Mirrored Orbitals Explain the Ortho/Para States of Helium

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ABSTRACT

Helium provides the simplest, multi-electron, atomic situation. Quantum mechanics addresses the different magnetic and spectral properties of ortho and para helium with "mirrored twin" electrons. This paper addresses that difference with "mirrored rooms" and no electron spin-reversed pairing in the same orbital – a different implementation of parity. Models are provided to illustrate why each form of helium can not be converted to the other in a single photon-induced step. These models also illustrate the vastly greater orbital sizes of the excited states over the ground state. Included is a reference to a paper demonstrating that classical physics provides the physical mechanism that explains why an electron's energy levels scale with the square of integers. The mirror-room orbitals would also be appropriate for non-classical approaches without requiring spin-reverse pairing of electrons in the same orbital.

INTRODUCTION

Back a century ago, scientists worked diligently to explain the spectral data of excited atoms. These spectra included S(harp), P(rincipal), D(iffuse), and F(undamental) lines that were to be addressed. The main thrust of the physical model that continues to this day got its start with Bohr's circular-turned-spherical orb. From this "electron globe of a house", plans for larger electron families were drawn. Thus, basic, "1-room", spherical bungalows" were up gradable to "4-room split levels". With plans for adding 5 or 7-rooms, "electron condos" were created. The plans got labeled: s (1-room), s+3p (4-room split-levels), d (5-rooms), and f (7-rooms) - spdf for short. Those versed in the subject will, of course, note the Upper-lower S/s, P/p, D/d, F/f case connection. Double occupancy was required to satisfy the periodic table of elements, starting with helium.

Pauli mused that there was a problem of which occupant was which when the rooms were doubly occupied. Heisenberg, who made significant contributions to what became "quantum mechanics"[1], came to his rescue when he wrote to Pauli in 1926 that electron spin might be the solution to the ortho/para helium phenomenon[2] and thus to Pauli's exclusion problem. So, "parity electron twins" that occupied the same room (cell, orbital) were created to give each twin a unique SS#[3]. Some would say that ortho/para helium proved the correctness of the quantum mechanics approach. In any case,

endorsement of the QM approach certainly stifled alternative views while encouraging additional explanations that supported the basic, spdf, design.

The "quantum mechanical – spin-paired" model still is the accepted convention: n (floor level), ℓ (room shape), m (wing), and s (left or right-handed twin in the double bed) are the notations that define an electron's place in the double-occupancy spdf rooms. While the mirroring of electrons ("mirrored twins") can be handled by mathematics, it is still not clear just how it happens in our physical world where electrons repel one another and all free electrons appear with the same handedness. It is also significant that only an "upright twin" can occupy a room alone! Not only that, but other "upright twins" fill a common suite of rooms before their "downright twins" can start pairing up with them. It would have made more sense to have mirrored the rooms with single occupancy by "an electron", but that option was eliminated when the lowest room in any condo had to be a doubly occupied, centered, sphere.

Scientists are now developing techniques to investigate electron levels at the sub-nanometer level[4]. Helium will likely be the next atom addressed. To provide an alternate particle approach to the current QM electron orbital model, a "mirrored room" model is herein described and applied to the differing spectra of ortho and para helium.

DISCUSSION

THE "MIRRORED ROOM" ELECTRON ORBITAL MODEL

A "mirrored room" equivalent of a sphere is easily envisioned. It is simply two, diametrically opposed, tetrahedral-lobed spaces with a common center (Figure 1). An electron moves progressively through each lobe of the quartet. When the orbitals (defined by the electron's energy to make the circuitous journey) are so small (minimal energy to complete the circuit) that e-repulsions between electrons would make filling more than one of them prohibitive, only one electron occupies each quartet; this is the case for hydrogen and helium. As the orbital sizes increase (increased electron lap-energy), each orbital lobe can contain a single electron. When an electron occupies each of the eight orbitals, the filling is complete; e.g., for the second level this occurs with neon. Not only does this "mirrored room" equivalent replace a sphere, it is also equivalent to the doubly occupied, s+3p, split-level group, but with only a single type of orbital. This is the MC portion of the MCAS model[5].
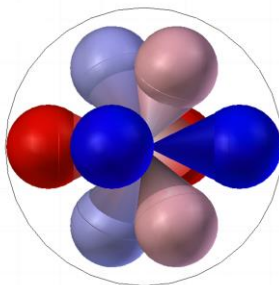
Figure 1: A "Mirrored room" electron orbital model

