Self-field theory: the mass of the photon and the fine structure constant.

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ABSTRACT: Based on the motion of the photon within the hydrogen atom, self-field theory (SFT) is used to obtain an analytic expression for m_γ the mass of the photon and provide a theoretical rationale for α the fine-structure constant. Recently, SFT was used to derive actual motions of the electron and the proton within the hydrogen atom in the form of eigensolutions to a system of partial differential equations based on the Maxwell-Lorentz equations. The atom was modeled mathematically via two point-mass particles, the electron, and the proton similar to the Bohr model. Planck's constant $\hbar = \frac{q^2}{4\pi\varepsilon_0 v_e}$ is seen as the energy per cycle of the principal eigenstate that depends on the motions of the electron, the proton, and the photon that are all involved in the dynamic balance of the atom. The photon performs relativistic motions transiting back and forth between the proton and electron that occur many times within each cycle of the electron and proton that rotate coherently about their centre of mass. The phase length of the photon each time it transits $\pi/2$ maintains the overall coherency of the atom's periodicity. This provides a method for analytically comparing the energy of the photon with that of the electron $m_\gamma c^2 = \frac{\hbar\omega_\gamma v_e}{4c}$, where ω_γ is the collision frequency of the photon. Assuming a polygonal motion circumscribes a circle representing the Bohr mageton, the photon collision frequency is estimated as 54 from the known value of the Landé g-factor. Thus m_γ evaluates to $0.396\times10^{-55}kg$ ($0.221\times10^{-19}eV$). The analytic expression for the photon mass is compatible with the expression for the fine-structure constant $\alpha = \frac{v_e}{c} = \frac{4m_\gamma c^2}{\hbar\omega_\gamma}$. The numerical value for m_γ is also compatible with the most recent experimental estimates for the lower limit of the photon mass listed by the Particle Data Group. Since the photon performs a discrete number of transits per cycle this suggests collisional based polygonal rotations for both the electron and proton rather than the circular rotations given by the ML equations. This suggests a method for checking more refined SFT models of the hydrogen atom that include the nuclear region.