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Kilonova Emission from a Binary Neutron Star Merger[1]

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On August 17 the LIGO/Virgo gravitational wave observatories detected the first binary neutron star merger event, a discovery followed by the most ambitious electromagnetic (EM) follow-up campaign ever conducted. Within 2 seconds of the merger, a weak burst of gamma-rays was discovered by the Fermi and INTEGRAL satellites. Within 11 hours, a bright but rapidly fading thermal optical counterpart was discovered in the galaxy NGC 4993 at a distance of only 40 Mpc. The properties of the optical transient match remarkably well predictions for "kilonova" emission powered by the radioactive decay of heavy nuclei synthesized in the merger ejecta by the rapid capture of neutrons onto lighter seed nuclei (r-process nucleosynthesis). I will argue that the end product of the merger was likely a temporarily stable "hyper-massive" neutron star, which collapsed to a black hole relatively quickly - within a few hundred milliseconds following the coalescence. This inference, as well as others obtained by the electromagnetic and gravitational wave signals, place strict constraints on the uncertain properties (radii and maximum mass) of neutron stars. I will conclude by previewing the potential diversity of kilonova emission expected in the impending era of multi-messenger astronomy, once at design sensitivity Advanced LIGO/Virgo detect a merger roughly weekly.

[1]NASA, National Science Foundation, Research Corporation for Science Advancement