APR13-2013-000714

Abstract for an Invited Paper
for the APR13 Meeting of
the American Physical Society

Niels Bohr and the Third Quantum Revolution

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In the history of science few developments can rival the discovery of quantum mechanics, with its series of abrupt leaps in unexpected directions stretching over a quarter century. The result was a new world, even more strange than any previously imagined subterranean (or in this case submicroscopic) kingdom. Niels Bohr made the third of these leaps (following Planck and Einstein) when he realized that still-new quantum ideas were essential to account for atomic structure: Rutherford had deduced, using entirely classical-physics principles, that the positive charge in an atom is contained in a very small kernel or nucleus. This made the atom an analogue to the solar system. Classical physics implied that negatively charged electrons losing energy to electromagnetic radiation would "dive in" to the nucleus in a very short time. The chemistry of such tiny atoms would be trivial, and the sizes of solids made from these atoms would be much too small. Bohr initially got out of this dilemma by postulating that the angular momentum of an electron orbiting about the nucleus is quantized in integer multiples of the reduced quantum constant $\hbar = \mathrm{h}/2\pi$. Solving for the energy of such an orbit in equilibrium immediately produces the famous Balmer formula for the frequencies of visible light radiated from hydrogen as an electron jumps from any particular orbit to another of lower energy. There remained mysteries requiring explanation or at least exploration, including two to be discussed here: 1. Rutherford used classical mechanics to compute the trajectory and hence the scattering angle of an α particle impinging on a small positively charged target. How could this be consistent with Bohr's quantization of particle orbits about the nucleus? 2. Bohr excluded for his integer multiples of $\hbar$ the value 0. How can one justify this exclusion, necessary to bar tiny atoms of the type mentioned earlier?