

Atomic Structure

The Structure and the Cause-Mechanism of Energy Levels of Quantized Atoms

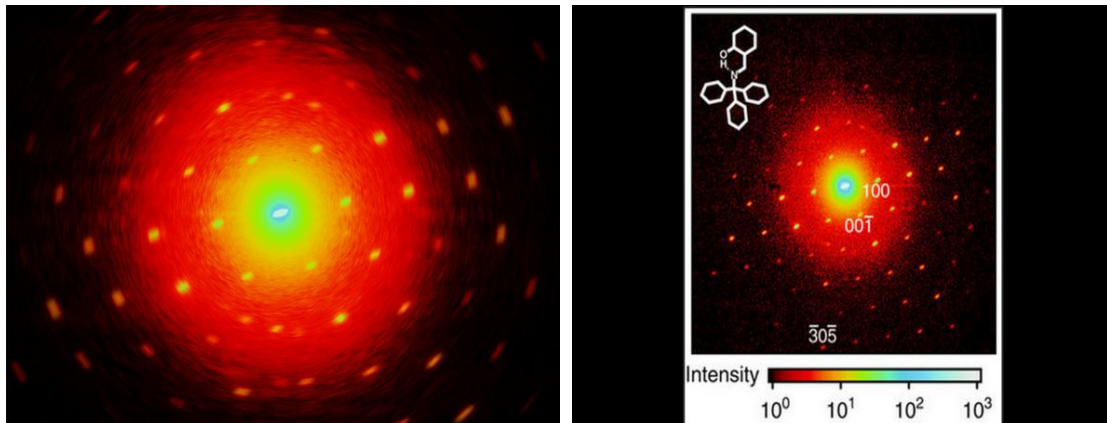
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Abstract: this article shows the atomic structure that has been proved by the related and independent experiments; Base on and combine with the atomic structure, give and show the causes and mechanism of the quantization of atomic energy levels.

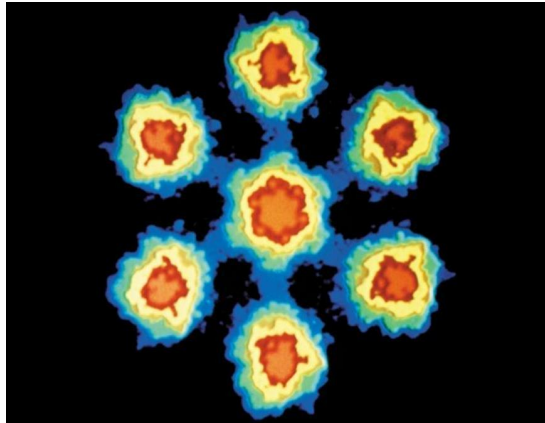
Atom, from the *Greek* word *atomos* which was first conceived around 2,400 years ago by a *Greek* man named *Democritus*, and it's means is indivisible. Atoms is the smallest constituent unit of ordinary matter that has the properties of a chemical element; even every solid, liquid and gas is composed of neutral or ionized atoms.^[1]

Every atom is composed of a nucleus and one or more electrons being bounding together by the electric field (isn't electromagnetic field);^[1] and, the nucleus has positive electric charges, every electron has a unit negative electric charge.



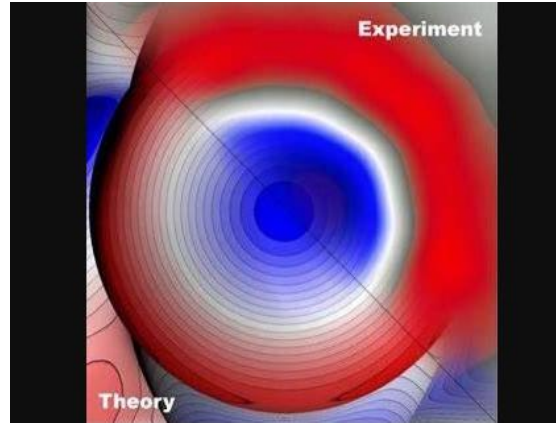
If ultrashort electron pulses hit a bimolecular crystal, they are diffracted from it. As a result, one obtains a characteristic diffraction image of the atomic structure. Credit: Graphic: Alexander Gliserin^[11]

Within an atom, further and however, the all electrons that the all extranuclear electric charges is a continuous viscous fluid, also is one kind of soft-matter which has the same and consistent of negatively charged ingredient; is a unified and complete whole with a single basic composition and structure, existing in and fulling completely the space which outside the nucleus of the atom; under the thermal energy effects, and by the mutual electromagnetic interaction with the nucleus and others related, Formed: the nucleus is the sphere center of atoms; different distribution of volume extranuclear electric charge densities, energy levels at and in the discrete states(energy levels quantized); from higher to lower since the inner to the outer; and with a concentric and multi-layer spherical pattern of volume extranuclear electric charge densities distribution structure and energy levels existence form.^{[2][3][4][5][6][7][8][9][10][11][12][13]}



Scanning transmission electron microscopy image of the hexagonal arrangement of the uranium atoms in a solution of uranyl acetate.