A simple quantum mechanics machine (shown in Figure 2, but discussed elsewhere[6]) indicates, a priori, why the excitation levels scale by n^2, where n is an integer. Implicit in the model is electron movement and coordination with the nucleus. The mirror-room" orbitals are simply that: orbitals; a different, but simpler set that explains the physical data and the periodic table. They would also be appropriate for non-classical approaches without electron-pairing should stanch adherents to the non-classical get past their objection to the fact that these orbitals can satisfy classical physics as well!
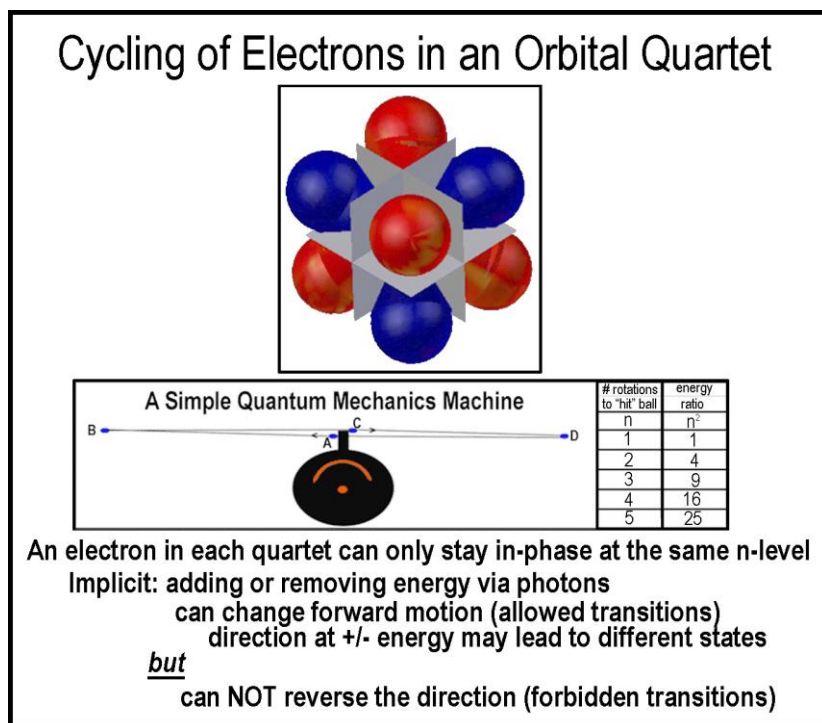

Figure 2: Electron levels scale by classical physics

At this point it is important to note the effect of adding and removing energy. Adding energy to or removing it from an electron's movement via photon addition or release is like accelerating and decelerating a car with the gas pedal – there is no effect on direction, per se. A reversal of direction by this action will not happen. Moving to a higher or lower lobe of similar shape is the norm. Moving to another orbital that has another orientation is possible, if the direction of the electron at the

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moment of energy change would send it there. Thus, an electron can NOT move from a **RED** orbital system to a diametrically opposed **BLUE** one or vice versa (Figure 2) by simply changing the energy level of the electron - this is a "forbidden" transition by photon action. To be "in-phase", two electrons must remain diametrically opposite one another or flowing in the same orbital group (Figure 3). To do this they need to be at the same energy level (n). Otherwise, the time to transverse the orbital lobes will be different. The "in-phase" state is the lowest for every energy level. Note that there are 3 non-diametric options even at the "same" energy level for the simple opposed quartets – these provide some fine structure before the unstable system moves to the more stable diametrically opposed position through energy changes. They provide staging points for transitions and may even make one electron appear more energetic than the other.
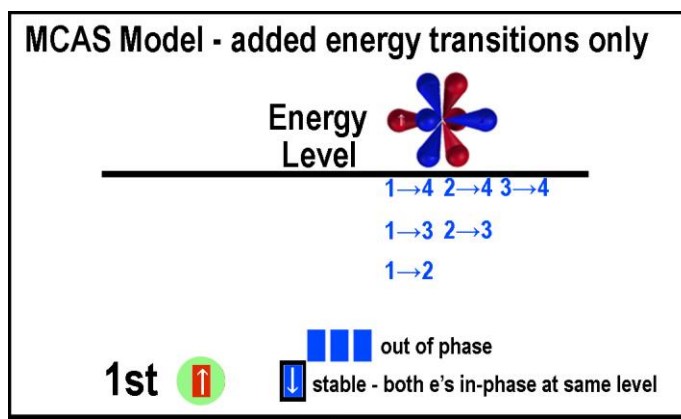

