The smallest black hole
and
Nuclear crystallography

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Abstract

There must be a paradox if we consider black hole as singularity in space-time!
Indeed, if all black hole mass is concentrated in one point (the alleged singularity) and its horizon consists in a sphere of radius R, then by definition of the black hole there must be no energy at all between the singularity and its horizon - for any energy inside the horizon must be absorbed by the so-called singularity! - this sphere must be absolutely empty.
The question then is, by which means this singularity does communicate with the rest of the universe?
It simply can't! Unless we accept that the horizon of the black hole is exactly its surface, so the black hole can't be a singularity but a macroscopic object .

The new approach I am proposing consists in a crystallographic structure to the black hole.

Actually, during the gravitational collapse of a star, the confinement will be so that the distance between two nucleons hardly exceeds the reach of strong interaction which, as a response gets into action to solder nucleons, and whatsoever movement for the nucleons will be very hard to be admitted within the black hole except the oscillation due to the uncertainty principle. Also less than certain distance between tow nucleons, the strong interaction became repulsive which prevent the black hole to go to so alleged singularity.

Once brought by gravitation to a distance equal to the reach of strong interaction, the nucleon cannot detach itself anymore, thus, the aggregation of the whole leads to a gigantic crystal which is the black hole. Nucleons must be frozen in a crystalline structure corresponding to a maximum filling of space by the matter, that is to say, the centralized faces of the cubic structure whose side is λ.

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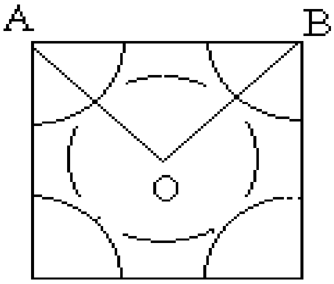
Every part of a nucleon must be at the reach of strong interaction, so the distance between two nucleons must be $R_0/2$, where $R_0 = \frac{\hbar}{m_\pi \times c}$ the strong interaction reach, m_π stands for pion $\pi^{\pm}$ mass.



OA = OB = $R_0/2$

AB = $\lambda = \frac{R_0}{\sqrt{2}}$

the density we get is : $\rho = \frac{4}{\lambda^3} = \frac{8\sqrt{2}}{R_0^3}$

Let V be the black hole volume, the number of nucleons it contains is N = ρV among which I suppose N/2 neutrons and N/2 protons. My supposition will be justified by the result.

Then if M_0 is black hole's mass out of gravitational potential energy considering electrons

$$M_0 = \frac{\rho V}{2} m_n + \frac{\rho V}{2} m_p + \frac{\rho V}{2} m_e$$

where m_n is neutron's mass, m_p is proton's mass, and m_e is electron's mass as constituents of deuterium atom.

As the proton and the neutron are at the reach of strong interaction

$$M_0 = \frac{\rho V}{2}(m_n + m_p + m_e) = \frac{\rho V}{2} m_d = \frac{2\pi}{3} \rho \, m_d \, R^3 \qquad (\ R\ :\ \text{black hole's radius}\ )$$

This M_0 as sphere encompass a potential energy E_p

$$dE_p = \frac{G(\rho \frac{4\pi}{3} r^3) \times (\rho \ [4\pi \ r^2 \ dr])}{r} = \frac{(4\pi)^2 \rho^2 G}{3} r^4 dr \quad \Rightarrow \quad E_p = \frac{(4\pi)^2 \rho^2 G}{3} \int_0^R r^4 dr$$

$$E_p = \frac{3GM_0^2}{5R} \Rightarrow \Delta M_0 = \frac{3GM_0^2}{5RC^2}$$

Then the total black hole mass is : $M = M_0 + \Delta M_0$

The black hole keeps electromagnetic waves from escaping if :

$$C=\sqrt{\frac{2GM}{R}} \Rightarrow C^2=\frac{2GM_0}{R}(1+\frac{3GM_0}{5RC^2})=\frac{4\pi\rho Gm_d R^2}{3}(1+\frac{2\pi\rho Gm_d R^2}{5C^2})$$

let $X=2\pi\rho Gm_d R^2$ then

$$2X^2+10C^2X-15C^4=0 \;\Rightarrow\; X=2\pi\rho Gm_d R^2=\frac{\sqrt{55}-5}{2}C^2$$

So the minimum black hole radius must be $R=C\sqrt{\frac{\sqrt{55}-5}{4\pi\rho\, Gm_d}}$

and the smallest black hole mass is given by $M=\frac{\sqrt{55}+5}{15}\pi\,\rho\, m_d\, R^3$

	ρ (m^{-3})	**R (m)**	**M/M$_s$**	**Ω$_{tn}$ (Kg/m^3)**
From π$^{\pm}$ mass	4,003349873 10^{45}	4 398,87	1,489	8.311 10^{18}
Relativistic result	4,221699342 10^{45}	4 282,65	1,45	8,765 10^{18}

Let you judge by yourself !

NB : Also neutron star must be same, just a big crystal made of neutrons.