Bumper crop of black holes in new gravitational wave paper

October 29 2020

LIGO team member entering one of the LIGO Livingston detector chambers. Credit: University of Portsmouth

Only a few years ago, scientists the world over celebrated as the first-ever gravitational waves were detected—confirming a long-held scientific theory and opening up an entirely new field of research.

Now, the international research team responsible for detecting gravitational waves has announced a further 39 gravitational wave

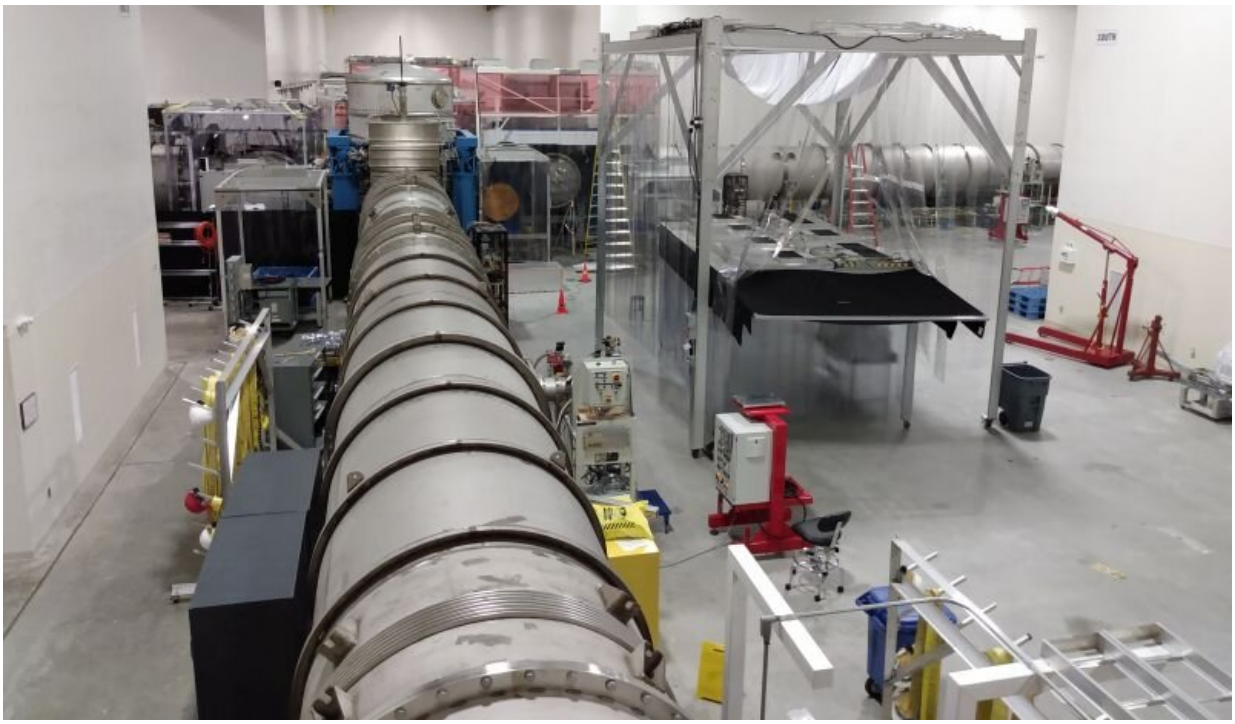
events, bringing the total number of confirmed detections to 50.

The Laser Interferometer Gravitational-Wave Observatory (LIGO) and Virgo Collaborations, which include researchers from the University of Portsmouth, have today published a series of papers that record events including the mergers of binary black holes, binary neutron stars and, possibly, neutron star-black holes.

These events were recorded during the first six months of the LIGO and Virgo detectors' third Observing Run.

Dr. Andrew Williamson, from the University of Portsmouth's Institute of Cosmology and Gravitation, said: "This new catalogue of discoveries includes 39 new gravitational wave events observed between 1 April and 1 October 2019. That's more than one discovery per week.

"Most of these were produced by merging pairs of black holes, but it also includes the second ever discovery of a colliding pair of neutron stars, and possibly the first discovery of a black hole and neutron star pair merging. Neutron stars are the extremely dense remains of dead stars, weighing more than our Sun but crushed into something the size of a city, less than 15 miles across.



The inside of the LIGO Livingston interferometer. Credit: University of Portsmouth

"Combined with 11 discoveries made before 2019, we have now discovered 50 gravitational wave events, with many more surely to come. We now have enough events that we can really begin to answer questions like: 'just how common are merging pairs of black holes?' and 'what does the population of black holes look like?'"

UK scientists have designed and built instrumentation for the LIGO detectors, which are based in the United States, and have contributed to the analysis and interpretation of the data collected throughout the three observing runs. The UK's contribution to the collaborations is funded by the Science and Technology Facilities Council.

With this new, expanded catalogue of detections, scientists are provided with a wealth of black hole data to rigorously test Einstein's General Theory of Relativity and give new insight into how black holes and neutron stars come into being.

Researchers at Portsmouth had a leading role in planning, building and running one of the main analyses that detected the gravitational waves included in this catalogue and Ph.D. student, Simone Mozzon, spent three months working at one of the LIGO detectors in Louisiana during the course of these observations.

Simone said: "I was lucky enough to work at LIGO in Livingston at the end of 2019 where my role was to reduce the impact of external noise sources to the gravitational wave data. LIGO detectors are extremely complex and sensitive, and each component has to be isolated from external noise disturbances like ground motion due to earthquakes, ocean waves and even people walking and talking."

The new observations include binary black holes ranging from approximately five times the mass of the Sun at one end of the scale, all the way up to 85 times the mass of the Sun. At the top of this scale, the biggest black holes are much more massive than previously thought to exist. In another observation, a black hole was seen to merge with an object 2.6 times the mass of the Sun. If that object was a black hole, it would have been lighter than thought possible. Alternatively, it may have been the biggest neutron star ever observed. Now, astrophysicists will look to find out how and where in the Universe the systems found by LIGO and Virgo were formed.

Dr. Williamson said: "These discoveries really challenge what we thought we knew about how these pairs of black holes form. In the coming years we expect to detect gravitational waves from deep space ever more frequently, allowing us to unravel these mysteries. And there

may well be more surprises in store."

Provided by University of Portsmouth