Credit: Mitsuo Ohtsuki/SPL^[12]



Researchers have, for the first time, directly imaged a Sigma-hole, an anisotropic pattern in the electron charge distribution that surrounds certain atoms.

Credit: T. Bellon/OCB Prague^[13]

Moreover, the energy and energy levels distribution state of atoms is mainly referring to the energy and energy levels distribution state of the all electrons of atoms – the all extranuclear electric charges of atoms which is one kind substance of *Bosons*.^[14]

Inside atoms, all extranuclear electric charges as a whole and forming a sort of *Hilbert spaces* which could be infinitely discretized and quantized in theory; the all electric charges existing in the mass density distribution state with a concentric and multilayer spherical pattern; the mass density ρ (divergences) is a function of the charges amount, temperature, pressure and electromagnetic strength, and $\rho = F(Q, T, P, E, B)$.^{[15][16][17]}

By $E = mc^2$ and $E/V = mc^2/V = \rho c^2$, and there be $\rho c^2 = hv$ (or there be a more profound relationship exists and at $E = f(m \sim x)$ and $v = g(\rho \sim y)$), and these physical meanings shows us the relationship of the energy density ρc^2 or the energy level hv that corresponding with to the mass density ρ (divergence) of a material system or a space area.

Within atomic systems that not at *Bose-Einstein condensate*, since the unit volume mass (mass density ρ ; divergences) of any two distinct extranuclear electric charges layers are different, the conclusion could be obtained that *the energy which contained in every unit volumes* (energy density ρc^2 or called as energy level hv) of any two distinct extranuclear electric charges layers are also different; and the normal frequencies (natural frequencies) ν of any two distinct extranuclear electric charges layers are all different from each other.

Further, the energy density (energy level) not only is the quantity and share of the energy which contained or combined in the unit volume of the matter, is also the quantity and share of the matter which contained or combined in the unit volume or called as the unit space. Same time, the mass density of the matter is proportional to its energy density (energy level), and the mass density of the matter is the characterization and the manifestation of its energy density states or energy level states.

In physics, the energy levels is quantized or said as quantization, means that the mass densities and energy densities (energy levels) of a material system or a space area is at a discrete and non-identical state – has nonuniform mass densities and nonuniform energy densities (energy levels); corresponding, a material system or a space area would be at an identical and energy level non-quantized state if the mass density and the energy density (energy level) both are identical and consistent in any unit space volumes and any measure scales.

An important physical fact which needs to be clear that the energy and the matter are can't mutual transformation. The matter is the carrier and habitat of the energy, is also the result of the effect and gather of the energy; and the energy is the guarantee and support of the matter can exist and keeping its density, is also the reason and driving force of the evolutions, phase transitions, and engender physical or chemical variations of the matter.

For instance, after a polyatomic system reached its *Bose-Einstein condensate* through the first-order and second-order of quantum phase transitions by loses the thermal energy and reduces the temperatures continues (*temperature – the scale and metric of the thermal energy density of a matter system*), then, the all atoms in the system would also reached an identical and consistent state, and the all extranuclear electric charges which one kind of *Bosons* is forming an unified and complete whole that in an exactly the same mass density, and no any cracks or electron-holes inside; the mass density and the energy density (energy level) of the polyatomic system is also at an identical and consistent state which its lowest – the ground state, in the state, the all extranuclear electric charges is a mass density non-discretization system; is also an energy level non-quantization system. On the contrary, after obtained the thermal energy and temperature rose continue and enough, the all extranuclear electric charges of this polyatomic system would return into the normal state which the mass densities discretized (non-identical state that has multivariate mass densities) and the energy levels quantized (non-identical state that has multivariate energy levels, or said the system in a multivariate quantum state). And, there only existences the increase and decrease of the thermal energy, as well as the variations of the matter states and the mass densities; but no any increase and decrease of the ingredients and mass of the matter in the process. ^{[18][19][20]}

Overall and in short, the natural world is composed of the matter (elementary particles and their composite particles) and the energy (thermal energy. and the essence of light is thermal energy; light is the existence, agglomeration and excitation of thermal energy in medium; it is the self-existence of heat energy manifested through the medium; is the mutual expression and co-presentation between the heat energy and the medium), under the controls of the thermal energy and the auxiliary roles of the other effects such as electromagnetic effect, the all material systems and natural world forming a non-identical and nonuniform distribution state which has multivariate mass densities and energy levels; the mass densities are discretized and the energy levels (energy densities) are quantized is the existence state, is also one of the basic properties of the natural world.