Figure 3: Orbital configurations for two electrons with one remaining at the lowest level

THE PHYSICAL SPACES OF ELECTRON TRANSITIONS

The Bohr circles that indicate simple one-electron n-state transitions do not indicate the magnitude of the energy involved in those transitions very well to students by my reckoning. Figure 4 is intended to provide a better feel. Note the tiny little first level.
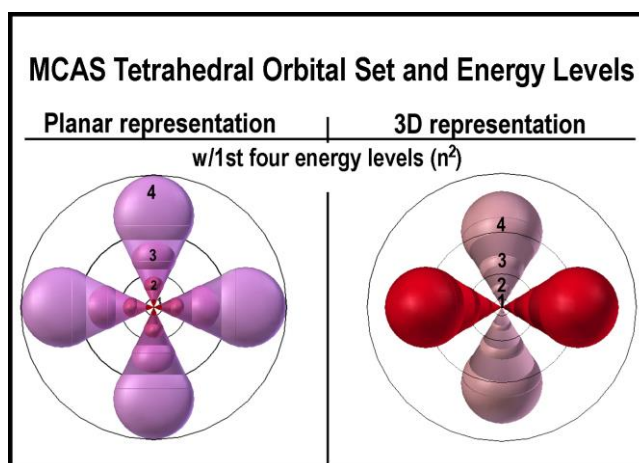

Figure 4: Spatial-energy level relationships of the simplest electron orbitals

Orbital size is dictated by the energy-path of the electron that permits the electron to arrive back at the required appointment moment with the nuclear regulatory checkpoint and pass on to the next lobe. The nucleus keeps its electrons in line with firm discipline based on the constancy of the spectral data. This raises the question as to when energy is added to or removed from an electron: does it occur only when it passes the nucleus, at some other place, at many places, any or everywhere? Do atoms have fly-through pump and dump zones ("stations")? Is photon energy actually input not to the electrons, but rather to the nucleus which then alters the movement of the surrounding electrons? Do electrons have to pass through nuclear magnetic "warping" zones as they orbit the nucleus? Knowing how electrons and nuclei interact is needed information for a more complete understanding of these miniature machines.

THE ENERGY STATES OF PARA AND ORTHO HELIUM

A composite of spectral energy levels for ortho and para helium from 3 web sources[7] is given in Figure 5. The data was consistent up to the 4th n-level, except for the 2nd level ortho "Principal", where none agreed, but did not differ greatly. The Sharp and Principal notations are the spectral assignments and, of course, in the quantum mechanical model, they lower-case initial letter also represents that model's orbital descriptions. Other energy levels are omitted here in order to focus attention on the first levels of energy changes. These spectral lines are handled by the C-orbitals of the "mirrored room", MCAS model.
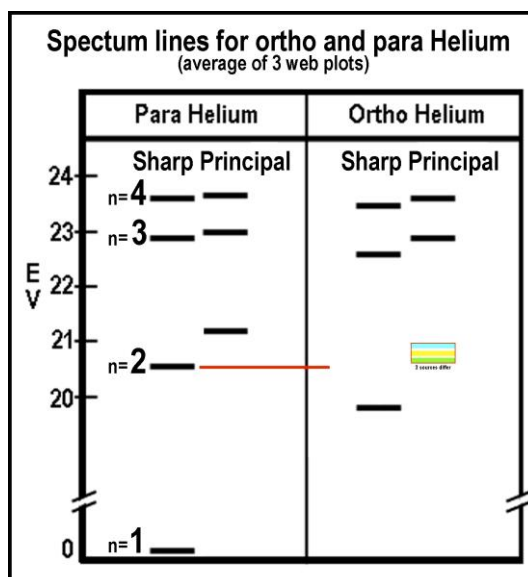

