Large and massive neutron stars:
Implications for the sound speed within QCD of dense matter

Analyses of recent NICER data suggest that the heaviest precisely known neutron star, PSR J0740+6620, has a radius in the range $R_{2.0}$ ≈ (11.4 – 16.1) km at the 68% level.

We studied the implications for the sound speed in the inner cores using chiral EFT calculations of the nuclear EOS with quantified uncertainties at the moderate densities encountered in the outer core.

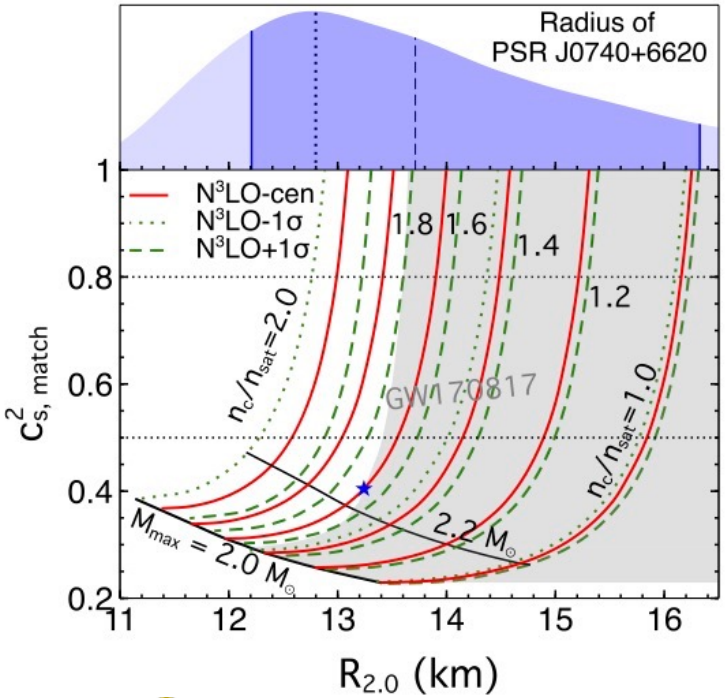
We find that a high sound speed, exceeding 75% of the speed of light at the 68% level, is required in J0740's inner core, should improved measurements confirm $R_{2.0}$ > 13 km in the future.

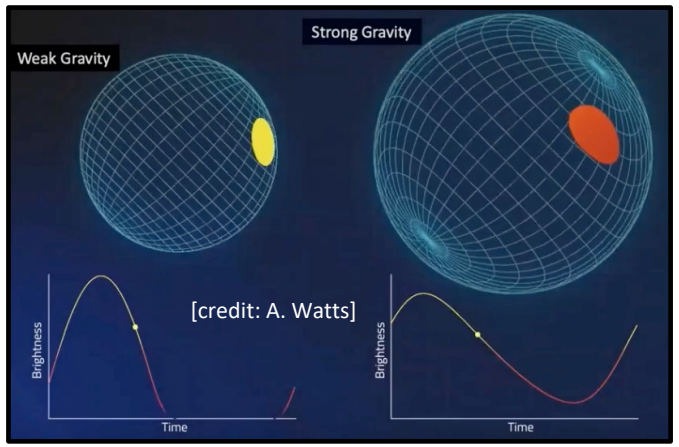
The strong increase in the sound speed might indicate a rapid transition from rather soft neutron-rich matter to a much stiffer, unknown form of strongly interacting matter.

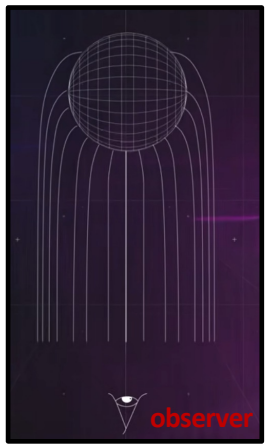
$$M = 2.08 \pm 0.07\,\mathrm{M}_\odot$$
Shapiro delay: Cromartie *et al.* (2020)

$$R_{2.0} = 12.39^{+1.30}_{-0.98}\,\mathrm{km}$$
Riley *et al.* (2021)

$$R_{2.0} = 13.7^{+2.6}_{-1.5}\,\mathrm{km}$$
Miller *et al.* (2021)







Emissions from neutron stars with hot spots probe the surrounding space-time geometry

X-ray pulse profiling and ray tracing allow inferring the neutron star's mass and radius

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