BLACK HOLE RADIATION: ENERGY OF A PARTICLE FROM A SOLAR MASS BLACK HOLE

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The crude calculation presented earlier gives the energy at infinity of a particle created near the event horizon of a black hole as

\[ E_\infty = \frac{\hbar}{4GM} \quad (1) \]

In GR units

\[ \hbar = 3.5153 \times 10^{-43} \text{ kg m} \quad (2) \]
\[ E_\infty = \frac{8.788 \times 10^{-44}}{GM} \text{ kg} \quad (3) \]

For a solar mass black hole \( GM = 1477 \text{ m} \), so

\[ E_\infty = 5.95 \times 10^{-47} \text{ kg} \quad (4) \]

In other units, this is (using \( 1 \text{ eV} = 1.602 \times 10^{-19} \text{ J} \))

\[ E_\infty = mc^2 \quad (5) \]
\[ = 5.355 \times 10^{-30} \text{ J} \quad (6) \]
\[ = 3.34 \times 10^{-11} \text{ eV} \quad (7) \]

This is an almost unimaginably small energy. For comparison, the energy of a single photon of visible light (with a wavelength of 500 nm) is around 2.5 eV:

\[ E = h\nu = \frac{hc}{\lambda} = 6.626 \times 10^{-34} \times \frac{3 \times 10^8}{5 \times 10^{-7} \times 1.602 \times 10^{-19}} \text{ eV} \quad (8) \]