Figure 5: Spectral energy levels for ortho and para helium

The full MCAS model of orbitals is given in Figure 6 along with the s+3p orbitals of the spdf model: an M-orbital is a mono-occupied C-orbital quartet.
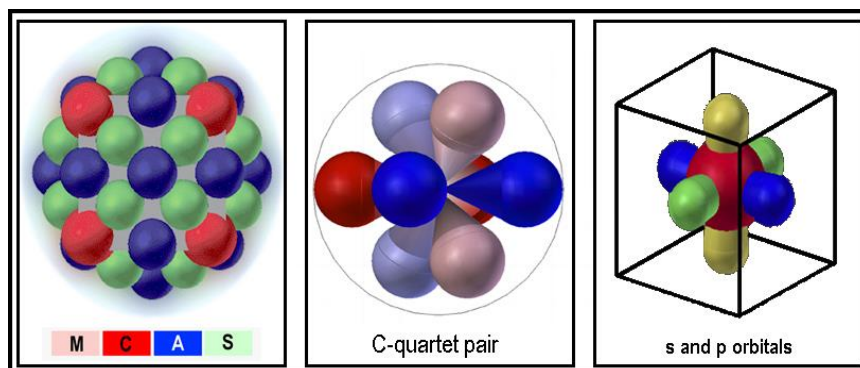

Figure 6: MCAS plus s and p orbitals

Elevation of the ground-state of para-helium to the next lowest energy level occurs in two steps without changes in electron spin (Figure 7).
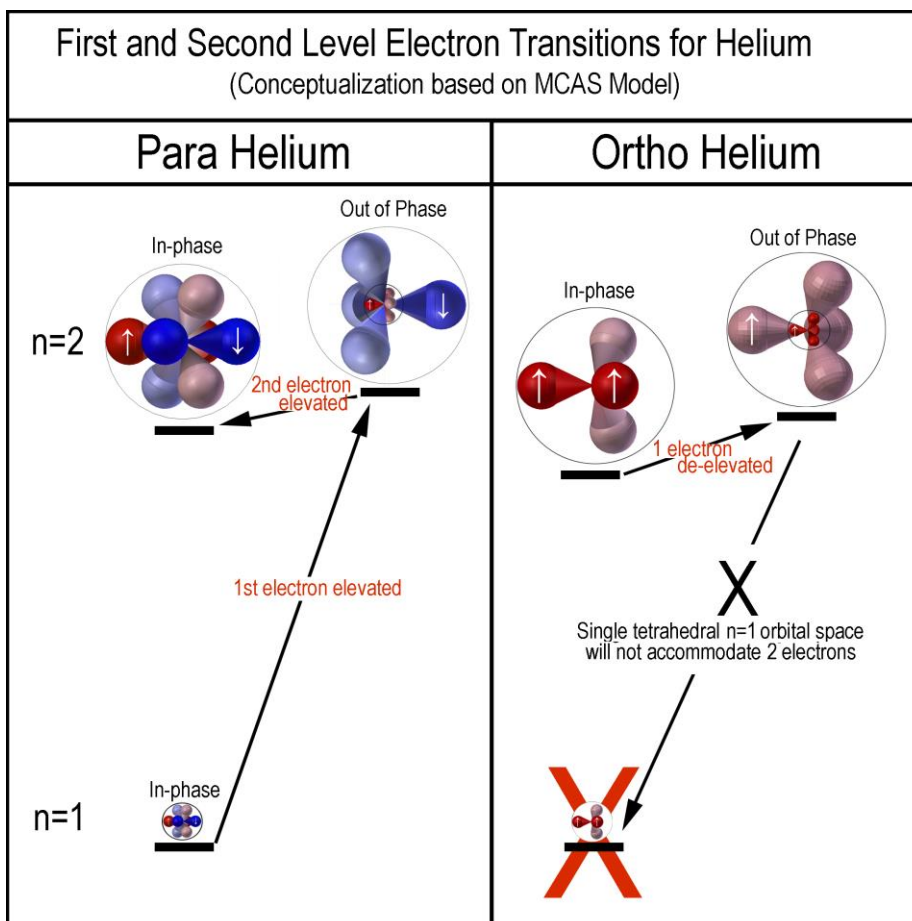

Figure 7: Electron excitation in orbitals for the first two energy levels of ortho and para helium

In the first step, one electron is elevated. This leads to a high energy, unbalanced (wobbly), out-of-phase, state. Part of the energy of this very unstable state is utilized in elevating the second electron.

