Symmetric cascade distribution of electrons in atoms

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Abstract

Through the spatial state analysis, the symmetrical cascade distribution of electrons in the atom is obtained. This kind of electron distribution can naturally describe the periodicity of elements and the characteristics of each element. The reason for the formation of the common valence of each element can be explained according to the number and state of valence electron orbitals. The rule that the number of electrons in the orbit tends to reach an even number is applicable not only within atoms, but also between atoms, and can uniformly explain the general process of binding between atoms.

Introduction

How the electrons in the atom are distributed outside the nucleus is a question of interest to both the physics and chemistry circles. With the development of aufbau principle and incompatibility principle, shell theory has gradually become a major theory. Electrons move in a series of shells, and electrons are gradually filled from low-energy orbitals to high-energy orbitals.

There are many challenges to the shell structure theory and the Madelung rule, which are not consistent with many experimental phenomena. In 1969, on the 100th anniversary of the periodic table, chemist Per-Olov Löwdin declared this derivation to be one of chemistry's major theoretical challenges¹. Even 150 years on, theoretical chemists, physicists and philosophers still need to step in to comprehend the gestalt of the periodic table and its underlying physical explanation².

Because the multi-electron distribution in the atom involves many-body problems, the accurate solution can't be obtained by solving the equation. From the point of view of spatial geometry, we construct the nuclear structure model based on the principle of dynamic symmetric equilibrium. Through the correspondence between electrons and protons, we obtain the dynamically symmetrical and cascading electron distribution. This electronic configuration corresponds very well to the periodicity of the elements and the properties of each element.

In this model, the electrons of each element are divided into three parts, both sides and the middle. The number of electrons and orbitals on both sides are the same and the electrons are symmetrically distributed. The parity of the ordinal number of elements is mainly reflected in the middle, and there is a single electron orbit in the middle of the element with odd ordinal number. As shown in Fig. 1, the electron distribution of the first 20 elements.

In Fig. 1, orbitals are divided into two categories, which are divided according to the number of electrons in the orbitals. The number of electrons in the orbit is even, which belongs to the stable orbit, in which the electrons belong to the stable electrons. In the picture, it is represented by a black loop and a ball, respectively. When there are only one or three electrons in the orbit, they belong to the valence electron orbit, and the electrons in the orbit are valence electrons, which are represented by red rings and balls, respectively.

The electron orbitals of elements 1–4 are on an axis. Starting from element 5, it distributes into three-dimensional space, and five electrons of element B form five valence electron orbitals. With the increase of the number of electrons, the new electrons gradually enter the original orbitals or merge orbitals, and the number of valence electron orbitals decreases gradually. Elements 6 to 10 have 4, 3, 2, 1 and 0 valence electron orbitals, respectively. Starting from element 7 N, the electron orbitals on both sides of element 7 and 8 are fused together. There are three electrons in the orbitals on both sides of element 7 and 8, and there are four same orbitals in elements 9, 10, 11, 12, 13 and 15. Elements 17, 18, 19 and 20 all have four electron pairs in the same layer. It can be seen that the number of electrons in the orbit tends to reach an even number.

Valence electron orbitals can merge, in which electrons can be transferred or deviated. Electrons transfer or shift from the position of high potential energy to the position of low potential energy, and the orbitals with basically the same potential energy merge into a new orbit. In this way, we can analyze the gain and loss of electrons in each element from the number and state of valence electron orbitals, and explain the reasons for the existence of common valence of each element. For example, the O atom has three orbitals, and the middle is a stable orbital, which does not need to add or subtract electrons. The orbitals on both sides need to get an electron from other atoms in order to stabilize the state. Therefore, this electron distribution of O corresponds to the usual valence-2 of O.

The atoms of alkali metal elements and alkaline earth metal elements are all valence electron orbitals with high potential energy, in which the electrons are easy to be lost, so their valence is usually + 1 and + 2, respectively.

Halogen elements have only one valence electron orbital with low potential energy in the atom, so it is easy to obtain one electron, and their valence is usually-1. The valence electron orbital potential energy of these elements is consistent, so the corresponding valence is relatively simple. They often make the number of electrons in the orbit even by means of electron transfer.

The potential energy of the four valence electron orbitals of C and Si atoms is the same, and the potential energy state is in the middle, in which the electrons are neither easy to lose nor easy to get other electrons. Generally, when combined with other valence electron orbitals, the number of electrons reaches an even number and forms new orbitals, and the probability of electrons appearing in the position of relatively low potential energy is relatively high. Therefore, their valence is usually-4 and + 4.

There are valence electron orbitals with different potential energies in the atoms of elements B, N, Al, P and S, and there are many ways to gain and lose electrons. Therefore, they have multiple common valences.

