The field of low energy nuclear reactions (LENR) has expanded since the early days of cold fusion, there are over a thousand papers published in this area, and there is a growing body of experimental evidence of isotopes appearing in reaction cells and power yields (without significant prompt radiation or residual radioactivity) to suggest actual applications.

BlackLight Power

BlackLight Power is the product of the early days of the cold fusion era. The founder of BlackLight Power, Inc. was unconvinced that the experiments of Pons and Fleischmann were demonstrations of a fusion process operating in the tabletop cells. The alternative explanation that he offered was that hydrogen itself was not sufficiently understood and that, in fact, hydrogen had quantum states below the traditional quantum states. If it were possible to stimulate decay into these lower energy states, then much more energy could be extracted from the sea of hydrogen that surrounds us on this planet. BlackLight Power, Inc. is an operating business and wholly owned subsidiary of Millsian, Inc. The championing of this new source of energy is distinctly different from LENR and is apparently exclusively within the purview of the corporation.

It is useful here to discuss the traditional solution of the Schrödinger equation for the hydrogen atom. The wave function for the spherically symmetric potential field can be written as[34]

$$\psi(r,\theta,\varphi)=\frac{u(r)}{r}Y_l^m(\theta,\varphi) \tag{4}$$

in which the angular functions are eigenfunctions and the eigenvalues are integers. The equation for the radial component of the wave function for the case of a spherically symmetric potential becomes

$$-\frac{\hbar^2}{2\mu}\frac{d^2u}{dr^2}+\left[\frac{\hbar^2 l(l+1)}{2\mu r^2}+V(r)\right]u=Eu. \tag{5}$$

It is necessary to consider the boundary conditions that can arise for *u*. For most problems the potential should have a finite value everywhere except possibly at the origin and should vanish infinitely far from the origin. Near the origin we could assume that

$$V(r)\sim r^{\alpha},\quad \alpha\geq -1. \tag{6}$$

It is important to note that Eq.(5) is valid only for non-zero values of *r* and that the solutions of that equation must be supplemented by a boundary condition for *u* at $r=0$. The appropriate boundary condition is arrived at by ensuring that the Hamiltonian is self-adjoint with respect to admissible eigenfunctions. This ensures that the probability interpretation of quantum mechanics is upheld. Then we must have

$$\int\int \psi^*\psi\, r^2 dr\, d\Omega=\int_0^{\infty} u^* u\, dr=1. \tag{7}$$

If the Hamiltonian operator is written as

$$\mathbf{H}=-\frac{\hbar^2}{2\mu r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial}{\partial r}\right)+\frac{\mathbf{L}^2}{2\mu r^2}+V(r), \tag{8}$$

then

$$\mathbf{H}u_k=E_k u_k. \tag{9}$$

[34] Merzbacher, E. Quantum Mechanics, New York: John Wiley & Sons, Inc. 1961, p.186ff

If Eq.(9) is multiplied by u_m, the same equation is written with *k* and *m* interchanged, and then the two equations subtracted from one another, then an integration over all of *r* shows that

$$\lim_{r\to 0}\left(u_k^* \frac{du_m}{dr} - \frac{du_k^*}{dr} u_m \right) = 0. \qquad (10)$$

The assumption that $u_{k,m}(0) = 0$ provides a sufficient but not necessary condition to satisfy Eq.(10). This traditional assumption leads to eigenvalues for the energy that are proportional to an integer equal to, or greater than, unity. The assumption that satisfies Eq.(10) leads to the traditional quantization of the hydrogen atom for which the ground state is well defined.

BlackLight Power has proposed a different set of boundary conditions for the wave function: for non-radiative states, the current density function must not possess space-time Fourier components that are synchronous with waves traveling at the speed of light. This leads to the conclusion that there are energy levels below the energy levels traditionally associated with hydrogen.

Although BlackLight Power offers a set of data on the behavior of matter with hydrogen as described, the astrophysical community has yet to discern any discrepancy in astrophysical hydrogen spectra. On the other hand, BlackLight Power identifies the hypothetical lower energy states as corresponding to fractional energy-level quantum numbers; these states could not make simple transitions through the emission or absorption of single photons, since the conservation of angular momentum would be violated. That is, the hypothetical state transitions would be forbidden. However, the conventional point of view is that energy levels below what is accepted as the ground state must inevitably be reached under natural conditions, these levels being energetically favored. The absence of such ready observation raises questions about the physical correctness of the BlackLight Power model of hydrogen.