

Listening to Chemistry

The mystery of cold fusion is based on the mystery of chemistry. Ever since Rutherford showed that the negative and positive charges that make up an atom have a structure in which most of the positive charge is located in a hard nucleus at the center of the atom, there has been the mystery as to what keeps the negatively charged electron matter from falling into and combining with the positive nucleus at its center. After all, the pull of the positively charged nucleus at the center of the electron "cloud" is vastly stronger than the pull of gravitation. Maxwell's theory of electromagnetism says that a moving localized electron charge must continuously lose energy if it is confined within a closed volume like that of an atom. Something else must be going on.

There are two things going on. It turns out that an electron requires more volume to "live in" when its kinetic energy is low than when its kinetic energy is high. Also, when it occupies this volume, there is no room for another electron with the same low energy to be in that same volume. The first of these rules is the so-called Heisenberg uncertainty principle, and the second is Pauli's exclusion principle. Without these two governing principles there would be no atoms, no molecules, and none of us humans trying to figure out the rules. With these rules operating, electrons crowd in as tightly as possible around the positively charge nucleus. Some people think of an atom as mostly empty space, which is true from the point of view of a radioactive decay particle like the alpha particles used by Rutherford in his famous scattering experiments. But if one views things from the electron's point of view, the atom is fully packed with electron matter crowded around the nucleus as tightly as possible.

Chemistry describes the many ways in which electrons can organize themselves to get close to the nucleus. In general, electrons seek to organize themselves so as to create the lowest possible energy arrangement. In molecules, there are multiple nuclei, and when there are more than 2 atoms, there are multiple geometric arrangements that can be formed. The atomic nuclei seek locations such that their combined system of "point-like" nuclei and space-occupying electrons are in the lowest energy configuration. Some geometric arrangements of the atoms can lead to a lower energy than other arrangements of the same atoms. Both are valid molecules, but only one has the lowest energy and is therefore the most stable. The other configurations can be almost as stable and equally useful as long as the geometric changes required to get to a lower energy shape are blocked by a high enough energy barrier.

Returning to atoms, the organized volumes that electrons fill in their attempt to minimize energy for the various atoms of the Periodic Table are called atomic orbitals. Each of these orbitals has its own shape and electron matter density distribution.* These orbitals have names. Figure 1.2,1 on page 9 shows the shape and density distribution of an s -orbital. The electron density distribution is spherical and describes the hydrogen atom. As one moves across the Periodic Table to atoms containing more electrons, the orbital shapes assume surprising form. Once you get to atoms having 5 or more electrons, you encounter the p -orbital. Figure 3.3,1 shows the density distribution of a p -orbital, such as describes the outermost electron of the boron atom.

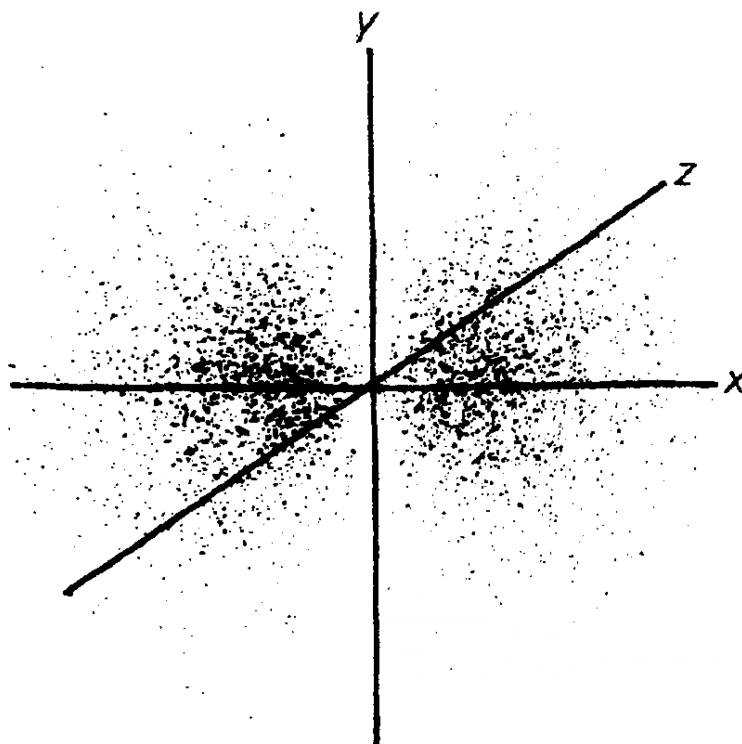


Fig. 3.3,1 The p -orbital of the outermost electron of the boron atom. The orbital is occupied by a single electron. The orbital is best pictured as a distribution of electron density which is partitioned into two halves, and which is continuously and smoothly present throughout the dotted volume. The electron matter is "coherently partitioned", yet behaves as a single entity, which is to say that the separated pieces are "entangled". The sum of pieces is the electron. The electron is best thought of as a quantum-of-mass of electron matter.

* The textbook used by American University is "Chemistry, The Central Science" by Brown, LeMay, and Bursten. It describes orbitals as **probability density** or **electron density** distributions (pp. 231-232). Electron density fits Penrose's "The Road to Reality", as discussed in Chapter 3.8.

The electron density distribution of the boron p -orbital illustrates a key aspect of submicroscopic physics. The p -orbital of the boron atom is occupied by a single electron. The electron density of the single electron is split equally between the two lobes despite the fact that the electron density at the node between the two lobes is zero. Each lobe is occupied by half of a single electron. The electron density of the single electron is split equally between the two lobes despite the fact that the rules of classical physics says this partitioning cannot happen. Each lobe contains half of the electron's matter. The electron is coherently partitioned into two halves. The two halves of the p -orbital are "entangled". This situation exists because the split electron shape minimizes system energy. Mathematically, one must sum over the two density distributions to get what we call an electron. Energy minimization, coherent partitioning, and entanglement are distinguishing features in the physics of cold fusion.

The same split-density distribution situation applies to the carbon atom, which has two p -orbitals, each occupied by a single electron, and nitrogen has three p -orbitals, each occupied by a single electron. In nitrogen the three p -orbitals are oriented along the x , y , and z directions of space (e.g., up-down, north-south, and east-west.).

Chemistry is mostly the chemistry of isolated molecules. The nuclei in the centers of atoms forming molecules can be arranged in an enormous variety of geometric configurations. Some arrangements are very simple, like the straight line geometry of the carbon dioxide molecule CO_2 . Some are in the form of a "ring", like the carbon atoms in the benzene molecule. Some are like the pulled wishbone of a chicken. The water molecule H_2O has this angular form. The 2 legs of the wishbone form an angle of 105° . In each molecule there are some electrons that are shared between 2 or more atoms. These shared electrons are called bonding electrons, or bonds. The bonding electrons are really orbitals, and have their own distinctive density distributions. The bond types and their geometries are an important part of modern chemistry. Their shapes and volumes can be visualized just like the electron matter orbitals of atoms. The bonding volume is densely packed with electron matter, and can be pictured in the same manner as atom orbitals.

