WHAT DID BOHR DO?

by: ARNOLD G. GULKO,
1835 Arcola Ave.,
Silver Spring, MD 20902.

In the Jan. 17, 1992 issue of **Science**, at pages 345-7, Frank Wilczek of the Institute for Advanced Study at Princeton reviews Abraham Pais' 1991 text about Niels Bohr. After glowing quotes from Born and Heisenberg, he refers to an anonymous modern physicist who states: What did Bohr really do?

Wilczek believes that Bohr's contributions were important, and they surely made an impact on the physics of his time. But when one evaluates an individual's contributions, one must at least ask whether he resolved the main problem before him.

Let us review the problem encountered by Bohr, starting where Wilczek starts, with Rutherford's experiment which proved that matter was mostly open space. When almost all the alpha particles fired at a foil target went through the foil without deflection, it was clear the massive portion of the atoms was concentrated tiny positively charged nuclei surrounded by distantly positioned electrons. In this way the remote electrons provide atoms with their great size.

How could this be? Coulomb's law states that electrons are attracted to positive particles by a force which increases like the inverse square as the distance decreases. The problem was: what kept the electrons away from the nucleus? If the electrons remained in contact with the nucleus, the atoms would be very tiny and lack the great size needed to form a foil which looks solid but which is almost entirely open space.

Bohr, Rutherford and Heisenberg were thus confronted by a straightforward problem. Something kept the electrons away from the proton despite electrostatic attraction, and thay had to figure out what it was and how it accomplished this task.

Rutherford proposed a model of the atom in which the electron orbited a tiny positively charged nucleus, being held in orbit by a balance between angular momentum and electrostatic attraction. The physical analogy was to a planet orbiting the sun to balance its angular momentum against the attraction of gravity.

Th s model had many problems. Wilczek points out physics was particularly troubled by the fact that a circling electron, such as the one in Rutherford's model, should lose energy: but none was lost. Bohr used his mathematical skills to suggest the electron was in a stationary state in which, never mind how, energy was not lost. He further suggested the energy losses which took place when hydrogen formed, represented changes in the electron's orbit as the hydrogen atom became smaller.

But this theory, even with Bohr's mathematical support, could not sustain itself against its many intrinsic flaws. Wilczek states:

A 'theory' based, as Bohr's atomic theory was, on an uneasy mix of nearly contradictory concepts ... was clearly meant to be used as a scaffold and to be discarded when a more finished structure could support itself. In fact it has been entirely superseded by modern quantum theory.

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The same thought is more frankly presented by John Gribbin in his text: **In Search of Schrodinger's Cat (Bantum Books, 1984). Gribbin points out that the Bohr** theory of the hydrogen atom *is wrong in almost every respect, but still represents just about the last model of the atom that bears any relation to the images we are used to in everyday life.* A mix of "nearly contradictory concepts" is not the same as "wrong in almost every respect", and something which lacks "any relation to the images we are used to in everyday life" does not provide "a more finished structure".

Bohr and Heisenberg both contributed to that modern quantum theory and the energy considerations in hydrogen can be calculated using either theory. But how do these theories bear upon the problem of understanding atoms?

The problem was to understand how the electron remained at a great average distance from the nucleus despite electrostatic attraction and how energy is lost in precise amounts when atoms form. The effort to understand focused upon the simplest situation in which the atomic nucleus was the single proton in hydrogen. Observation now demonstrates that the hydrogen electron moves erratically, holding to no plane and primarily moving back and forth directly toward and away from the proton.

Observation thus establishes there is no orbit and no angular momentum to balance against the electrostatic attraction. So how does the electron remain away from the proton?

The progressive loss of energy expected from a circling electron is a trifling puzzle compared with the problem raised by the observations. When a rapidly moving electron is stopped a great deal of energy is normally lost, X-rays being produced in exactly this way. The electron in hydrogen is constantly moving and stopping but energy is not released. What is going on?

So Bohr's concept of the hydrogen atom was totally wrong. An abrupt change in the electron's motion does not trigger the release of energy. Quantum analysis provides no substitute physical understanding to answer the questions facing Bohr, Rutherford, Heisenberg and the rest of the physics community.

