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LIGO TEAM DETECTS SECOND MERGER OF TWO NEUTRON STARS

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Photo of merging neutron stars as conceived by artist | Photo Credit: Special Arrangement

Gravitational wave signals detected by the LIGO detector at Livingstone, Louisiana, on April 25, 2019, are likely due to the collision of two neutron stars, a new study reveals. This is the first time the group is making an announcement based on signal detected by only one of three active detectors in the world.

The total mass of the binary system is estimated to lie between 3.3 and 3.7 times the mass of the Sun. This value lies well above what is “normal” for binary neutron star pairs in our galaxy. One possibility for this is that the neutron stars formed separately and later drifted together to form a binary star pair, though this cannot be confirmed by the data.

The pair of neutron stars most likely collided at a distance of 520 million light years away, as inferred by the data. This combined mass is much larger than that of any known binary neutron star system that we know till date in the Milky Way. The team, therefore, cannot rule out the possibility that one, or even both, of the members of the binary system is a black hole. However, the most straightforward explanation is that the pair consists of neutron stars.

“This event is weaker than the first binary neutron star detection in August 2017 and hence does not allow precise measurement of the composition of the stars. Therefore, the possibility of one or both components being black hole(s) cannot be ruled out. Either this is the heaviest binary neutron star system observed till date or the lightest binary containing a black hole. Though the former agrees better with the conventional wisdom, the latter cannot be ruled out, which is what is exciting about this event,” says Prof. K.G. Arun of the Chennai Mathematical Institute, who is one of the authors of the paper that has been submitted to *The Astrophysical Journal Letters.*

The LIGO system consists of two detectors – one at Hanford, Washington, and the other at Livingstone, Louisiana. At the time of detection of this signal, dubbed GW190425, the detector at Hanford was offline and did not detect any signal. However, a strong signal was detected by LIGO Livingstone. The European Virgo detector was also taking readings at this time; however, the signal received by it was not above the detection threshold. This is because the detector has a lower sensitivity than the LIGO detectors and also perhaps the event occurred in a part of the sky that was not very accessible to it.

This merger was detected in the third observing run of the LIGO detectors, which started on April 1, 2019, and is still going on. Between observing runs, the detectors are offline and are upgraded with technology to improve their sensitivities. In the second run (November 2016 – August 2017), the detectors detected the first neutron star merger on August 17, 2017. This was accompanied by a gamma ray burst, a brilliant flash of light, which was picked up by electromagnetic detectors across the world. The important thing about the latest described merger – GW190425 – is that there was no such electromagnetic counterpart either.

Given all these constraints, the LIGO scientists were able to locate the event to a point that could lie within about 20% of the sky. This is a wide range of uncertainty. In comparison, the earlier event (GW170817) was located within 0.04% of the sky, nearly 500 times improved accuracy. This is because that signal was picked up by three detectors each located far away

from the other, and accuracy improves with the number of such faraway detectors.

Finally, the fact that now two neutron star mergers have been spotted has also been used by the team to predict a rate of neutron star mergers as 250-2810 per gigaparsec-cubed per year.

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