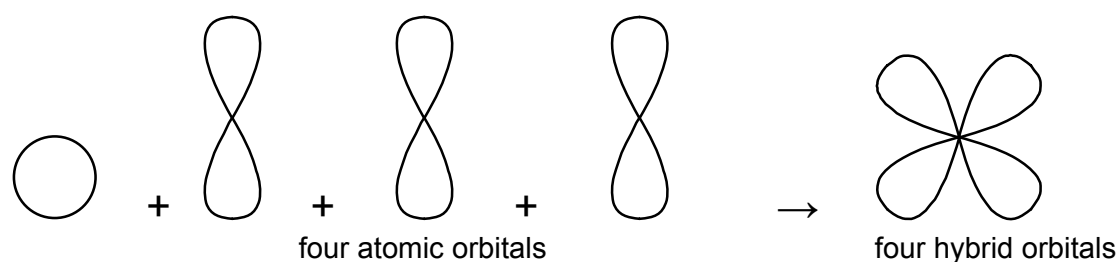


Linus Pauling (1901 – 1994)

Linus Pauling has the unique distinction of winning two *unshared* Nobel Prizes – one for Chemistry in 1954 and one for Peace in 1962. His Chemistry Prize was for improving our understanding of the chemical bond and his Peace Prize was for his campaign against nuclear weapons testing.

Pauling was born in 1901 in Portland, Oregon, in the USA. His father was a pharmacist, so he could be said to have chemistry in his blood. After his degree (in chemical engineering) and a PhD at the California Institute of Science and Technology ('Caltech'), Pauling spent two years in Europe where he met many of the leading scientists working on the then-new fields of atomic and nuclear structure and quantum mechanics, including Niels Bohr, Erwin Schrödinger and William Bragg.

These influences may have led him to the work for which he won the Chemistry Prize. This was a quantum mechanical explanation of why a shared pair of electrons should form a bond between two atoms – something fundamental to the whole of chemistry. He also introduced the idea of hybrid electron orbitals. This explains why carbon (electron arrangement $1s^2, 2s^2, 2p^2$) can form four identical bonds in a compound such as methane, CH_4 . His explanation was that the single $2s$ and the three $2p$ orbitals that made up carbon's 'outer shell' of electrons could mix together to give four equivalent sp^3 orbitals each containing one electron. Each of these orbitals can form a single covalent bond by sharing its single electron with an electron from another atom.



The four so-called hybrid orbitals point to the corners of a tetrahedron, which explains the shape of the methane molecule.

Pauling also developed the concept of electronegativity or 'electron pulling power' of atoms which means that some atomic nuclei attract shared electrons towards themselves more than do others so that certain covalent bonds are polarised. He developed the scale of electronegativity that is named after him. Using this scale, we can predict that in the compound hydrogen fluoride, H-F, fluorine (electronegativity 4) will pull the shared electrons towards itself much more than will hydrogen (electronegativity 2.1 and so the bond will be polarised $\text{H}^{\delta+}-\text{F}^{\delta-}$).

These ideas were explained in his book *The nature of the chemical bond*, published in 1939 and one of the most influential chemistry textbooks ever.

After the Second World War, Pauling turned his scientific attentions to biochemistry and the helical structures of proteins which are held in place by hydrogen bonds. He also began his protest against the testing of nuclear weapons that led to his Nobel Peace Prize. However this was the era of the rabidly anti-communist senator McCarthy and 'reds under the bed'. The US authorities did not take kindly to Pauling's activities and withdrew his passport which meant that he could not attend scientific conferences abroad. His passport was only reinstated so that he could travel to Sweden to collect his Nobel Chemistry Prize.

There is speculation that his inability to travel abroad might possibly affected the outcome of another Nobel Prize. Having worked on the helical structure of proteins, he began to work on DNA, 'the molecule of life' at the same time that the then virtual unknowns Francis Crick, James Watson, Maurice Wilkins and Rosalind Franklin were doing so in England. Pauling proposed a triple helix as a possible structure but it is interesting to speculate whether he might have spotted the correct double helix structure if he had been able to attend a conference in London in 1952 where the latest X-ray diffraction results of DNA were shown. This conference was attended by Crick and Watson who eventually did propose a double helix which led to their 1962 Nobel Prize (which was shared with Wilkins but not Franklin who by then had died). To add piquancy to the story, Pauling's son, Peter, was working for his PhD in the same laboratory as Crick and Watson who were concerned that Linus would win the 'race' to the correct structure. The pair were concerned that Peter might leak clues about their progress to his father but also used him as a source of information on Linus' work.

During the Cold War, Pauling's protests about the bomb brought him to the attention of the general public and one story gives an insight into his character. In 1962, a party was thrown by President Kennedy to honour Nobel prizewinners. Pauling spent the day outside the White House carrying an anti-nuclear testing banner and then in the evening, sat down to an elegant dinner with the Kennedys. Pauling's protests were vindicated when, in 1962, the International Test Ban Treaty was signed.

Later, Pauling became interested in the role of vitamins in nutrition and promoted the view that vitamin C (ascorbic acid) could help to prevent and even cure the common cold.

Linus Pauling continued to work on a range of scientific ideas almost until his death – his last patent being issued when he was 92.