The number of valence electron orbitals of B and Al is 5, and there is one low potential energy valence electron orbital in the middle, which can absorb one electron from four adjacent high potential energy valence electron orbitals. Therefore, B and Al usually show the state of three high potential energy valence electron orbitals, and their valence is usually + 3. The state of more valence electron orbitals can

also be shown in certain cases, for example, after one electron of Na atom is obtained in the middle of B and Al in NaBH_4 , $\text{NaAl}(\text{OH})_4$, the four valence electron orbitals bind to four H and OH respectively.

P has seven valence electron orbitals, one low potential energy valence electron orbit in the middle, four symmetrically distributed high potential energy valence electron orbitals, and two valence electron orbitals with lower potential energy at both ends. The number and state of the orbitals in the middle are similar to those of Al, in which the low potential energy orbitals obtain one electron from four high potential energy orbitals, showing the state of five valence electron orbitals. For example, in the PF_5 molecule, three valence electrons in the middle and two electrons at both ends are transferred to five fluorine atoms to form a triangular bipyramidal structure, and the valence of P is + 5. When the electrons with higher potential energy enter the low potential energy orbitals in the middle, the four symmetrically distributed high potential electrons can also be in equilibrium. For example, in the PH_3 molecule, the valence electron orbitals in the middle and at both ends get electrons from the H atom to form stable orbitals, and the P atom gets three electrons with a valence of -3. It can be seen that the level of orbital potential energy is a relative concept.

There are two valence electron orbitals in the N atom. There are three electrons in each of the valence electron orbitals on both sides. There is only one electron in the valence electron orbit in the middle. The two sides combine electrons in the way of $3 + 1$, and the middle combine electrons in the way of $1 + 1$, so that the number of electrons in the orbit reaches an even number. They not only have different potential energy states, but also have different binding modes with other valence electron orbitals. Therefore, N shows a variety of states of gain and loss of electrons and has multiple valence. Electrons can be obtained from three valence electron orbitals, for example, the valence of NH_3 , N is -3. Each of the three valence electron orbitals can lose one electron, for example, the valence of NF_3 , N is + 3. Although there are three electrons on each side of the orbitals of N and O, the states of the orbitals are quite different. The three electrons in N orbitals have partial single electron properties and their potential energy is higher than that of O. For example, in HNO_3 molecules, the electrons in the valence electron orbitals on both sides of N move to O atoms; the valence electron orbitals in the middle of N absorb one electron of H atom, where the valence of N is + 5.

The motion space of the three single electrons on each side of the S atom is not in the same space layer, and only a small part of the motion region of the top one single electron is connected to the adjacent two single electrons. Therefore, it is often shown as 6 valence electron orbitals, and + 6 valence is the common valence of S. The potential energy of the valence electron orbitals at the top is lower than that of the valence electron orbitals on both sides, and it is easy to obtain electrons, and S can also have -2 valence. For example, in H_2S molecules, the orbitals at each end of S absorb an electron from an H atom.

The state of the valence electron orbitals in the atom determines the expression of the valence of the elements. When the orbital states are consistent, the common valence of the elements is usually relatively simple. The atoms of elements have valence electron orbitals with different potential energy and different

orbital binding modes, so there are many ways to combine with other atoms, and the valence of elements will be more.

The gain and loss of interatomic electrons can be obtained from the number, potential energy and binding mode of valence electron orbitals, which has a natural corresponding relationship with the main valence of elements.

This electronic configuration has the following characteristics: 1. The symmetrical cascading distribution of electrons, and the electrons in the same layer tend to form a symmetrical distribution of four electrons or four pairs of electrons. 2. Electrons tend to move in low potential energy orbitals. 3. The number of electrons in the orbit tends to reach an even number, which is the basic rule for increasing and decreasing electrons in the orbit. It is applicable both within and between atoms and has consistency.

Results And Discussion

The cascading distribution structure of electrons can not only describe the electron distribution of each element, but also explain the gain and loss between atoms naturally. The valence electron orbitals tend to reach an even number, which is consistent both within and between atoms. Compared with the shell structure, the cascade distribution structure of electrons has the following characteristics:

First, the relationship between electrons can be better described.

The interaction between charges is inversely proportional to the square of the distance. The distance between electrons is smaller than that between electrons and protons, and the interaction between electrons can't be ignored. Considering the interaction between electrons, it is impossible for electrons to maintain the same distribution shape in each shell. For example, the range of motion of several S-layer electrons can't all remain spherical. Therefore, the stabilization mechanism of electron-electron equilibrium in atoms needs to be considered.

