QGD States of Atomic Electrons

In this section, we show how the energy states of atomic electrons follow naturally from the laws of momentum.

For simplicity, we will describe of the energy states of the electron of hydrogen atom system but the same principles apply to complex atomic systems.

A ground state of an atomic electron is the state of equilibrium between the extrinsic forces acting on it. For hydrogen, which consists only of a proton and an electron, the extrinsic forces are the forces between them that act on the electron. For more complex elements, the extrinsic forces are produced by the interactions of a given electron, the other electrons and the components of the nucleus. And as we will see, each of the electrons has a ground state that is dependent on the ground states of all the other electrons.

At ground state $\sum_{i=1}^{n_{e^-}} \vec{F}_i = \vec{0}$ where the i indexes the n_a extrinsic forces acting on e^-. These forces are either gravitational (which QGD's equation for gravitational interactions predicts must be over a hundred orders of magnitude greater at the atomic scale than at cosmic scale) or electromagnetic which is actually the resulting effect of the interactions between charges particles and the free $preons^{(+)}$ which as we have seen earlier for the magnetic field.

The third law of momentum dictates that permitted changes in momentum of any particle or structure a is proportional to its mass. That is: $\left\|\Delta\vec{P}_a\right\| = \alpha m_a$ or for an electron $\left\|\Delta\vec{P}_{e^-}\right\| = \alpha m_{e^-}$. where $\alpha \in N^+$.

Let δ_0 denote the ground state of the electron of a hydrogen atom and γ_0 be a photon such that $\left\|\vec{P}_{\gamma_0}\right\| = m_{e^-_{\delta_0}}$. The electron $e^-_{\delta_0}$ can absorb γ_0 since it imparts a change in momentum that respects the third law; that is: $\left\|\vec{P}_{\gamma_0}\right\| = \left\|\Delta\vec{P}_{e^-}\right\| = \alpha m_{e^-}$ where $\alpha = 1$. After absorption of the photon, the electron's momentum has changed from state δ_0 to state δ_1. The momentum vector, mass and energy of the electron in δ_1 states are respectively $\vec{P}_{e^-_{\delta_1}} = \vec{P}_{e^-_{\delta_0}} + \vec{P}_{\gamma_0}$,

$m_{e^-_{\delta_1}} = m_{e^-_{\delta_0}} + m_{\gamma_0}$ and $E_{e^-_{\delta_1}} = E_{e^-_{\delta_0}} + E_{\gamma_0} = \left(m_{e^-_{\delta_0}} + m_{\gamma_0}\right)c$.

The change in the momentum vector also changes the distance between the electron and the proton so that $\sum_{i=1}^{n_{e^-_{\delta_1}}} \vec{F}_i = \vec{F}_{\delta_1} = -\underset{\delta_0\to\delta_1}{\overrightarrow{\Delta P}}$. So if there is no other force acting on $e^-_{\delta_1}$, it will be pushed back to its δ_0 state and it can be on this state of equilibrium by respecting by emitting a photon which momentum is equal to the difference in momentum between the two states. That is

$\vec{P}_{\gamma'_{emit}} = \vec{P}_{e^-_{\delta_{\alpha+\alpha'}}} - \vec{P}_{e^-_{\delta_0}}$ or, since momentum and energy are numerically equal for photons, we can also say that photon emitted has an energy equal to the difference in the energy between the two states or $E_{\gamma'_{emit}} = E_{e^-_{\delta_{\alpha+\alpha'}}} - E_{e^-_{\delta_0}}$ but the momentum description preferred since it is complete and specific while the energy description is general.

From the above we can generalize in the following manner.

A state δ_α is that which results from a transition $\delta_0 \to \delta_\alpha$ by photon such that $\left\|\vec{P}_{\gamma_0}\right\| = \alpha m_{e^-}$ or by a series of x transitions such that $\sum_{i=1}^{x}\left\|\vec{P}_{\gamma_i}\right\| = \alpha m_{e^-}$.

From this we understand that the difference in momentum of an electron between any two states δ_x and δ_y is $\vec{P}_{e^-_{\delta_y}} - \vec{P}_{e^-_{\delta_x}} = (y-x)m_{e^-}$.

Also, if an electron (or other similarly charged particle) is captured by a proton (or more generally by an atom), it will emit a photon or series of photons which sum will be equal to the difference between its momentum and the momentum of an electron at ground state following the mechanism we described.

States of Muonic Hydrogen

In the previous section we have shown that the difference between to states is dependent upon the mass of the electron. This implies that in muonic hydrogen, in which the electron has been replaced by a muon, which particle as greater mass, then the momentum difference between two states of the muon will be greater than the difference between two equivalent states of the electron of ordinary hydrogen.

So to return to ground state from a higher state, since $\left\|\Delta\vec{P}_{\mu}\right\| = ym_u$ and $\left\|\Delta\vec{P}_{e^-}\right\| = ym_{e^-}$ during the $\delta_y \to \delta_0$ transition the muon of muonic hydrogen will emit a photon with higher momentum (and energy) than that of photon emitted by the electron of ordinary hydrogen. This is consistent with the measurements of recent experiments[11] which quantum mechanical interpretation led to the proton size problem.

Determination of the Proton Size

Quantum mechanics correctly predicts that the transition energy of an electron between states is the difference between the energies specific to each state. The momentum of the photon emitted during the transition between two given states should be the same for the muonic hydrogen and ordinary hydrogen. Recent experiments show that this is not the case.

[11] Muonic hydrogen and the proton radius puzzle, R. Pohl, R. Gilman, G. A. Miller, K. Pachucki http://arxiv.org/abs/1301.0905

We have shown that the momentum gaps between two permitted states, known as Lamb shifts, is dependent on the mass of the particle. Therefore, when taking this into account, there will be no discrepancy between the size of the proton derived from hydrogen experiments from that derived from muonic hydrogen or any other experiment.

Radius of a Proton

If the masses of the proton and electron in fundamental units are known, then:

1. Resolve the equation for the electromagnetic effect to obtain the distance between the region occupied by the electron and that which is occupied by the proton and
2. resolve the gravitational interaction equation to find the distance between the electron and the centre of gravity of the proton.
3. The difference between the two will give the radius of the proton.

The QGD description of the electromagnetic effect will be derived and discussed in a dedicated section.

The Photoelectric Effect

Consider a state δ_x of an atomic electron interacting with a photon γ where $\vec{P}_\gamma = m_{e^-_{\delta_x}}$. If $\overrightarrow{P^{\text{A}}_{e^-_{\delta_{x+1}}}} > \sum_{i=1}^{n_{e^-}} \overleftrightarrow{F}_i$, then the electron will become unbounded and the momentum of the unbound electron will be $\vec{P}_{e^-_{\delta_{x+1}}} = \vec{P}_{e^-_{\delta x}} + \vec{P}_\gamma$. The above $\delta_x \rightarrow \delta_{x+1}$ transition is the photoelectric effect.

Conclusion

We have shown that the mechanisms of atomic electron transition as derived from QGD's axiom set not only describes observations but provides a fundamentally based explanation. Also, the model is consistent with muon states transitions of muonic hydrogen.