George Berkeley (1685-1753):

Esse est percipi.

To be is to be perceived.

HR: observation of an event :=
interaction that occurs
if and only if the event takes place.

exist := being observable, able to interact;

fact := a verifiabl{y|e} observed phenomenon;

reality := *all* that exists; the entirety of *all* facts
(i.e. observable & observed reality).

There exists no observational evidence of anything unobservable.

Physics is about reality & not about brainchildren.

"Existance postulate":

An entity cannot exist unless it is able to fully manifest all of its properties.

Based on common sense, essentially refines definition of exist.

∴ An entity having any spatial property requires a minimal amount of space in order to exist.

An entity having *mass* has at least two spatial properties: its *Schwarzschild radius* and its *Compton wavelength*.

∴ **A *mass* requires more than zero space in order to exist.**
We could (re)define ***size*** as this minimally required space.

Schwarzschild volume = sphere with diameter $= 2r_S$:

$$\boldsymbol{V_S} = \frac{4\pi}{3} r_S^3 = \frac{4\pi}{3}\left(\frac{2GM}{c^2}\right)^3 = \frac{4\pi}{3} \cdot \frac{8G^3M^3}{c^6} \boldsymbol{=} \boldsymbol{\frac{32\pi G^3 M^3}{3c^6}}$$

Compton volume = sphere with diameter $= \lambda_C$ ("Compton dipole"):

$$\boldsymbol{V_C} = \frac{4\pi}{3}\left(\frac{\lambda_C}{2}\right)^3 = \frac{4\pi}{3} \cdot \frac{h^3}{8m^3c^3} \boldsymbol{=} \boldsymbol{\frac{\pi h^3}{6m^3c^3}}$$

Tipping point: $$V_S = \frac{32\pi G^3 m_{SC}^3}{3c^6} = \frac{\pi h^3}{6m_{SC}^3 c^3} = V_C$$

$$\therefore \frac{32\pi G^3 m_{SC}^3 \cdot 6 m_{SC}^3 c^3}{3c^6 \cdot \pi h^3} = 1 \therefore \frac{64 G^3 m_{SC}^6}{c^3 h^3} = 1 \therefore m_{SC}^6 = \frac{c^3 h^3}{4^3 G^3}$$

$$\therefore \boldsymbol{m_{SC}} = \sqrt{\frac{ch}{4G}} \approx \mathbf{27.27756} \ \boldsymbol{\mu g}$$ (CODATA 2018).

$$\Delta l_{SC} = \frac{h}{cm_{SC}} = \frac{h\sqrt{4G}}{c\sqrt{ch}} = \sqrt{\frac{4hG}{c^3}} \approx \mathbf{8.102701 \times 10^{-35}} \ \mathbf{m}$$

$$\Delta t_{SC} = \frac{\Delta l_{SC}}{c} \approx \mathbf{2.702770 \times 10^{-43}} \ \mathbf{s}$$

Seems more fundamental than Planck mass & length.

But Schwarzschild-Compton density & pressure

seem hilariously laughably ridiculously gargantuan:

$$\boldsymbol{\rho_{\mathrm{SC}}} = \frac{\boldsymbol{m_{\mathrm{SC}}}}{\boldsymbol{V_{\mathrm{SC}}}} = \frac{m_{\mathrm{SC}}}{\pi h^3/6m_{\mathrm{SC}}^3 c^3} = \frac{6m_{\mathrm{SC}}^4 c^3}{\pi h^3} = \frac{6\sqrt{\frac{ch}{4G}}^4 c^3}{\pi h^3} = \frac{6\frac{c^2h^2}{4^2G^2}c^3}{\pi h^3} = \frac{6c^2h^2c^3}{16\pi h^3G^2}$$

$$= \frac{\boldsymbol{3c^5}}{\boldsymbol{8\pi h G^2}} \approx \mathbf{9.793038 \times 10^{94}\ kg/m^3}$$

$$\boldsymbol{p_{\mathrm{SC}}} \coloneqq \boldsymbol{\rho_{\mathrm{SC}}} \cdot \boldsymbol{c^2} \approx \mathbf{8.801543 \times 10^{111}\ Pa.}$$

Diameters of proton (1.6826 fm) & neutron (~1.6 fm) slightly exceed their respective Compton wavelengths (1.3214 fm & 1.3196 fm).

Compton density & pressure of proton (the only stable baryon):

$$\boldsymbol{\rho}_{\mathbf{C,p}} \coloneqq \frac{m_\mathrm{p}}{V_\mathrm{C,p}} = \frac{m_\mathrm{p}}{\pi h^3/6m_\mathrm{p}^3c^3} = \frac{6m_\mathrm{p}^4c^3}{\pi h^3} \approx \mathbf{1.3845 \times 10^{18}\ kg/m^3}$$

$$\boldsymbol{p}_{\mathbf{C,p}} \coloneqq \rho_\mathrm{C,p} \cdot c^2 \approx \mathbf{1.2443 \times 10^{35}\ Pa}$$

(neutron: 1.3921×10^{18} kg/m^3 & 1.2512×10^{35} Pa).

Do you know the ***observed*** internal pressure of a proton?

It is of $\mathcal{O}(10^{35}$ Pa)[1]

Even strong nuclear force does not crush nucleons inside atomic nucleus, does it?

At neutron Compton density, m_SC would have a diameter of ~ 3.345 nm.

[1] Burkert, V.D., Elouadrhiri, L. & Girod, F.X. The pressure distribution inside the proton. *Nature* **557,** 396-399 (2018).