

High Energy D₂ Bond from Feynman's Integral Wave Equation

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Chemical bonding is a well understood quantum phenomena with the accuracy of Schrodinger based predictions determined by the computing power applied [1]. The hydrogen molecule ion, H₂⁺, is the most studied and theoretically understood molecule, with no unexplained observations. Thus, to understand how two deuterons could possibly fuse to ⁴He, a more fundamental approach than the Schrodinger equation is possibly required. The general approach used in nuclear physics might be appropriate, which generally begins with the Lagrangian of the particle interactions. From the Lagrangian, a solution to Feynman's path integral is sought; often evolving to the more familiar Schrodinger equation. This generally requires many assumptions and or approximations to arrive at a reasonable solution. Applying this technique to the relatively simple deuterium molecule ion, D₂⁺, would seem a reasonable starting point. The masses and forces on each particle are well known and for the most part non-relativistic, so it just remains to search for an unexplored region in the solution space.

In this work the previously unexplored region of the Lagrangian will be shown to be the maximum of the action integral, instead of the minimum action of orbital mechanics used to predict the well known electron behaviour describing chemical properties. Generally in physics it is the '*principle of least action*' that is considered. At the atomic level the principle of least action is not a necessary condition for an observable in a system of particles. The necessary condition is a classical solution to the Lagrangian action; an '*extremum*', as emphasized by Feynman [2]. It is this extremum which predicts the build up of probability of possible paths, making an observable state possible.

By restricting the three particles of the D₂⁺ molecule ion to a co-linear path (one-dimension), a classical bond can be demonstrated between two deuterons mediated by an electron. Classical in this context means motion as predicted by Newtonian mechanics from initial conditions, velocity and position, and the electrostatic forces between the particles. The one-dimensional classical like behaviour of the high energy electron, with a long path length, is very similar to high quantum number conditions familiar to our macroscopic experience. A classical closed path with the deuterons orbiting each other can be inferred from this model, with the electron oscillating along the axis through the two nuclei. A *perfect* classical path will be shown to exist as a maximum of the action, however unstable. Using the classical path as a starting point, mathematical techniques clearly outlined by Feynman and Hibbs [2] allow for a straight forward quantum analysis. This analysis predicts a bond between the deuterons of ~30keV.

The same result can be derived starting with the Schrodinger wave equation. This approach can be interpreted as diffraction of solid-state electron waves giving an additive interference pattern between two closely spaced deuterons (<0.1 angstrom). Although the result is the same, the intuitive notion of the origins of the state, are not as convincing as Feynman's approach.

Using this High energy bond as a starting point, it is straight forward to derive a mechanism of degenerate states evolving in time. These degenerate states yield energies consistent with reported LENR reactions. The possible pathways to [tr+p], [³He+n], [⁴He gamma+or electrons], are all considered, with the products determined by the quantum kinetics. The result is predominantly ⁴He, with energy dissipation through ~1keV electrons, ppm tritium and no neutrons, consistent with experiments.

[1] D.Sholl, J.Steckel, "Density Functional Theory", Jon Wiley & Sons, Inc., Hoboken, New Jersey, pp. 209-230

[2] R. Feynman, A. Hibbs, D. Styer, "Quantum Mechanics and Path Integrals", Emended edition, Dover Publications, Inc., Mineola, New York, pp.26-78, 2010.

