Black hole

One type is the remains of a massive, "old", "dead" star. Fuel is the process of fusion, keeping the stellar object shining brightly. Once the nuclear transformations cease, the internal pressure begins to decrease. The force of gravity begins to dominate and the star collapses. Consequently, the gravitational field strength increases to such an extent that not even light can escape and it appears black, hence the name.

JF²

$$v_{escape} = \sqrt{\frac{2GM}{R}}$$

Use $M = M_{\odot} = 2.0 \times 10^{30}$ kg

$R = R_{\odot} = 6.9 \times 10^{8}$ m

$G = 6.67 \times 10^{-11}$ N m² kg⁻²

With its present mass, what must be the radius of the Sun for it to have a velocity of escape of c, that is, 3.0×10^{8} m s⁻¹ ?

Substituting:

$$3.0 \times 10^{8}\ \mathrm{m\,s^{-1}} = \sqrt{\frac{2 \times 6.67 \times 10^{-11}\ \mathrm{N\,m^2\,kg^{-2}} \times 2.0 \times 10^{30}\ \mathrm{kg}}{R}}$$

Squaring both sides and rearranging:

$$R = \frac{2 \times 6.67 \times 10^{-11}\ \mathrm{N\,m^2\,kg^{-2}} \times 2.0 \times 10^{30}\ \mathrm{kg}}{9.0 \times 10^{16}\ \mathrm{m^2\,s^{-2}}}$$

$$= 3000\ \mathrm{m}\ (3\ \mathrm{km})$$

Check that the units reduce to "m". Note that "N" can be rewritten as "kg m s⁻²"

What would be the density of this object?

$$d = \frac{m}{V} = \frac{2.0 \times 10^{30}\ \mathrm{kg}}{\frac{4}{3}\pi \times (6.9 \times 10^{8}\ \mathrm{m})^3}$$