Besides, although the mass densities and the energy densities (energy levels) of the all material systems and the whole space area are discretized and quantized, however, the absorption and emission of energy is continuous within the all and every existing and defining energy levels of the all material systems and the whole space area.^[21]

With regard to all atomic systems, in particular, at their *Bose-Einstein condensates*, the extranuclear electric charge of an atom or a polyatomic system forming an unified and complete whole body that has no any cracks or electron-holes inside, and has an exactly the same mass density as well as an identical and consistent energy level; at the normal state, under the controls of thermal energy and the auxiliary roles of electromagnetic effect, the all extranuclear electric charges of the atom forming a non-identical and nonuniform distribution state which has multivariate mass densities, as well as a non-identical and nonuniform state which has multivariate energy levels - forming $k(\geq 2)$ matter layers that the mass densities and the energy densities are different from each other at a concentric and multilayer spherical pattern. Based on them, some conclusions would be obtained as following:

1. M is the total mass of the all extranuclear electric charges of an atom; Q is the total amount of the all extranuclear electric charges of the atom; V_o is the total volume of the all extranuclear electric charges in its *Bose-Einstein condensate*(ground state), ρ_o is the mass density of the extranuclear electric charges in the ground state, ν_o is its normal frequency(natural frequency) in the ground state, and $\rho_o c^2 = h\nu_o$ is its energy density and energy level in the ground state, E_o is its total energy in the ground state, and there be $E_o = \rho_o c^2 V_o = h\nu_o V_o = Mc^2$, the energy level of the all extranuclear electric charges of the atom in the ground state is an identical at $\rho_o c^2 (h\nu_o)$ and is non-quantized.
2. M_i is the mass of the i -th electric charges layer; Q_i is the electric charges amount of the i -th electric charges layer; V_i is the volume of the i -th electric charges layer; ρ_i is the mass density of the i -th electric charges layer; ν_i is the normal frequency (natural frequency) of the i -th electric charges layer; and $i = 1, 2, \dots, k$.
3. E_{io} is the energy density or energy level of i -th extranuclear electric charges layer, and there be $E_{io} = \rho_i c^2 = h\nu_i$; and $i = 1, 2, \dots, k$.
4. E_i is the energy of i -th extranuclear electric charges layer in the normal state, and then there be $E_i = M_i c^2 = \rho_i c^2 V_i = h\nu_i V_i$; and $i = 1, 2, \dots, k$.
5. E is the total energy of the all extranuclear electric charges of the atom in the normal state, then there be

$$E = E_1 + E_2 + \dots + E_k = h\nu_1 V_1 + h\nu_2 V_2 + \dots + h\nu_k V_k = \rho_1 c^2 V_1 + \rho_2 c^2 V_2 + \dots + \rho_k c^2 V_k = Mc^2.$$

$$E = Mc^2 = E_o = \rho_o c^2 V_o = h\nu_o V_o; \quad M_i = \rho_i V_i; \quad 0 < M_i < M, \quad 0 < Q_i < Q, \quad 0 < V_i < V_o;$$

$$M_1 + M_2 + \dots + M_k = M, \quad Q_1 + Q_2 + \dots + Q_k = Q, \quad V_1 + V_2 + \dots + V_k < V_o;$$

$$\rho_i > \rho_o, \quad \nu_i > \nu_o, \quad \rho_i c^2 (h\nu_i) > \rho_o c^2 (h\nu_o); \quad \text{and } i = 1, 2, \dots, k.$$

(Remark: since this article mainly discusses for the atomic basic structure, in order to reach the clear and brevity, thus, the gradient of mass density and the fine even the hyperfine structure of every charges layers have been not discussed in here)

These above results shows that increase external energy can't change the innate energy of the all extranuclear electric charges, but can changes the distribution states of the mass densities and energy densities of the all extranuclear electric charges – making the all extranuclear electric charge is separated from a single complete and density consistent state into a concentric and multilayer pattern which having different mass densities and different energy densities; this is made the extranuclear electric charges into the state which matter distribution diversification, mass densities are discretized and energy levels are quantized, and their degrees of quantities and levels both are proportional and synchronous to the intensity and level of the external energy. ^{[15][22]}

Same time, every extranuclear electric charges layer, forming a fundamental field; k electric charges layers formed k fundamental fields. All particles produced from the same electric charges layer are identical particles which their energy levels are all $E_{i0} = hv_i$ and $i=1,2,\dots,k$; or is an identical energy flow which its energy level is $E_{i0} = hv_i$ and $i=1,2,\dots,k$.

Every extranuclear electric charges layer uniquely corresponds to one spectral line; k electric charges layers correspond to k spectral lines, and the frequency of the spectral line which corresponds to i -th electric charges layer is ν_i and $i=1,2,\dots,k$.

On the contrary, if there be k spectral lines, should corresponding to be the existence of k different electric charges layers; if the frequency of a spectral line is ν_i , then, the electric charges layer which corresponding and emitting to the spectral line should be i -th electric charges layer and its normal frequency (natural frequency) is ν_i and $i=1,2,\dots,k$.

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