

Estimate the ratio of the energy obtained dropping a Mars bar into a black hole to that obtained from its chemical energy.

Dropping an object (from rest at infinity) into a maximally rotating black hole releases $1 - 1/3$ of its rest mass energy, hence

$$\begin{aligned} E_{\text{BH}} &= (1 - 1/3) mc^2 \\ &= \frac{3 - \sqrt{3}}{3} mc^2 \\ &= \frac{1.26}{3} mc^2 \\ &= 0.42 mc^2 \end{aligned}$$

A standard Mars bar is about 60g, and the speed of light is $c = 3 \times 10^8 \text{ ms}^{-1}$.

We now need the chemical energy of a Mars bar. I expect this to be a few hundred calories, but I don't know exactly how much. I think milk chocolate is about 2000 kJ per 100g, so if a Mars bar averages the same as milk chocolate

$$\begin{aligned} E_{\text{chem}} &= \rho_{\text{chem}} m \\ &\approx (20 \times 10^6) m \end{aligned}$$

where ρ_{chem} is energy density. For $m = 60\text{g}$

$$\begin{aligned} E_{\text{chem}} &\approx (20 \times 10^6) (60 \times 10^{-3}) \\ &= 1200 \text{ kJ} \end{aligned}$$

I know $1 \text{ kcal} \approx 4.2 \text{ kJ}$, hence

$$\begin{aligned} E_{\text{chem}} &\approx \frac{1200}{4.2} \\ &\approx 300 \text{ kcal} \end{aligned}$$

which seems about right. Taking the ratio, we see m cancels, so we didn't need to estimate that.

$$\begin{aligned} E_{\text{grav}} &= 0.42c^2 \\ E_{\text{chem}} &= \frac{0.42 \text{ kcal}}{(20 \times 10^6)} \\ &= 0.42 (3 \times 10^8)^2 \\ &= 0.2 \times 10^{10} \\ &= 2 \times 10^9 \end{aligned}$$

That is a large number! It is much more efficient to throw Mars bars into black holes than to eat them.

[Exact: $E_{\text{grav}}/E_{\text{chem}} = 2.012 \times 10^9$; $E_{\text{chem}} = 1095 \text{ kJ}$ for $m = 58 \text{ g}$ ($E_{\text{chem}} = 260 \text{ kcal}$)].