A ping-pong ball of neutronium

Radius of atomic nucleus: $R_A = R_0 \cdot \sqrt[3]{A}$ where $R_0 \approx 1.25$ fm

Volume: $V_A = \frac{4\pi}{3} R_A^3 = \frac{4\pi}{3} R_0^3 A \approx A \cdot 8.18 \times 10^{-45}$ m^3

Mass: $m_A = A \cdot 1.675 \times 10^{-27}$ kg (using *mass* of neutron)

Density of atomic nucleus: $\rho_A = \frac{m_A}{V_A} \approx \frac{1.675\times10^{-27}}{8.18\times10^{-45}} \approx 2.05 \times 10^{17}$ kg/m^3

Close-packed *density* of neutronium: $\rho_{N,cp} \approx 5.78 \times 10^{17}$ kg/m^3

Their average: $\rho_N \approx 3.92 \times 10^{17}$ kg/m^3

Diameter of a ping-pong ball: $\varnothing_{pp} = 40$ mm (ITTF[1], Oct. 2000)

Volume of a ping-pong ball: $V_{pp} = \frac{4\pi}{3}(0.02)^3 \approx 3.35 \times 10^{-5}$ m^3

Mass of a ping-pong ball sized blob of neutronium: $m_{N,pp} = \rho_N V_{pp} \approx 1.3 \times 10^{13}$ kg $=$ 13 bln. metric tonnes

Roughly 10 billion (in Dutch: 10 miljard) average cars!

For this *mass*, the *Roche limit* for bodies with a *density* ρ close to that of water (1000 kg/m^3), like living creatures such as YOU, roughly equals[2]: $d = \sqrt[3]{\frac{9m_{N,pp}}{4\pi\rho}} \approx 2.1$ km

and within that *distance* (if not supported by some stable surface) you would be pulled apart by *tidal forces* if you would be held together by your own internal *gravitation* only. Since intermolecular attraction can be quite strong you can still more or less safely approach the thing closer than this *Roche limit*, but be careful!

At $r = 1$ m away from a neutronium ping-pong ball, the gravitational acceleration would be:

$$g_N = \frac{G \cdot m_{N,pp}}{r^2} \approx 870 \text{ m/s}^2 \approx 88 \cdot g_{earth}$$

so if supported by some stable surface, you would undergo 88 G which is to be considered lethal within a very short time. At rest, an average human of $m_h = 75$ kg would weigh 65 000 newtons (roughly the *weight* of 6 average cars).

Were you in orbit around it or in free fall towards it, you would undergo a *tidal force per mass* per Δ*distance* of:

$$g = \frac{G \cdot m_{N,pp}}{r^2} \quad \therefore \quad \frac{dg}{dr} = \frac{-2G \cdot m_{N,pp}}{r^3} \approx \frac{-1753}{r^3} \text{ N/kg/m} \quad (r \text{ in metres}).$$

Orbital velocity at $r = 1$ m would be: $v = \sqrt{\frac{G \cdot m_{N,pp}}{r}} \approx 29.5$ m/s

orbital period would be: $T = \frac{2\pi r}{v} \approx 0.2$ s

Two kilograms (cubic decimetres) somewhere in your body at half a meter out of each other and on average 1 m away from the thing, would feel a stretching *tidal force* of roughly 900 newtons, more than the average human total *body weight* on Earth. This applies to any pair of kilograms in your body at that mutual *distance*, so you'll probably not be able to withstand it. If in orbit you'll be pulled apart by it and in free fall (feet forward) your feet would want to accelerate far more than your head, thus stretching you over the limit (spaghettification). Within a very short time you will quite heavily collide with the thing, which will finalise your termination.

R.I.P.

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[1] http://www.ittf.com

[2] https://en.wikipedia.org/wiki/Roche_limit#A_more_accurate_formula

