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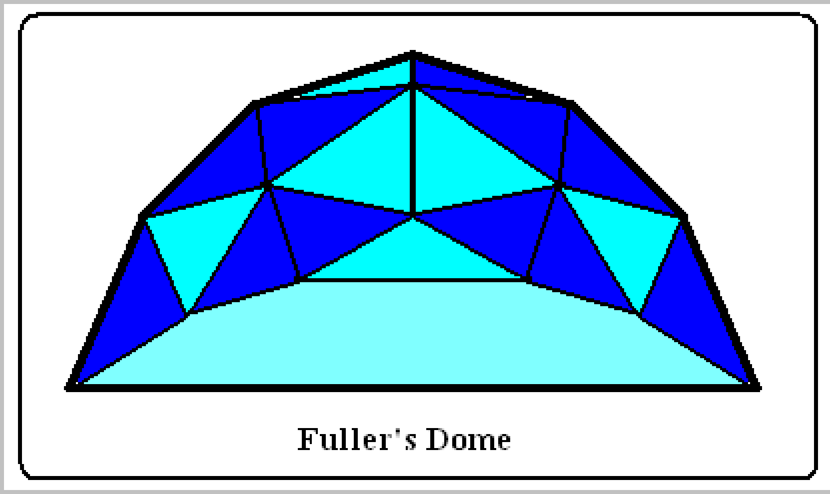
The Calico Dome at nano-scale

Geodesic domes and carbon nanotubes have things in common, says S.Ananthanaryanan.

The Geodesic dome is a nearly spherical structure built of straight members connected along great circles (or geodesics) over a nearly spherical shape. The geodesics intersect to form triangles, and the dome is seen to consist of interconnected triangles.	

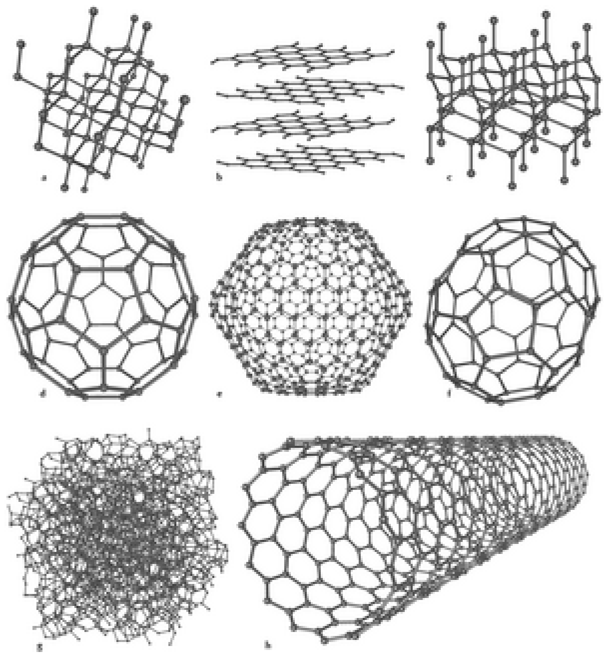
Strength of the structure

The triangles are both rigid as well as distribute the stress over the entire dome. This property makes the geodesic dome one of the strongest structures made from linear elements and actually gets stronger as it gets larger. It also has the highest known ratio of enclosed volume to weight, for structures made of linear members.

The shape was developed in the 1940s by Buckminster Fuller, an American designer, visionary, architect, author. Fuller thought the design may be the answer to the postwar housing crisis and over the years a large number of celebrated ***Bucky Domes*** have come up in many parts of the world.

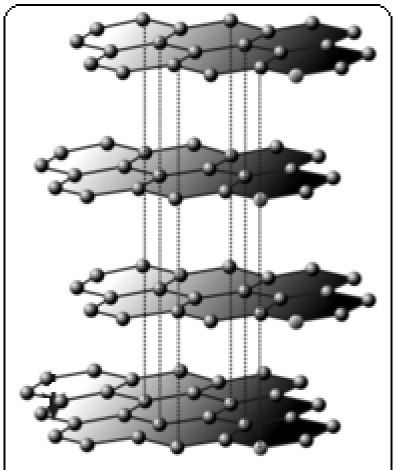
Fullerenes

Buckminster Fuller also lent his name to a class of carbon allotropes, or configurations of carbon atoms. The carbon atom is in a unique class of elements which have 4 outer shell electrons, which is half way between giving all of them up or accepting 4 more, while combining with other atoms, to arrive at the stable, ‘octet’ condition for atoms. Carbon atoms can thus form a variety of bonds with other atoms, including other carbon atoms. Hence the world of ‘organic’ chemicals, which are based on carbon, and also the properties of the forms of solid carbon, like diamond or graphite.



Allotropes of carbon

Fullerenes are allotropes of carbon which were discovered in 1985. They are molecules composed entirely of carbon, which take the form of a hollow sphere, ellipsoid, or a tube. Spherical fullerenes are sometimes called buckyballs, while cylindrical fullerenes are called buckytubes or nanotubes. Because the spherical shapes resemble Fuller’s Bucky Domes, it was thought that the name ***Fullerene*** was appropriate.

 Graphite	Fullerenes are similar in structure to graphite, which consists of sheets of carbon atoms in hexagons. But fullerenes have pentagons and heptagonal rings, which enable them to take shapes like a football or a tube. Fullerenes can form cages to contain other molecules and are the rage in the development on nanotechnology.

Fullerene properties

The special, large-scale mechanical properties of the Fullerene shapes correspond to remarkable electronic and quantum mechanical properties of the carbon molecules in these forms. A fine sheet of graphite, just one atom thick is known as ***graphene***. In graphene, the carbon atoms are arranged in hexagons, each carbon atom linking with 3 others. But because carbon atoms have 4 outer electrons, this leaves one electron to wander – which gives graphene excellent electrical conductivity.

But in graphene, the electrical properties are a class apart. In ordinary semiconductors or conductors, the way conducting electrons are described is like the theory of the billiard ball, where the energy is proportionate to the square of the momentum. But in the honeycomb structure of graphene, the energy is found to be related to the momentum itself, not it's square. This, in fact is the way the energy of 'massless' particles, like photons (ie light) is related to momentum, with the help of Einstein's theory of relativity. The electrons in graphene, in fact move at a speed of nearly a million metres a second, (1/300 of the speed of light).

The phenomenon has led to deep understanding of the quantum mechanical processes involved and holds out promise for carbon based electronic devices.