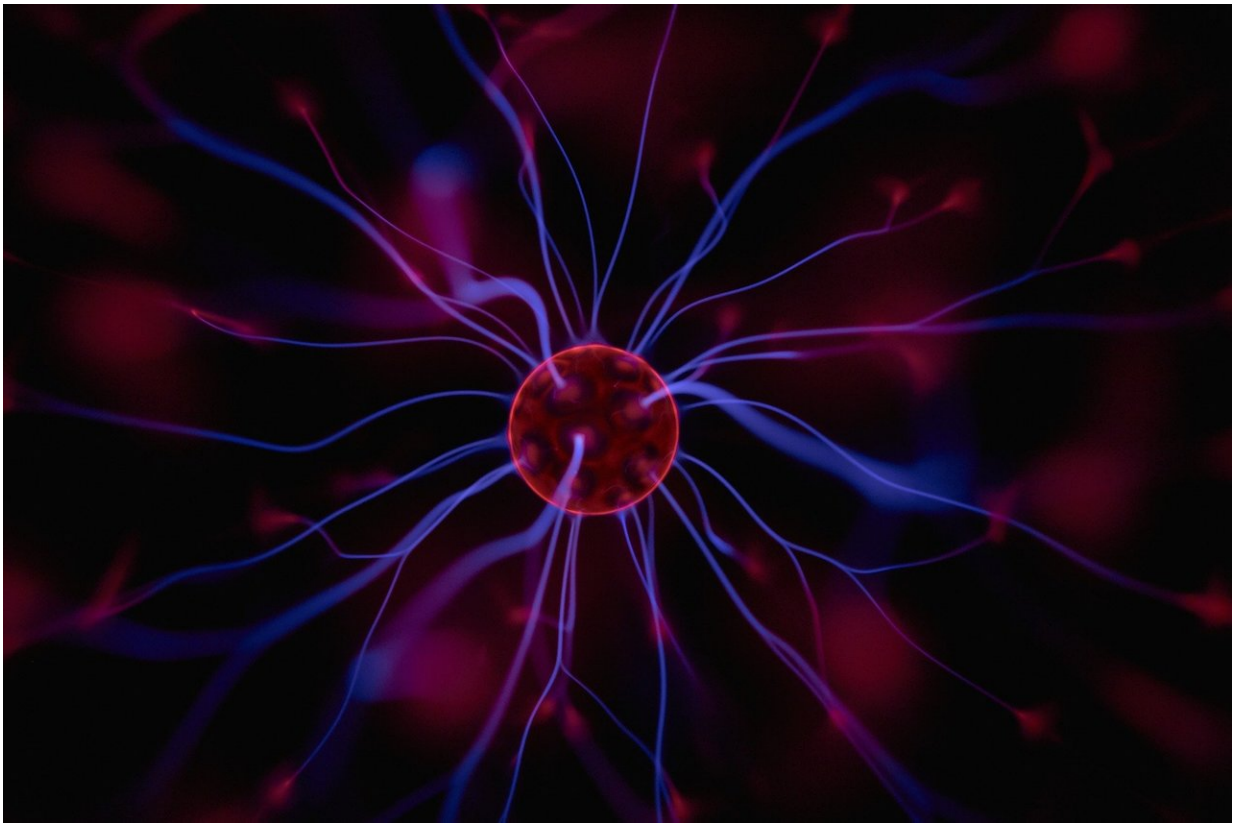
Researchers suggest collapsar accretion disks might be source of heaviest elements

May 9 2019, by Bob Yirka



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A trio of researchers at Columbia University is suggesting that collapsar accretion disks might be the major source of the heaviest elements. In their paper published in the journal *Nature*, Daniel Siegel, Jennifer

Barnes and Brian Metzger describe their study of the accretion disks that form as neutron stars collapse into black holes, and what they found.

Space scientists believe that the lightest elements, helium, hydrogen and lithium, originated just after the Big Bang. They also believe that heavier elements such as iron were created in the centers of stars. But heavier elements such as uranium and gold have remained a mystery—until now, there has been no plausible explanation for their origin. In this new effort, the researchers suggest that such elements were created in accretion disks formed when neutron stars collapse into black holes.

Prior research has suggested that the heaviest elements were created by what is known as the "r-process," in which a chain reaction results in atomic nuclei absorbing neutrons. Astrophysicists had theorized that two neutron stars colliding would likely give way to the conditions necessary for the r-process to occur, creating some of the heaviest elements. Two years ago, the team credited with observing the first gravity waves reported the effects of two neutron stars colliding. Subsequent study of the event showed that it was likely that the r-process had occurred, giving strong credence to the theory. But there was still one problem. The collision of neutron stars is a rare event—too rare to account for the amount of the heaviest elements that exist today. That led the researchers to consider other neutron star activities—such as their gravitational collapse.

Prior research had shown that when neutron stars die, they collapse into black holes. But not all of their material falls into the black hole; some is left behind and forms into an accretion disk. Computer simulations the researchers created showed that conditions in the accretion disks were ripe for the r-process, giving way to creation of the heaviest elements. The team suggests that approximately 80 percent of these elements originate in accretion disks, and the remainder are created when neutron stars collide.

More information: Daniel M. Siegel et al. Collapsars as a major source of r-process elements, *Nature* (2019). DOI: 10.1038/s41586-019-1136-0