Most Black Holes Might Come in Only Small and Large

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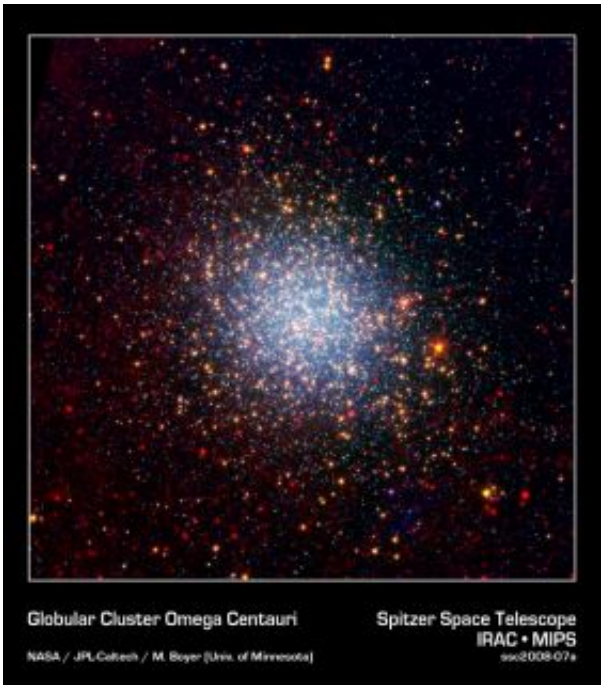

Until now, astronomers had suspected that globular clusters like the one pictured here were the most likely place to find medium-sized black holes -- elusive objects that have proved difficult to pin down. Globular clusters are spherical collections of stars that orbit around larger galaxies like our Milky Way. Scientists analyzed a globular cluster called RZ2109 and found it does not possess a medium-sized black hole. RZ2109 is much farther away than the globular cluster pictured here, called Omega Centauri.Image Credit: NASA/JPL-Caltech/ NOAO/AURA/NSF

(PhysOrg.com) -- Black holes are sometimes huge cosmic beasts,

billions of times the mass of our sun, and sometimes petite with just a few times the sun's mass. But do black holes also come in size medium? A new study suggests that, for the most part, the answer is no.

Astronomers have long suspected that the most likely place to find a medium-mass black hole would be at the core of a miniature galaxy-like object called a globular cluster. Yet nobody has been able to find one conclusively.

Now, a team of astronomers has thoroughly examined a globular cluster called RZ2109 and determined that it cannot possess a medium black hole. The findings suggest that the elusive objects do not lurk in globular clusters, and perhaps are very rare.

"Some theories say that small black holes in globular clusters should sink down to the center and form a medium-sized one, but our discovery suggests this isn't true," said Daniel Stern of NASA's Jet Propulsion Laboratory in Pasadena, Calif. Stern is second author of a study detailing the findings in the Aug. 20 issue of *Astrophysical Journal*. The lead author is Stephen Zepf of Michigan State University, East Lansing.

Black holes are incredibly dense points of matter, whose gravity prevents even light from escaping. The least massive black holes known are about 10 times the mass of the sun and form when massive stars blow up in supernova explosions. The heftiest black holes are up to billions of times the mass of the sun and lie deep in the bellies of almost all galaxies.

That leaves black holes of intermediate mass, which were thought to be buried at the cores of globular clusters. Globular clusters are dense collections of millions of stars, which reside within galaxies containing hundreds of billions of stars. Theorists argue that a globular cluster should have a scaled down version of a galactic black hole. Such objects would be about 1,000 to 10,000 times the mass of the sun, or medium in

size on the universal scale of black holes.

In a previous study, Zepf and his colleagues looked for evidence of a black hole in RZ2109, located 50 million light-years away in a nearby galaxy. Using the European Space Agency's XMM-Newton telescope (which derives its name from X-ray Multi-Mirror design), they discovered the telltale X-ray signature of an active, or "feeding" black hole. But, at that point, they still didn't know its size.

Zepf and Stern then teamed up with others to obtain a chemical fingerprint, called a spectrum, of the globular cluster, using the W.M. Keck Observatory on Mauna Kea in Hawaii. The spectrum revealed that the black hole is petite, with roughly 10 times the mass of our sun.

According to theory, a cluster with a small black hole cannot have a medium one, too. Medium black holes would be quite hefty with a lot of gravity, so if one did exist in a globular cluster, scientists argue that it would quickly drag any small black holes into its grasp.

"If a medium black hole existed in a cluster, it would either swallow little black holes or kick them out of the cluster," said Stern. In other words, the small black hole in RZ2109 rules out the possibility of a medium one.

How did the scientists figure out that the globular cluster's black hole was small in the first place? Using modeling techniques, Zepf and his colleagues concluded that the spectrum taken by Keck reveals high-velocity flows of matter, or "winds," firing out of the black hole. Only a small black hole could spit out these observed high winds.

Zepf explains, "We knew from X-ray data that this black hole was actively swallowing up, or accreting, material. If an intermediate-sized black hole were accreting this material, it wouldn't be too big of a deal

for it. But if a small black hole were accreting this material, it would be a lot for it to take and therefore some material would be ejected in the form of high winds. Thus, the high winds were our smoking gun showing that this black hole is small."

Is this the end of the story for medium black holes? Zepf said it is possible such objects are hiding in the outskirts of galaxies like our Milky Way, either in surrounding so-called dwarf galaxies or in the remnants of dwarf galaxies being swallowed by a bigger galaxy. If so, the black holes would be faint and difficult to find.

Provided by NASA