Resonance - Origins and Usage

The word 'resonance' has acquired various shades of meaning as a result of usage in different contexts.

Resonance is an evocative word which is used in several branches of science. The word entered the English language in the 15th century as an acoustic term to describe the reinforcement or prolongation of sound. A passage in a book from 1491 reads:

> *"Marueyllous howlynges and waylyngs ... whereof the resonnaunce or sonne was soo horryble that it semyd it wente vppe to heuen"*

More commonly, the word is associated with music (resonance of a piano or organ) and in a figurative sense with positive qualities. These are evident in the following powerful phrases: *"For the beaute, for the force and for the resonaunce"* (Ordinary Crysten Men, 1502) and in the pious wish: *"So ought our hearts ... to have no other resonance but of good thoughts"* (World of Wonders, 1607).

The meaning of a word changes with the context. Not surprisingly, a word can acquire new shades of meaning when used in different scientific disciplines. The original term 'resonance' refers to the reinforcing effect caused by reflections or more specifically by synchronous vibrations. However, this phenomenon is not restricted to sound waves, since it may be associated with all periodic processes. As is widely known, troops crossing a bridge are asked to break step; any resonance of synchronous marching with the natural vibrations of the bridge can have disastrous consequences. The same term, resonance, is used to describe the condition of an electrical circuit adjusted to allow the greatest flow of current at a certain frequency. Similarly, a radio set must be in resonance to receive music from a radio station.

High energy physicists encounter very short-lived 'particles', which can be thought of as temporary associations of the components which collide to produce them, or even just as a cluster of states of the system bunched near a given energy. Guess what these entities are called? 'Resonances'! The name is not arbitrary; the graph showing how the probability of collision varies with energy is peaked like resonance. In the same spirit, metastable radical anions of a molecule can be associated with a resonant state in which the neutral molecule has momentarily captured an electron with appropriate energy.

In a general sense, systems with nearly the same energy are said to be in resonance when they are coupled. The phenomenon has important consequences in physics and chemistry. Magnetic resonance, Fermi resonance in infrared spectroscopy, Resonance Raman spectroscopy are all famous examples involving different types of oscillators.

Resonance is also a simple bonding concept in chemistry. Many aspects of structures, stabilities, and charge distributions, especially of conjugated organic molecules, can be readily understood by visualising the total electronic structure as a superposition of building blocks of covalent bonds which are in resonance. While alternative bonding models are available, resonance remains the first choice for a large number of chemists. (A detailed article on the concept of resonance in chemistry will appear in a future issue.)

J Chandrasekhar