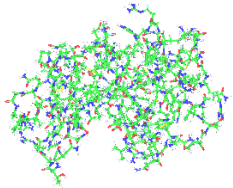
MODELS AND SCIENCE

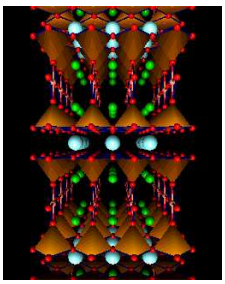
In understanding the complex world in which we live mankind has always needed models. Models allow our minds to safely explore reality; and models scale tiny and huge objects to a size that we can comprehend and become familiar with. Models are therefore essential in the scientific quest for a rational understanding of the physical universe. Visualization is, moreover, an immense aid to the scientific imagination, as it seeks new relationships and connections between concepts and phenomena - the process which is at the heart of scientific discovery.

Models have been used since the beginning of scientific thought, and some of the earliest and most detailed scientific models relate to astronomical observations. The earth centric cosmologies of the ancient world were perfected in the Ptolemaic system of the universe. This highly complex and beautiful structure explains a wide range of observations on the motions of planets and stars. The Ptolemaic system was of course swept away by the Copernican revolution in the 16th century, which produced far simpler heliocentric models for the solar system; these explain astronomical data more straightforwardly and could subsequently be rationalized by Newton's gravitational theory.

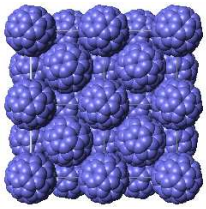


The structure of the enzyme lysozyme.

In astronomy and cosmology, which are among the most enduring scientific grand challenges, models are therefore crucial. 'Global modeling' is also playing an increasingly important role in new sciences that aim to understand how the earth's atmosphere, oceans and interior work. Their role in engineering and applied sciences is obvious, but contemporary technology is expanding enormously their range and sophistication. For example, the complex model of the distribution of pressure over the wings of a fighter aircraft in flight; and detailed and accurate information of this type is, of course, a valuable design tool in the aeronautics industry. Our emphasis is, however, on the role of models in understanding matter at the microscopic level - the world of atoms and molecules - and in revealing the marvellously varied ways in which atoms combine to give structures of immense complexity and beauty; structures that support life like the enzyme lysozyme above whose atomic architecture was first elucidated at The Royal Institution in 1965. And structures which lead to extraordinary and technologically important properties, such as the high temperature superconducting material whose crystal structure is shown below. While the symmetry and elegance of molecular structures is illustrated by the spherical carbon molecules of 'Buckminster Fullerene' materials.



A high temperature superconducting oxide material.



C_{60} 'Buckminsterfullerene'.

Computers and Models