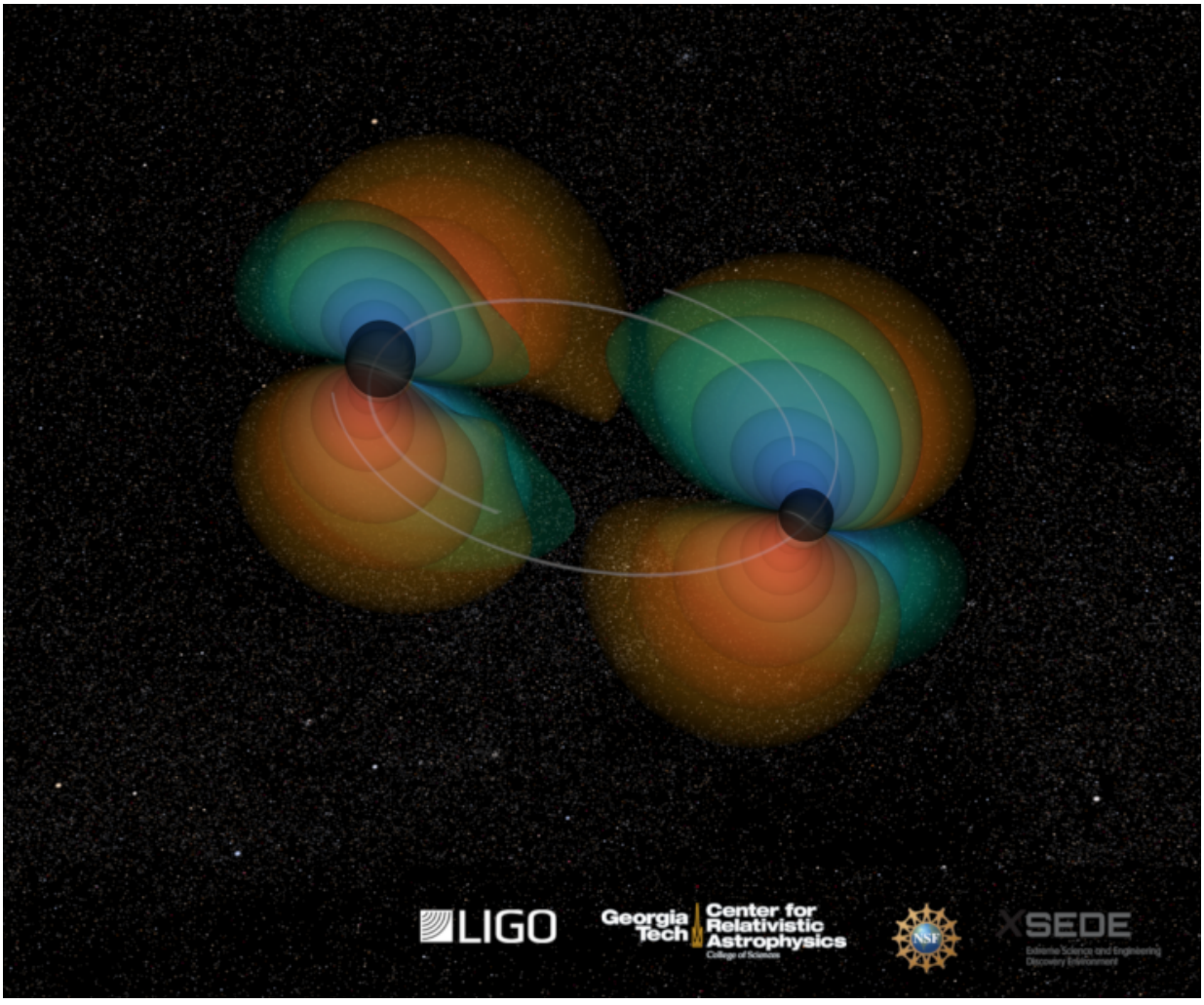
Gravitational waves data suggest Goldilocks black holes are rare

May 24 2017, by A. Maureen Rouhi



Credit: Georgia Institute of Technology

Black holes can be divided into three classes according to mass. On the low end are those with masses 10 times that of the sun. Examples are the two black holes whose merger generated the first gravitational wave to be detected, by the LIGO Scientific Collaboration (LSC), an international team including researchers in the School of Physics' Center for Relativistic Astrophysics (CRA). LIGO stands for Laser Interferometer Gravitational-Wave Observatory, a facility based in the U.S.

On the high end are black holes that are a million times as massive as the sun. Evidence for them comes from NASA images.

For the Goldilocks black holes, with masses in between, no hard proof exists to date. Indirect evidence has been offered, but nothing unambiguous so far. A single detection can transform our understanding of the first stars in the universe.

As it happens, LIGO has been designed to detect gravitational waves arising from collisions of midsize black holes. A recent study suggests that the Goldilocks of black holes may be uncommon. Analysis of LIGO data collected from September 2015 through January 2016 found no evidence for midsize black holes. However, the work enables scientists to estimate more accurately than ever before the abundance of such black holes.

The paper reports a "survey of the universe for midsize-black-hole collisions up to 5 billion light years ago," says Karan Jani, a former Georgia Tech Ph.D. physics student who participated in the study. That volume of space contains about 100 million galaxies the size of the Milky Way. Nowhere in that space did the study find a collision of midsize black holes.

"Clearly they are much, much rarer than low-mass black holes, three

collisions of which LIGO has detected so far," Jani says. Nevertheless, should a gravitational wave from two Goldilocks black holes colliding ever gets detected, Jani adds, "we have all the tools to dissect the signal."

The study was undertaken by hundreds of scientists worldwide belonging to LSC and the Virgo Collaboration, another international team observing gravitational waves from a facility in Italy. Georgia Tech scientists worked on the paper in close collaboration with colleagues from the Albert Einstein Institute Hannover, in Germany; Hillsdale College; Kenyon College; Massachusetts Institute of Technology; Pennsylvania State University; Radboud University, in the Netherlands; Université Paris Diderot, in France; and the University of Birmingham, in England.

More information: Search for intermediate mass black hole binaries in the first observing run of Advanced LIGO. arxiv.org/pdf/1704.04628.pdf

Provided by Georgia Institute of Technology

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