Octet Rule and Space

Ilgaitis Prūsis[1,] Peteris Prūsis[2]

Abstract

In contemporary physics and chemistry Octet rule states that an atomic shell is complete if it has eight electrons. It follows that there are eight basic groups in the periodic table of elements. Attempts to explain why there are exactly 8 groups are unsuccessful. The paper shows that it is determined by the structure of the atomic nucleus. There is a 4-dimensional space in the nucleus of an atom. It follows that a nuclear shell can contain 8 protons according to the Pauli principle. This corresponds to 8 groups in the periodic table. The atom is located in a 3-dimensional space. Therefore, the outer shell (8 electrons) may have 2 subshells *p* (6 electrons) and *s* (2 electrons).

Keywords: physics, chemistry, octet rule, space, atom, nucleus, Periodic table of elements, electron, proton

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01.55.+b General physics; 31.10.+z Theory of electronic structure, electronic transitions, and chemical binding; 21.60.-n Nuclear structure models and methods; 12.10.-g Unified field theories and models

[1] Independent researcher;

[2] Independent researcher

Introduction

Looking at the periodic table [1] of the elements, it can be seen that each period began with a chemically highly active alkali metal and ended with an inert noble gas. There are 8 elements in each period (Fig. 1) that make up the 8 main groups from IA to VIIIA.

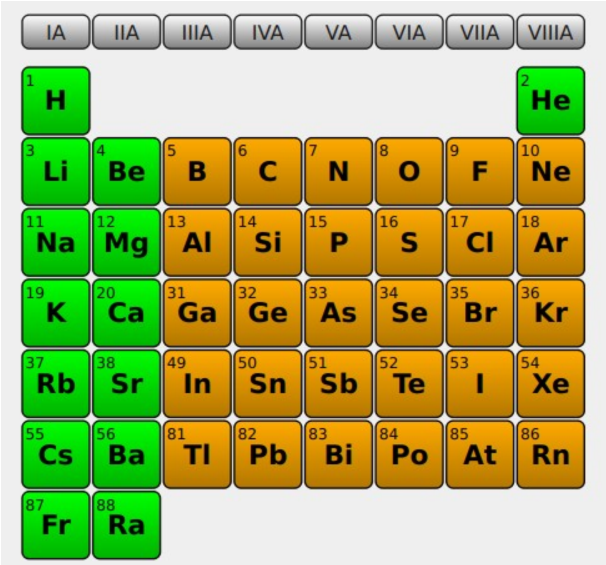
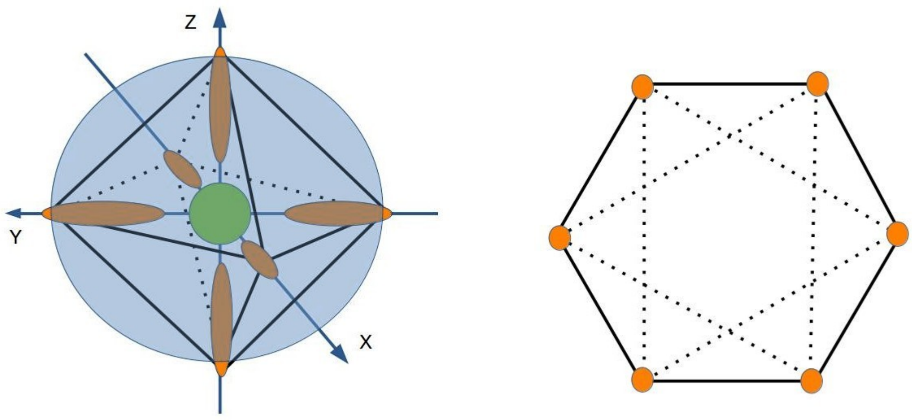


Fig. 1. Short periodic table.
Elements with outer *s* orbitales (green) and *p* orbitales (dark yellow).

A formally simpler geometric figure with 8 vertices is a cube. Therefore, Irving Langmuir (1919) created a cubic atom model [2] with electrons at the vertices of the cube. However, further studies have shown that the outer electron shell of an atom consists of 2 subshells *s* and *p* [3]. In addition, the fulfilled p-subshell consists of 3 mutually orthogonally oriented orbitals corresponding to the axes of the 3-dimensional space. According to Pauli exclusion principle, there can be 2 electrons in each orbital. So a full p-subshell can have 6 electrons. The simplest geometric figure with 6 vertices is an octahedron (Fig. 2).



a b

Fig. 2. Octahedron (a) and its graph (b) with electrons at the vertices.
s – electrons green,
p – electrons dark yellow

Assuming that the structure of the atomic nucleus is similar to the structure of the atom, i.e., the nucleons in the nucleus are arranged in shells [4] and the nuclear space has 4 dimensions [6, 7], the outer shell can have up to 8 protons, i.e., 2 protons in each dimension. Protons in inner shells of nucleus have negligible effect on atomic electrons because their field is shielded by external protons. This explains why the main groups of the periodic table are eight for all periods, why all noble gases (except helium) have eight external electrons.

In a 4-dimensional space, the simplest figure with eight vertices is a hyperoctahedron (Fig. 3.).

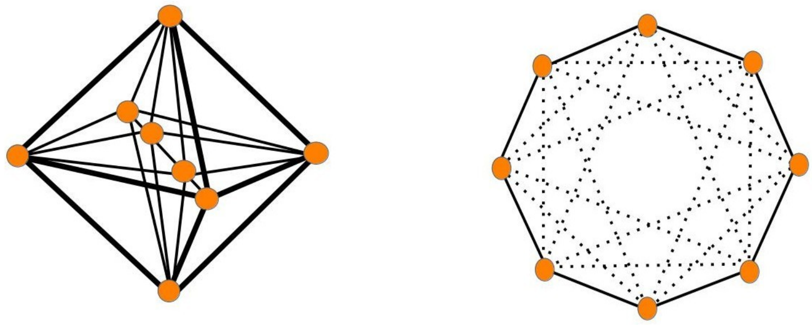


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Fig. 3. Hyperoctahedron (a) and its graph (b).

In a real 4-dimensional space (on the surface of the nucleus), the protons are evenly distributed.

Conclusions

Every day one can see that in our 3-dimensional space there are objects with three (apple), two (sheet of paper) and one dimension (cord). Therefore, it is difficult to imagine that there could be objects with 4 dimensions. A similar situation exists with 3-dimensional objects in 2-dimensional space. They can only exist in a very limited part of space. For example, a bubble in a film of fat on the surface of the soup. The surface of the bubble is a 2-dimensional space, but inside is a 3-dimensional space. When viewed from a 2-dimensional space (film) the bubble will always look like a circle.

The same is true with nucleons, i.e., their surface is 3-dimensional space, inside is 4-dimensional space and looking from our 3-dimensional space we see spheres. They are nucleon projections in our space [5]. In nuclear physics they are called quarks. Each nucleon has 3 projections, i.e., 3 quarks.

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Correspondence and requests for materials should be addressed to I.P. (ilgaitis@gmail.com).