This gives rise to a balanced, in-phase state that has a lower total energy. Think about thermodynamics and chemical reactions. In the vernacular of chemical reaction mechanisms, the out-of-phase state is a high-energy, meta-stable state. In essence, the energy to promote the two electrons in the n=1 in-phase state to the n=2 in-phase state is less than that required to promote one electron from the n=1 state to the n=2 state. The process, however, must occur in two steps. The second step can only occur when the electrons are in diverging "pseudo" in-phase movement which allows a simple energy kick to put the second electron "in-phase" for a lower total energy. To return to the ground state, the process is reversed. Spectral lines indicate the energy of stable and meta-stable states; line intensities reflect the measurable quantity of these states. One should consider this when declaring that electrons are making "quantum leaps" from state to state.

With ortho-helium, the two electrons are in the same orbital quartet. Readers who are familiar with chemistry will recognize the ortho (adjacent) and para (opposite) placement of the arrows in the two "n=2 in-phase" images in Figure 7. Having two electrons in the same orbital quartet at the n=1 level is energetically prohibitive. Thus, the lowest state for two electrons in the same orbital quartet is at the n=2 level. This is the reason that lithium starts the second row of the periodic table[8]. As in the case with para-helium, a higher energy state can occur with one of the electrons dropping down to the n=1 level. Unlike in the para case, however, the second electron cannot drop down and this "out-of-phase, meta-stable" state simply reverts back to the more stable, but still high energy, in-phase state.

At first glance, it would seem strange that the n=2 ortho-state is lower in energy than the comparable n=2 para-state. Consider the relationships in Figure 8. The overall electron interactions and wobble are just greater in the para-state than in the ortho-state as they move through the orbitals and the are subjected to nuclear "supervision" on the way to the next lobe.
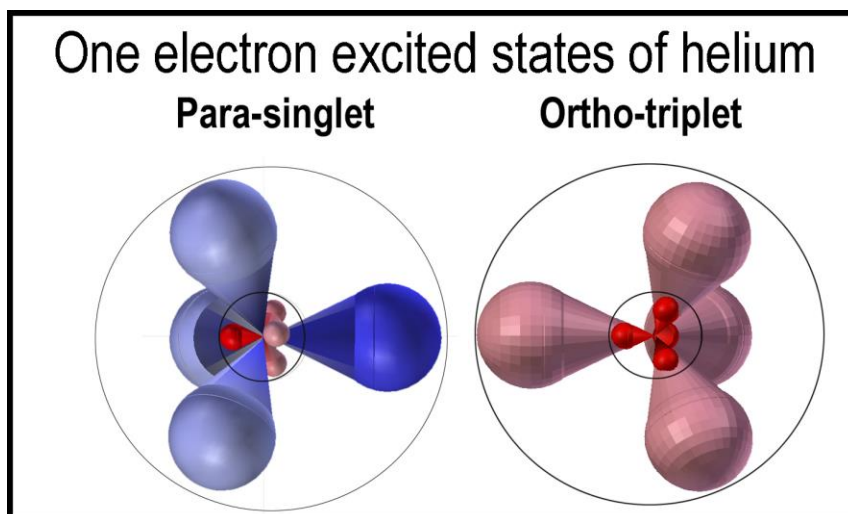

Figure 8: Orbital relationships of one electron excited in ortho and para helium

The second electron in ortho-helium can not reverse direction under photon action and, thus, be converted to the para arrangement. The conversion of ortho to para of vice versa will not occur with the simple addition or removal of photon energy as a reversal of direction is needed. Strong magnetic fields are needed to align the movement of the electrons (orbitals) and thus pair electron flow; collision impacts are needed to reverse them.

SUMMARY

The "mirrored room", MCAS, orbital model provides an excellent explanation for the difference between ortho and para helium. Spin-pairing is accomplished through movement through opposing orbital units rather than through the "mirroring of electrons" in the same orbital space as is done in the spdf model. The MCAS model clearly demonstrates why ortho and para helium are not converted from one to another with photon energy. The model also demonstrates that electrons are operationally connected to one another as they pass by and coordinate with the nucleus. They do not exist as clouds of negativity, although they emit negative fields. Energy levels are related to "coordinated junctions" near the nucleus and scale according to classical acceleration and deceleration laws of electron velocity and their related electrostatic attractions (and repulsions?) with the nucleus and repulsions with other electrons[9]. The MCAS model demonstrates that the lowest (n=1) energy level of atoms can only have two electrons moving in opposite directions (paired) and can not have electrons flowing in the same orbital quartet. This explains why the periodic table begins a new period after helium with a higher energy, more spatially expanded, set of orbitals which does allow additional electrons to occupy the same quartet. The rationale for G.N. Lewis' "rule of eight" is quite clear with the eight-equivalent lobes of the "mirrored room" model. The MCAS "mirrored room" electron orbital model offers the simplest explanation for this and many other atom-atom interactions and does so without having to "hybridize" orbitals to make compounds and "reverse" the actual spin of electrons to effect pairing.