Let us examine orbital motion more closely. A planet circling a sun moves more rapidly and has more energy when its orbit lies closer to the sun. This change in the energy of an orbiting object is essential to maintain the balance between inertia and attraction demanded by Kepler's law. In any orbital situation the change in average distance from the center of attraction is progressive and is reflected in the energy content of the orbiting object, not in the absorption or emission of energy.

The action in hydrogen is very different. Energy is gained or lost rapidly, not progressively. When the size of the atom decreases, energy is lost instead of being gained by the electron. So the closer electron has not gained energy and cannot possess the greater momentum needed to offset the stronger attractions present closer to the proton. Clever mathematics cannot conceal these unexplained inconsistencies between the mechanics of planetary orbits and the mechanics of hydrogen.

So there is no actual orbit and orbital variation cannot be the source of the energy released during the formation of hydrogen. Bohr should have realistically confronted the question of how energy is released when the electron associates with a proton to form hydrogen, but that question was not answered by Bohr and Heisenberg and remains unanswered by modern physics.

In describing Bohr's theory, Wilczek states:

Bohr simply postulated ... that the electron could peaceably orbit in what he called stationary states.

But erratic motion toward and away from a proton is a violent action which does not resemble a peaceable orbit. The essence of the Bohr analysis of hydrogen is the motion of the electron. But an erratic motion is manifestly inconsistent with the sharp lines in hydrogen's spectrum. The capacity to calculate provided by Bohr and quantum mechanics prevents understanding.

Quantum mechanics rests upon Heisenberg's uncertainty principle which is based on the concept that the velocity and position of the electron in hydrogen are conjugated variables which cannot be accurately measured at the same time. Since one cannot precisely know the motion of the hydrogen electron, Heisenberg concluded that predicting the fate of the hydrogen atom was impossible. But it is now clear that the electron's erratic motion cannot determine the release of only a few precise amounts of energy.

Bohr and Heisenberg have thus given us a physics of failure. They had to resolve one straightforward puzzle and in three quarters of a century they and the institution of physics have failed to resolve it. Wilczek's review evaluates Bohr's contribution without acknowledging his failure to comprehend the problem before him. This is wrong.

While Bohr and Heisenberg failed to solve the problem before them, they nonetheless convinced their fellow physicists that their failure should be ignored. How remarkable! But these fellow physicists had also faced the same problem which Bohr and Heisenberg could not resolve and they had also failed to resolve it. Physics could hardly fault Bohr and Heisenberg for their inability to resolve the very issues which had mystified them and which they have still failed to resolve.

There is another fundamental question involving hydrogen which was not apparent when Bohr presented his theory of the hydrogen atom in 1913 but which has now been apparent for many years. Oppositely charged particles having the same mass annihilate one another on contact. The proton and electron in hydrogen are oppositely charged and surely come into contact when the electron moves directly toward the proton. How does the difference in mass prevent these oppositely charged particles from destroying one another? This question is unanswered.

Also the lines in the hydrogen spectrum include a fine structure having a constant ratio which Bohr did not address in his theory. So Sommerfeld assumed an elliptical orbit and calculated the fine structure constant using relativity theory. But these calculations represent mathematical trickery, for there is no orbit, elliptical or otherwise.

The logical conclusion drawn from Sommerfeld's relativistic calculations is that the electron in hydrogen is really in an elliptical orbit, but that is wrong. It follows that every conclusion drawn from relativity calculations is wrong until it can be physically corroborated. If mathematics is to be regarded as a science, it must follow the rules of science.

Relativity calculations now support the Big Bang theory which is inconsistent with many of the presently available observations of space. We now know where the error is, for calculations based on relativity are here established to be unreliable. We again have the physics of failure, for today's physics does not allow us to understand what we see in the cosmos.

Hydrogen involves an electron having a classical charge radius and an energy radius (its Compton wavelength divided by 2π). These radii are attributes of the electron as an independent particle, but hydrogen's fine structure constant is the ratio of these radii and the average spacing between the particles in the ground state hydrogen atom is the square of the energy radius divided by the charge radius.

