Selected References

Gaukroger, Stephen (1995). *Descartes: An Intellectual Biography*. Oxford: Clarendon Press.

—— (2002). *Descartes' System of Natural Philosophy*. Cambridge: Cambridge University Press.

Rodis-Lewis, Geneviève (1998). *Descartes: His Life and Works*, translated by Jane

Marie Todd. Ithaca, New York: Cornell University Press