Echoes from the Abyss: A highly spinning black hole remnant for the binary neutron star merger GW170817

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The first direct observation of a binary neutron star (BNS) merger was a watershed moment in multi-messenger astronomy. However, gravitational waves from GW170817 have only been observed prior to the BNS merger, but electromagnetic observations all follow the merger event. While post-merger gravitational wave signal in general relativity is too faint (given current detector sensitivities), here we present the first tentative detection of post-merger gravitational wave "echoes" from a highly spinning "black hole" remnant. The echoes may be expected in different models of quantum black holes that replace event horizons by exotic Planck-scale structure and tentative evidence for them has been found in binary black hole merger events. The fact that the echo frequency is suppressed by $\log M$ (in Planck units) puts it squarely in the LIGO sensitivity window, allowing us to build an optimal model-agnostic search strategy via cross-correlating the two detectors in frequency/time. We find a tentative detection of echoes at $f_{\rm echo} \simeq 72$ Hz, around 1.0 sec after the BNS merger, consistent with a 2.6-2.7 $M_\odot$ "black hole" remnant with dimensionless spin $0.84-0.87$. Accounting for all the "look-elsewhere" effects, we find a significance of 4.2σ, or a false alarm probability of 1.6×10^{-5}, i.e. a similar cross-correlation within the expected frequency/time window after the merger cannot be found more than 4 times in 3 days. If confirmed, this finding will have significant consequences for both physics of quantum black holes and astrophysics of binary neutron star mergers.

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