Numerical Solutions for the Radial Equation of the Hydrogen Atom

Reduced mass: $\mu := 1$ Angular momentum: $L := 0$ Integration limit: $r_{max} := 18$

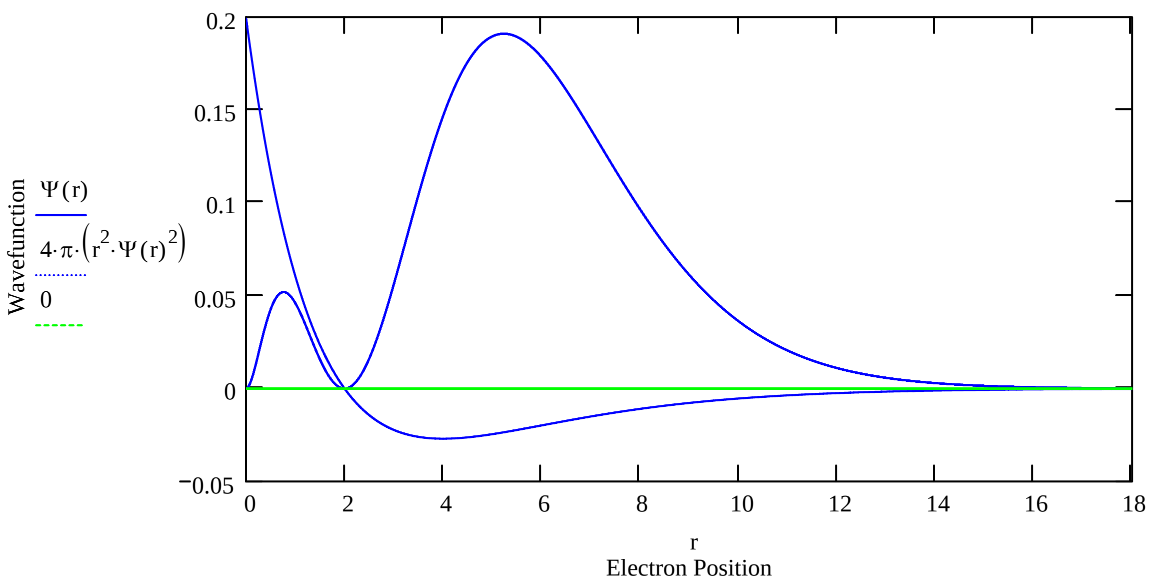
Nuclear charge: $Z := 1$

Solve Schrodinger's equation numerically use Mathcad's ODE solve block:

Given $\frac{-1}{2\cdot\mu}\cdot\frac{d^2}{dr^2}\Psi(r) - \frac{1}{r\cdot\mu}\cdot\frac{d}{dr}\Psi(r) + \left[\frac{L\cdot(L+1)}{2\cdot\mu\cdot r^2} - \frac{Z}{r}\right]\cdot\Psi(r) = E\cdot\Psi(r)$ $\Psi(.0001) = .1$ $\Psi'(.0001) = 0.1$

$\Psi := \text{Odesolve}(r, r_{max})$ Normalize the wavefunction: $\Psi(r) := \left(\int_0^{r_{max}} \Psi(r)^2\cdot 4\cdot\pi\cdot r^2\, dr\right)^{\frac{-1}{2}}\cdot\Psi(r)$

Energy guess: $E \equiv -.125$ $r := 0, .001 .. r_{max}$



Calculate average position: $\int_0^{r_{max}} \Psi(r)\cdot r\cdot\Psi(r)\cdot 4\cdot\pi\cdot r^2\, dr = 5.997$

Calculate kinetic energy: $\int_0^{r_{max}} \Psi(r)\cdot\left[\frac{-1}{2\cdot\mu}\cdot\frac{d^2}{dr^2}\Psi(r) - \frac{1}{r\cdot\mu}\cdot\frac{d}{dr}\Psi(r) + \left[\frac{L\cdot(L+1)}{2\cdot\mu\cdot r^2}\right]\cdot\Psi(r)\right]\cdot 4\cdot\pi\cdot r^2\, dr = 0.125$

Calculate potential energy: $\int_0^{r_{max}} \Psi(r)\cdot\frac{-Z}{r}\cdot\Psi(r)\cdot 4\cdot\pi\cdot r^2\, dr = -0.25$