Primordial Black Holes May Spur Production of Heavy Elements

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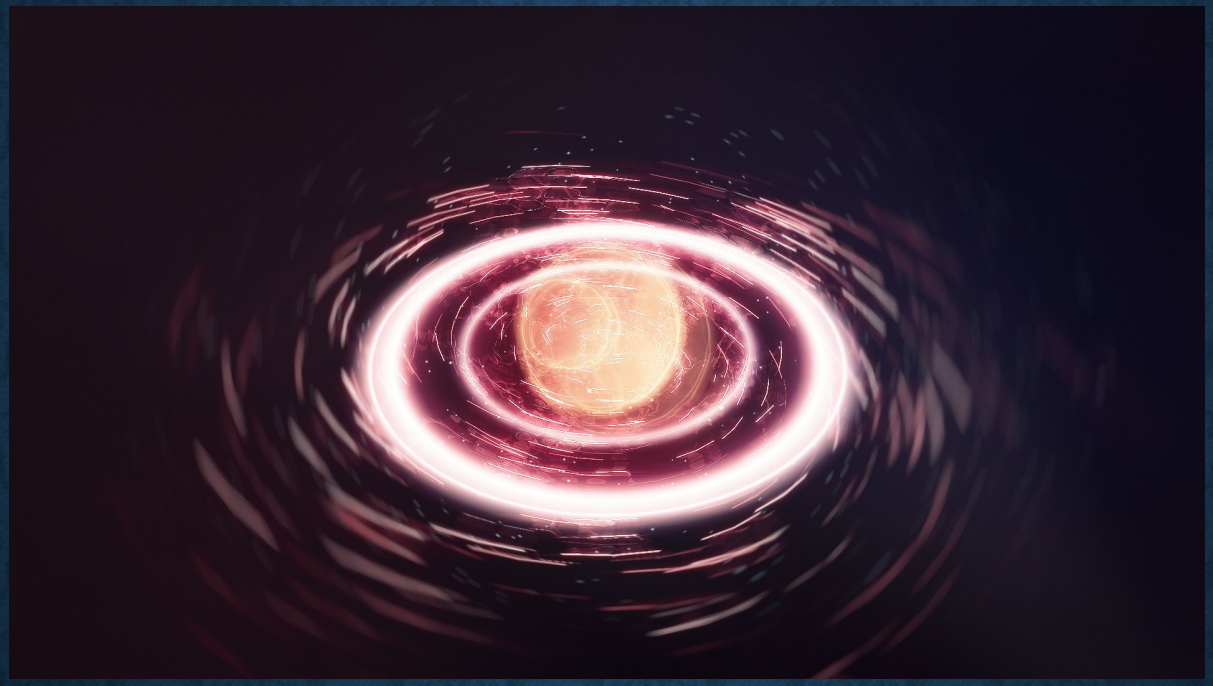
SALIENT POINTS

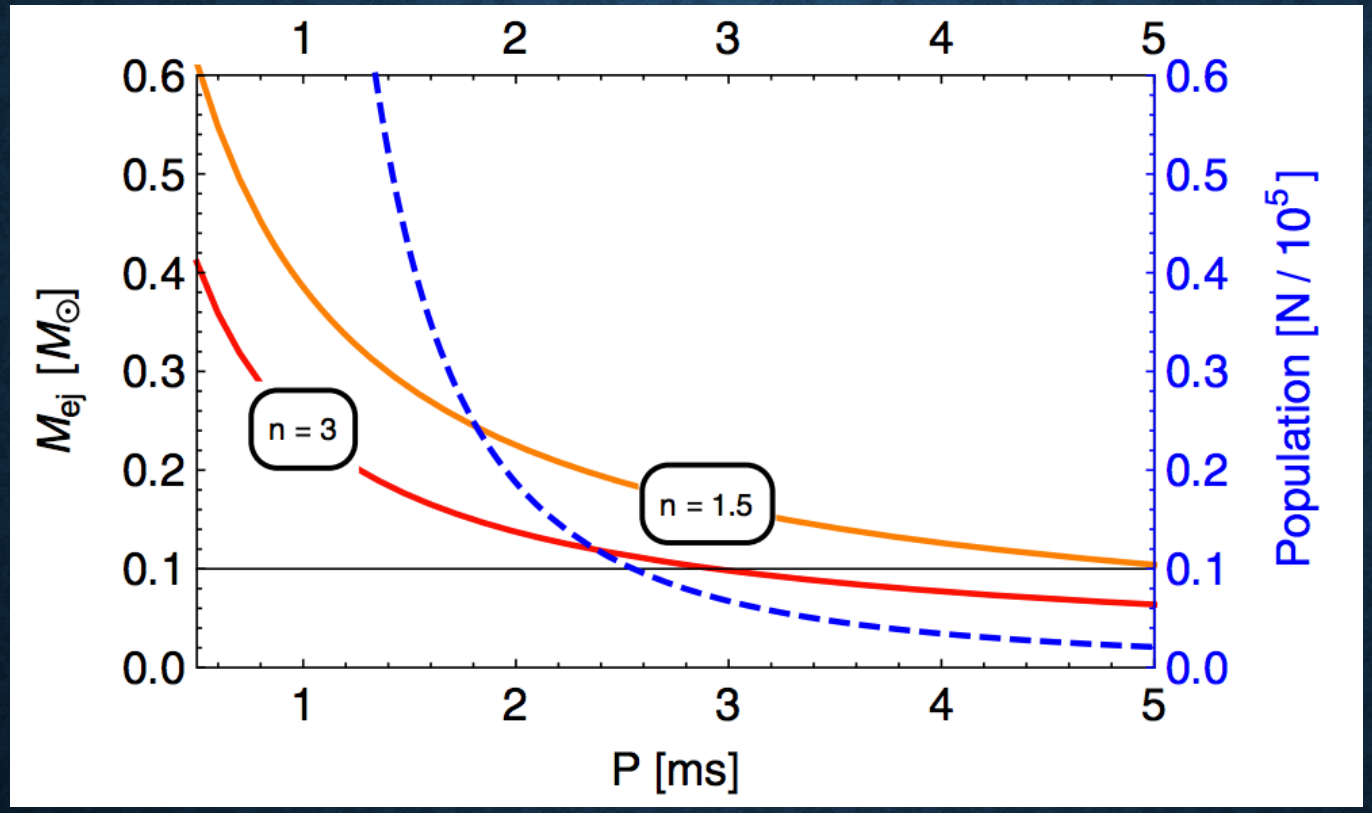
- Primordial black holes (PBH) may find their way into the cores of rotating neutron stars (pulsars).
- The presence of a PBH can cause outer neutron rich layers to be ejected, showering space with r-process material.
- Statistics of expected neutron star disruption process, and expected mass of ejected matter account for r-process content in our galaxy.
- PBH disruptions of NS are expected to be accompanied by fast radio bursts and gamma rays. Moreover, significant gravitational waves and neutrino showers are not expected to be observed, providing means of testing idea.

