

WHEN BLACK HOLES COLLIDE

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R = 8\pi GT_{\mu\nu}$$

Images courtesy Caltech/MIT/LIGO Laboratory and APS

A colloquium sponsored by the Department of Mathematics and the Department of Physics to celebrate the **discovery of GRAVITATIONAL WAVES**

- predicted by Einstein in 1916, confirmed by LIGO a century later -

BEVERLY BERGER

Observation of gravitational waves from a binary black hole merger: a new window on the universe

LIGO's detection of gravitational waves from a binary black hole merger inaugurates a completely new mode of observational astronomy and represents the culmination of a quest lasting half a century. After a brief review of gravitational waves in general relativity, I will discuss the detection itself. How do the LIGO instruments work? How do we know the signal was caused by a binary black hole merger? What does this detection tell us about binary black holes? Then I will focus on how this moment came to pass. The detection required many ingredients to be in place including (1) developments in theoretical relativity to allow proof that gravitational waves were not coordinate artifacts; (2) a bold vision to recognize that gravitational wave detection was not impossible; (3) technological developments of novel vacuum systems, lasers, optical coatings, active seismic isolation, etc.; (4) the successful conclusion of a 35 year effort to simulate binary black holes on the computer; (5) development of sophisticated, new data analysis methods to tease a waveform from noisy data; (5) the growth of the field of gravitational wave science from a handful of practitioners to the more than 1000 authors on the detection paper; and finally (6) the (nearly) unwavering support of the National Science Foundation. Finally, I will discuss the future — more binary black holes, other sources of gravitational waves and what we might learn, instrument upgrades, new facilities — and other ways to detect gravitational waves — from space and from monitoring millisecond pulsars.



Beverly Berger with Kip Thorne at the APS special session in her honor

MARCH 23, 2016 at 5 PM
WILDER AUDITORIUM
KNIGHT PHYSICS BUILDING
(refreshments at 4:30 PM
in the Physics Library)

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