Fall
2016

Mathematical Sciences Seminar

"When black holes collide: 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. The first detection was followed by a second one in this first "science run" and soon another science run will begin. I will end with discussion of 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 K. Berger

Thursday, October 27, 2016

Lally 104

Host: Jeffrey Banks

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