research highlights

GRAVITATIONAL WAVES

Duo becomes a trio

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One month into the second observing run of the Advanced Laser Interferometer Gravitational-Wave Observatory (LIGO), the two US-based detectors recorded a third gravitational wave signal with high statistical significance, GW170104. The signal originated from the merger of a pair of stellar-mass black holes, coalescing to form a ~50 $M_\odot$ hole and radiating the equivalent of ~2 $M_\odot$ worth of energy. With the two previous detections, GW150914 (62 $M_\odot$ final mass) and GW151226 (21 $M_\odot$ final mass), the science team has constrained the rate of binary black hole mergers to 12–213 mergers per cubic gigaparsec per year.

The merger event GW170104, which occurred roughly 3 billion years ago, involved black holes with masses of ~30 and ~20 $M_\odot$, at a redshift of $z \sim 0.2$ — the highest yet. The high masses indicate that the metallicity of the host environment could be subsolar. There is some small (and quite possibly negligible) indication that the progenitor black holes were spinning in misaligned directions: a possible sign that they were not originally a binary pair but perhaps combined due to their proximity in a dense stellar cluster.

The LIGO scientists have also used this third detection to perform more stringent tests on general relativity (GR). They assessed the potential for a departure from GR of the wave's dispersal relation (dispersal is forbidden by GR), examined the expansion coefficients of the wave in an effective-precession model, and investigated whether the merger–ringdown portion of the GW signal was consistent with the inspiral part. No tests indicated a significant departure from GR.

The present observing run continues until mid-2017, when further sensitivity upgrades will take place. The LIGO community is currently working on studying six more candidate merger event signals. Hopefully at least one might involve a neutron star so that some kind of electromagnetic signal might also have been detected. No counterpart electromagnetic signals have been detected for any of the three events announced to date.

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