The effects of nuclear mass on the wavelengths of emitted electromagnetic radiation from H2 and D2 atoms

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April 27, 2024

Abstract

In the early 20th century, the Bohr model of the hydrogen atom was developed to address many failures in the classical model. This described the atom in terms of central force problem, mediated through the Coulomb attractive force, in which a negatively charged electron orbits a positively charged nucleus with quantized angular momenta, which could only change is certain amounts, determined by the atomic structure. This helped to give a theoretical explanation as to why the electromagnetic radiation emitted from the hydrogen atom appeared in defined spectral lines, as opposed to a continuous spectrum, as predicted by the classical model. Additionally, this model helped to show how the Rydberg equation would change depending on the reduced mass of an atomic electron in response to nuclear mass. Using the Bohr model as the theoretical basis, we perform a spectroscopy analysis of the electromagnetic radiation emitted from a narrow, low pressure tube of excited hydrogen H2 and deuterium D2 atoms. The radiation beam is processed by a device known as a grating monochromator spectrometer, which then feeds the processed signal into a photomultiplier detector and is digitized. The data are then taken and plotted using a linearized version of the Rydberg equation where a fit function is applied in order to obtain the value of each atom's respective Rydberg constant. Using this value, we then attempt to derive the reduced mass of each atomic electron and compare this result with a theoretically calculated value.