Contribution ID: **61** Type: **Working Group Sessions**

Primordial Black Holes and r-Process Nucleosynthesis

Tuesday, 20 June 2017 12:30 (20 minutes)

We show that some or all of the observed inventory of r-process nucleosynthesis can be produced in interactions of primordial black holes (PBHs) with neutron stars (NSs) if PBHs of 10^(−14) to 10^(−8) solar masses make up a few percent or more of the dark matter. A PBH captured by a neutron star (NS) sinks to the center of the NS and consumes it from the inside. When this occurs in a rotating millisecond-period NS, the resulting spin-up ejects ~0.1-0.5 solar masses of relatively cold neutron-rich material. This ejection process and the accompanying decompression and decay of nuclear matter can produce electromagnetic transients, such as a kilonova-type afterglow and fast radio bursts. These transients are not accompanied by significant gravitational radiation or neutrinos, allowing such events to be differentiated from compact object mergers occurring within the distance sensitivity limits of gravitational wave observatories. The PBH-NS destruction scenario is consistent with pulsar and NS statistics, the dark matter content and spatial distributions in the Galaxy and Ultra Faint Dwarfs (UFD), as well as with the r-process content and evolution histories in these sites. Ejected matter is heated by beta decay, which leads to emission of positrons in an amount consistent with the observed 511-keV line from the Galactic Center.

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Session Classification: Working Group: Astroparticle physics and cosmology

Track Classification: Astroparticle Physics and Cosmology Working Group