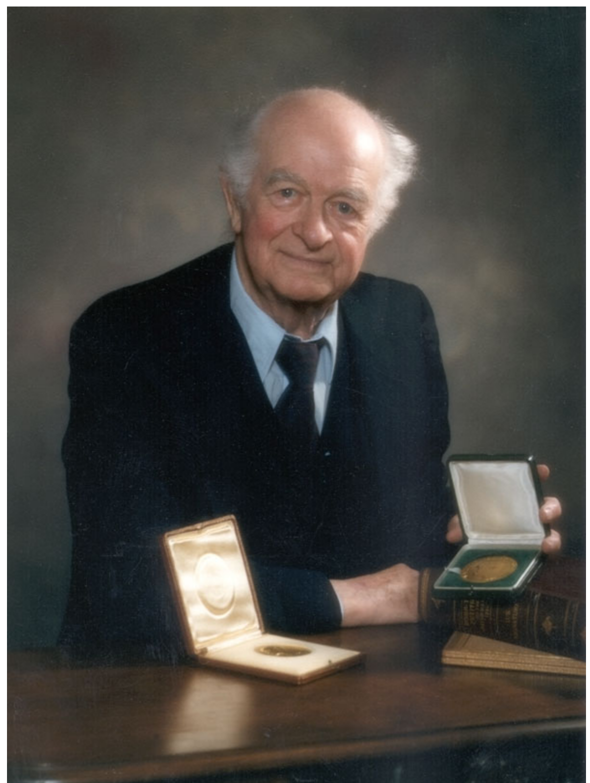
LINUS PAULING

Modern structural chemistry

Nobel Lecture, December 11, 1954



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Harshita Nagar

Frankland in 1852 suggested that an atom of an element has a definite capacity for combining with atoms of other elements - a definite valence. Six years later Kekulé and Couper, independently, introduced the idea of valence bonds between atoms, including bonds between two carbon atoms, and suggested that carbon is quadrivalent. In 1861 Butlerov, making use for the first time of the term "chemical structure", stated clearly that the properties of a compound are determined by its molecular structure, and reflect the way in which atoms are bonded to one another in the molecules of the compound.

The structure theory of inorganic chemistry may be said to have been born only fifty years ago, when Werner, Nobel Laureate in Chemistry in 1913, found that the chemical composition and properties of complex inorganic substances could be explained by assuming that metal atoms often coordinate about themselves a number of atoms different from their valence, usually four atoms at the corners either of a tetrahedron or of a square coplanar with the central atom, or six atoms at the comers of an octahedron. His ideas about the geometry of inorganic complexes were completely verified twenty years later, through the application of the technique of X-ray diffraction.

After the discovery of the electron many efforts were made to develop an electronic theory of the chemical bond. A great contribution was made in 1916 by Gilbert Newton Lewis, who proposed that the chemical bond, such as the single bond between two carbon atoms or a carbon atom and a hydrogen atom represented by a line in the customary structural formula for ethane, consists of a pair of electrons held jointly by the two atoms that are bonded together. Lewis also suggested that atoms tend to assume the electronic configuration of a noble gas, through the sharing of electrons with other atoms or through electron transfer, and that the eight outermost electrons in an atom with a noble-gas electronic structure are arranged tetrahedrally in pairs about the atom. Applications of the theory and additional contributions were made by many chemists, including Irving Langmuir and Nevil Vincent Sidgwick.

After the discovery of quantum mechanics in 1925 it became evident that the quantum mechanical equations constitute a reliable basis for the theory of molecular structure.

These early applications of quantum mechanics to the problem of the nature of the chemical bond made it evident that in general a covalent bond, involving the sharing of a pair of electrons between two atoms, can be formed if two electrons are available (their spins must be opposed, in order that the bond be formed), and if each atom has available a stable electronic orbital for occupancy by the electrons.

Further detailed information about the chemical bond resulted from a consideration of the energy of single bonds in relation to the relative electronegativity of the bonded atoms[3]. It was found that the elements can be assigned electronegativity values such as to permit the rough prediction of the heats of formation of compounds to which chemical structures involving only single bonds are conventionally assigned, and that many of the properties of substances can be discussed in a simple way with the use of the electronegativity values of the elements.

The idea that the properties of many organic compounds, especially the aromatic compounds, cannot be simply correlated with a single valence-bond structure, but require the assignment of a somewhat more complex electronic structure, was developed during the period 1923 to 1926 by a number of chemists, including Lowry, Lapworth, Robinson, and Ingold in England, Lucas in the United States, and Arndt and Eistert in Germany. It was recognized that the properties of aromatic and conjugated molecules can be described by the use of two or more valence-bond structures, as reflected in the names, the theory of mesomerism and the theory of intermediate states, proposed for the new chemical theory. In 1931 Slater, E. Hückel, and others recognized that these theories can be given a quantum mechanical interpretation: an approximate wave function for a molecule of this sort can be set up as the sum of wave functions representing the hypothetical structures corresponding to the individual valence-bond structures. The molecule

The valence theory of metals and intermetallic compounds is still in a rather unsatisfactory state. It is not yet possible to make predictions about the composition and properties of intermetallic compounds with even a small fraction of the assurance with which they can be made about organic compounds and ordinary inorganic compounds. We may, however, hope that there will be significant progress in the attack on this problem during the next few years.

We may, I believe, anticipate that the chemist of the future who is interested in the structure of proteins, nucleic acids, polysaccharides, and other complex substances with high molecular weight will come to rely upon a new structural chemistry, involving precise geometrical relationships among the atoms in the molecules and the rigorous application of the new structural principles, and that great progress will be made, through this technique, in the attack, by chemical methods, on the problems of biology and medicine.

Linus Pauling

ForMemRS

Pauling in the 1940s

Born	Linus Carl Pauling February 28, 1901 Portland, Oregon, U.S.
Died	August 19, 1994 (aged 93) Big Sur, California, U.S.
Education	Oregon State University (BS) California Institute of Technology (PhD)

Signature

Scientific career

Fields	Quantum chemistry Biochemistry
Institutions	*As faculty member* [show] *As fellow* [show]
Thesis	*The Determination with X-Rays of the Structures of Crystals* (1925[3])
Doctoral advisor	Roscoe Dickinson Richard Tolman[1]
Other academic advisors	Arnold Sommerfeld Niels Bohr[2]

Awards	ACS Award in Pure Chemistry (1931) Irving Langmuir Award (1931) Davy Medal (1947) Nobel Prize in Chemistry (1954) Nobel Peace Prize (1962) Roebling Medal (1967) Lenin Peace Prize (1968–1969) National Medal of Science (1974) Lomonosov Gold Medal (1977) NAS Award in Chemical Sciences (1979) Priestley Medal (1984) Vannevar Bush Award (1989)

"I feel sorry for people who don't understand anything about Chemistry.

They are missing an important source of happiness!"

Linus Pauling

thank you