NEUTRON STAR DISRUPTION



- Consider a PBH merging into the core of a rotating NS. The PBH pulls in matter decreasing the size of the star. Conservation of angular momentum will then yield "differential rotation".
- Depending on the viscosity and magnetic stresses in the system, the outer layers of the star can reach escape velocity showering surrounding space with (0.1-0.5) solar masses of neutron rich matter.

SOLVING EQUATION OF STATE



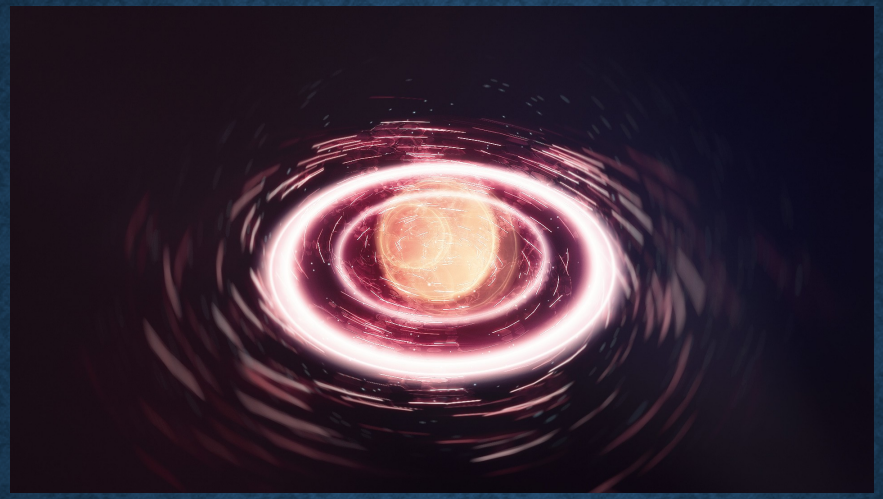
Fuller et.al 2017

- Faster rotating pulsars will eject more mass than slower counter parts

GOOD TAKEAWAYS

- Neutron ejection process leaves the star relatively cool hence neutrino exposure is limited, and neutrino capture is suppressed.
- PBH disruption theory can account for A=130 and A=195 observed r-process abundance peaks.
- 10^5 neutron star disruption processes are expected to have occurred in the lifetime of our galaxy ejecting neutron rich material between 0.1 and 0.5 solar masses.
- Simple calculation shows this corresponds to 10,000-50,000 solar masses of neutron rich matter.

TESTING



- PBH disruption expected to be accompanied by fast broadband radio bursts (FRB) and gamma ray emissions due to the release of stored magnetic energy and acceleration of charged particles.
- Significant gravitational waves and neutrino flux are not to be accompanied by FRBs and Kilonova like signatures.
- A combination of these clues are not expected in compact object mergers, or supernova scenarios, thus providing means of testing PBH disruption theory.

IN CASE YOU'RE CURIOUS

- George M. Fuller et al. Primordial Black Holes and r-Process Nucleosynthesis, Physical Review Letters (2017). DOI: 10.1103/PhysRevLett.119.061101