The electrons are symmetrically distributed in the orbit, each layer is symmetrically distributed, and the layers are added together according to the order. The interaction of electrons in each layer reaches a state of equilibrium, the interaction between the layers is small, and the electrons can move in a relatively fixed space. In our model, when electrons form a symmetrically distributed structure of four electron pairs, they are fixed and become the basis of the electron distribution of the elements in the next cycle.

In this cascading model, the interaction between electrons is fully taken into account, and it is impossible to have a completely overlapping orbital distribution in the radial direction. Even in the middle of the electron, the radial distributions of the high and low potential energy orbitals are different. For example, for the electrons in the middle of Na and K atoms, the outer high potential energy orbitals are in the middle, while the internal low potential energy electrons are separated on both sides. Therefore, we think that whether the motion space of electrons can overlap in the radial direction is worth thinking about, and whether the electrons are distributed in the way of shell or cascading is worth discussing repeatedly.

Second, it can better explain the periodicity of elements and the differences of chemical properties among elements of the same group.

This model can not only explain the periodicity of elements, but also explain why some families of the same family elements are very similar and why some families are very different. The electrons in the atom tend to form the same layer symmetry of four electrons and four electron pairs, especially the distribution of the symmetrical four electron pairs is the most stable distribution structure. With the increase of the number of elements and the increase of the number of electrons in the periphery of the atom, other electrons can only be symmetrically distributed on the basis of it, and then gradually form the same structure. these structural barriers add up to form the basic structure of the electronic configuration. The electronic configurations of Kr and Xe can be regarded as one-layer and two-layer similar structures superimposed on the basis of Ar, respectively. The formation process of each saturated structure is the formation process of an element cycle.

The chemical properties of halogen group elements, inert gas elements, alkali metal elements and alkaline earth metal elements are basically the same. The position and state of their valence electron orbitals are basically unchanged, only adding equilibrium and stable orbitals.

The number, position and state of valence electron orbitals among other elements of the same group have changed, and the corresponding chemical properties are quite different. For example, according to the difference between the same family element B and Al, the five valence electron orbitals of element 5 B are distributed in space, the four valence electron orbitals around element B are tetrahedral, and the five valence electron orbitals of element 13 Al are in the same space layer. There are great differences in the position and state of valence electrons between them, which lead to many differences in physical and chemical properties between them.

Conclusion

By the way of reverse reduction, the electronic configurations of symmetrical and cascaded elements 1–20 are obtained according to the method that electrons correspond to protons. It can naturally describe the relationship between electrons, the periodicity of elements and the characteristics of elements. In this model, the symmetrical distribution of four electrons or four electron pairs in the same layer is a relatively stable structure, which becomes the basic structure of the following elements. The number of electrons in the orbit tends to reach the rule of even number, which is applicable not only within atoms but also between atoms, showing the unity and continuity of the rules. The number and state of valence electron orbitals determine the gain and loss of electrons of the element, which is basically consistent with the valence state of the element.

Methods

The distribution model of electrons is a part of the whole material system model, which is obtained according to the way corresponding to the protons in the nucleus. The distribution of protons mainly refers to the cluster nucleus structure model. Many experimental phenomena show that clusters of two protons and two neutrons, namely a cluster, are easily formed in the nucleus. Kiyomi.Ikeda systematically collated this information in 1968 and gave an intuitive image 3. Recently, Bo Zhou and Zhongzhou Ren research group studied $^{20}\text{Ne}_4$; Yang Z H, Ye Y L research group studied $^{12}\text{Be}_5$; W, B, He, Y, G, Ma research group studied ^{12}C and $^{16}\text{O}_6$. These studies show that nucleons tend to form a cluster, that is, $2\text{P}2\text{N}$.

According to the characteristic that nucleons are easy to form clusters, we construct a symmetrically cascaded nuclear structure in the way of symmetric dynamic equilibrium of nucleons. Protons have a relatively fixed range of motion in stable nuclides, and we get the position of electron distribution according to the way that the range of motion of electrons corresponds to protons. The electron has a larger degree of freedom than the proton, and the closely adjacent electron motion space is fused. As long as there are three or more electrons in the same layer, their ranges of motion will converge. For example, the three electrons on each side of N and O are in the same orbit. F and the four electrons on each side of Ne are in the same orbit. The concept of orbit in the moving space of electrons is simplified, and the cascading distribution structure of electrons is obtained.

Declarations

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Figures

The symmetrical cascade configuration of the electrons of element 1-12

Figure 1

electron distribution and orbital states of elements 1 to 12

The symmetrical cascade configuration of the electrons of element 13-20

Figure 2

electron distribution and orbital states of elements 13 to 20

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