The essential parameters of hydrogen are thus determined solely by the structure of the electron. The opportunity to understand is clearly present, but Bohr

and quantum mechanics have ignored this opportunity, probably because the electron has no size or internal structure in quantum mechanics. So the contributions of Bohr again function to prevent any effort to comprehend hydrogen.

It would embarrass the institution of physics if someone not a professional physicist resolved these problems, albeit the arrogance of modern physics is such that this possibility is ignored. It would be like having the most important early advance in medicine (the germ theory of disease) contributed by someone not a physician (like Louis Pasteur). The medical community of that day was offended by Pasteur's interference.

We now see the ignorance which causes the institution of physics to refuse to publish dissenting views and to avoid publications it does not control. In this way they avoid acknowledging their failure to understand any event in the fundamentals of our nature, the failure to understand hydrogen being but one illustration of this ignorance.

At the same time they avoid this writer's publications which explain how the electron remains away from the proton in hydrogen and how some of the electron's energy is lost when positive and negative particles associate [1]. This writer's publications even explain how the proton and electron avoid mutual annihilation [2], and the fine structure constant is also explained [3].

A successful explanatory effort demands a plausible physical model and the capacity to calculate the energy considerations of hydrogen from the model. This must be done with a model which is not theoretically and observationally absurd, as was the model proposed by Bohr and Rutherford [4].

After the disaster encountered by Bohr, physics shuns physical models. A physical model can be tested to demonstrate its error, as happened to complete the destruction of Bohr's concepts. With quantum mechanics every inconsistency with observation is dismissed as an 'ambiguity'. One cannot get away with this when a physical model is relied upon.

So Wilczek in his review avoids the fact that Bohr confronted a central problem and failed either to make sense of it or to solve it. This is why only peripheral incomprehensible mathematical contributions remain, and modern physicists seeking to understand nature ask: "What did Bohr really do?"

Bohr pursued an analogy to a planet orbiting a sun which he knew was wrong. The quantum mechanics which Bohr helped to construct to replace his orbital theory is also founded on incorrect assumptions. As a result, Bohr's clever mathematics has destroyed the capacity of modern physics to think clearly about the fundamentals of our nature, and this is why physics has made little progress in the effort to understand.

References

[1] (a)- Gulko, A. G., **The Cause of the Fine Structure in the Spectrum of Hydrogen**, J. British-American Scientific Research Assoc., Dec. 1986, pp. 28-32.

(b)- Gulko, A. G., **The Size of Hydrogen & the Energy Released in its Formation**, J. B.A.S.R.A., Mar. 1989, pp. 39-44.

[2] (a)- Gulko, A. G., **The Relationship Between Energy, Mass and Charge**, The Toth-Maatian Review, V. 9, #3, Oct. 1990, pp. 4589-601.

(b)- Gulko, A. G., **The Paradox of Antimatter**, T-M. R., V. 4, #2, July 1985, pp. 1886-9.

[3] Gulko, A. G., **The Fine Structure Constant**, T-M. R., V. 7, #2, July 1988, pp. 3661-9.

[4] This writer's first description of hydrogen, including the energy flows which account for hydrogen's spectrum and function to assocaite the electron and proton, was in Chapter 3, pp. 28-49, of his 1979 text **The Vortex Theory**. That text was revised and republished as a second edition in 1984 in which appendix F was added to the text, pp. F1-13, entitled 'The Energy Relationships in Hydrogen' which provides a mathematical analysis of hydrogen based on the geometrical model in the 1979 text.

After 1984, this writer published several papers which discuss aspects of the hydrogen atom, as noted above. Some of these published papers have now been combined with other papers into a new text **Advances in Understanding the Fundamentals of Nature.** References [1, a, b]; [2, a, b]; [3] have been revised and are respectively Chapters 11 a, b; 6 a; 5 a; and 11 c of the new text. The new text contains 185 pages plus a comprehensive index and is available from the author.