

**The Neutral Pion is a Black Hole**

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The black hole condition means that the escape speed of any object is equal to the “light speed”:

$$c^2 = \frac{2m_0G_0}{x_0} \quad \text{and} \quad F = G_0 \frac{m_0^2}{x_0^2} \quad \Leftrightarrow$$

$c$  – “Light speed”;  $m_0$  -- mass;  $x_0$  -- radius;  $G_0$  -- unified gravitational constant

$$\Leftrightarrow \quad c^2 = \frac{2Fx_0}{m_0} \quad \text{and} \quad F = \frac{kh(c^2 - v^2)^2 f_0^4}{c^2(c^2 + vw_0)(w_0 + v)^3} \quad \Leftrightarrow$$

Some formulas:

$$x_0 = \frac{\sqrt{c^2 - kf_0^2}}{f_0} ; \quad m_0 = \frac{hf_0}{c^2 - kf_0^2} ; \quad f_0 = \frac{\sqrt{c^2 - w_0^2}}{\sqrt{k}} ; \quad x_0 = \frac{w_0}{f_0}$$

$$\Leftrightarrow \quad c^4(c^2 + vw_0)(w_0 + v)^3 = 2w_0^3(c^2 - w_0^2)(c^2 - v^2)^2$$

For a neutral particle  $w_0 = iV_0$  :

$$c^4(c^2 + ivV_0)(v + iV_0)^3 = -2iV_0^3(c^2 + V_0^2)(c^2 - v^2)^2 \quad \Leftrightarrow$$

$$\Leftrightarrow \quad \begin{cases} V_0^4 - 3V_0^2c^2 - 3V_0^2v^2 + c^2v^2 = 0 \\ c^4(v^2V_0(v^2 - 3V_0^2) + c^2(3v^2V_0 - V_0^3)) = -2V_0^3(c^2 + V_0^2)(c^2 - v^2)^2 \end{cases}$$

$$\Leftrightarrow \quad \begin{cases} V_{0A} = \pm 8.145727242 \times 10^8 \\ v_A = \pm 3.70822473 \times 10^8 \end{cases} \quad \text{or} \quad \begin{cases} V_{0B} = \pm 6.387764312 \times 10^8 \\ v_B = \pm 2.23141343 \times 10^8 \end{cases}$$

$$kf_0^2 = c^2 + V_0^2 \quad \Leftrightarrow$$

$$f_{0A} = 5.97669344 \times 10^{25} ; \quad f_{0B} = 4.85872975 \times 10^{25}$$

Real force:

$$F = \frac{kh(c^2 - v^2)^2 f_0^4 v(c^2(v^2 - 3V_0^2) - V_0^2(3v^2 - V_0^2))}{c^2(c^4 + v^2V_0^2)(v^2 + V_0^2)^3}$$

$$F_A = -5.55927474 \times 10^{-3} ; \quad F_B = -1.91554072 \times 10^{-1}$$

And 
$$F = \frac{khf^4}{c^3} \quad \Leftrightarrow$$

$$\Leftrightarrow f_A = 3.2175814 \times 10^{22} ; \quad m_A = 2.37216072 \times 10^{-28}$$

$$\underline{E_A = 133MeV}$$

$$f_B = 7.79556965 \times 10^{22} ; \quad m_B = 5.7472809 \times 10^{-28}$$

$$\underline{E_B = 322.4MeV}$$

The neutral pion ( $\pi^0$ ) has a energy of  $E = 135MeV$  so it can be a black hole.

There are several other solutions that we didn't explore.

There is also a particular solution for a charged particle indicating the electron also is a black hole.