REFERENCES AND NOTES

[1] Heisenberg was awarded the 1932 Nobel Prize "for the creation of quantum mechanics": Landsman, N.P. Getting even with Heisenberg. An Essay Review of P.L. Rose's, HEISENBERG and the Nazi Atomic Bomb Project: A Study in German Culture (Berkeley: University of California Press, 1998 http://philsci-archive.pitt.edu/9362/1/heisenberg.pdf

[2] (a) James, J. and Joas, C. http://quantum-history.mpiwg-berlin.mpg.de/news/workshops/hq3/hq3_talks/16_joas-james.pdf, **2010**; (b)Bloch, F. Reminiscences of Heisenberg and the early days of quantum mechanics, *Physics Today*, **1976**, Dec, 27; http://physics.clarku.edu/courses/171/sreading/HeisenbergW.pdf http://www.slac.stanford.edu/th/mpeskin/stuff/mpeskin/SUSYspectrum.pdf - M. E. Peskin, Dec, 2001

[3] Many countries have SS numbering systems. A common one is the US's social security system which is supposedly humanitarian. Nazi SS's numbering, on the other hand, was hardly that.

[4] Stodolna, A.S., et al. Quantum microscope' peers into the hydrogen atom - Hydrogen Atoms under Magnification: Direct Observation of the Nodal Structure of Stark States. *Phys. Rev. Lett*. **2013**, 110, 213001; http://physicsworld.com/cws/article/news/2013/may/23/quantum-microscope-peers-into-the-hydrogen-atom. The results presented are based on averaging massive amounts of data points taken over time. While circular orbital structures are described as being observed, their images are best interpreted as simply showing the outer boundary of the orbitals and not the shape of the orbitals themselves. Electron movement to or from the nucleus is minimal (nearly stationary relative to the nucleus) at the outermost limit of the orbital and, thus, more easily detected.

[5] (a)Williams, J.M. The MCAS Electron Orbital Model. http://vixra.org/abs/1205.0114 **2012** or http://pages.swcp.com/~jmw-mcw/MCAS/The_MCAS_Electron_Model_Booklet_for_web.pdf (booklet); (b)Modeling the MCAS Way. http://pages.swcp.com/~jmw-mcw/science or http://arxiv.org/html/physics/9902046v2 **1999**

[6] (a)Williams, J.M. The Bohr Model, Electron Transfer and Newtonian-derived Quantum Numbers. http://gsjournal.net/Science-Journals/Essays/View/4083 **2012**; (b)Why do Electrons (Orbitals) Have Discrete Quantum Numbers? http://vixra.org/abs/1210.0133 **2012**

[7] Web sources for He excitation levels: (a)http://web.ift.uib.no/AMOS/PHYS261/2011_09_08/; (b) http://www.ipf.uni-stuttgart.de/lehre/online-skript/f40_03.html; (c)http://hyperphysics.phy-astr.gsu.edu/hbase/quantum/helium.html

[8] (a)Williams, J.M. Creating the Familiar Periodic Table via MCAS Electron Orbital Filling. http://pages.swcp.com/~jmw-mcw/The Familiar Periodic Table of Elements and Electron Orbital Filling.htm; (b)The MCAS Electron Orbital Model as the Underlying System of the Periodic Table. http://gsjournal.net/Science-Journals/Essays/View/4268 **2012**; (c)The Periodic Table and the MCAS Electron Orbital Model. http://vixra.org/abs/1208.0068 **2012**

[9] Some might say that electrons "talk" to one another. Since electrons emit electromagnetic fields, they certainly "influence" each other. The nucleus is doing the major controlling, however. The electron "drones" are just responding to its "warping" and the total electrostatic and magnetic fields generated by all of the atomic components. How the nucleus implements its warping influence would be very useful for understanding how these tiny atomic machines operate.