

COLLOQUIUM
UNIVERSITY OF PITTSBURGH
FRIDAY, APRIL 1, 2016
704 THACKERAY HALL
3:30 P.M.

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EINSTEIN'S GENERAL RELATIVITY, BLACK HOLES
& THE QUIXOTIC SEARCH FOR GRAVITATIONAL WAVES

ABSTRACT: On September 4th 2015 at 5.51 a.m. (EDT), almost exactly one hundred years after Albert Einstein finished constructing his theory of space-time and gravity, two detectors, one in Livingston, Louisiana, and a second in Hanford, Washington, seven milliseconds apart, recorded a pulse of gravitational waves, inaugurating a new era in astronomy and cosmology.

Analysis of these waves showed them to be the product of a distant collision, so violent that it can only be explained as a merger of massive black holes. That black holes would exist in Einstein's theory was proved mathematically by Roger Penrose some fifty years ago. Their properties were later developed by a series of masters of general relativity, including our own Ted Newman. Now they can be studied in the laboratory!

In this talk, I will begin by tracing the history of the development of the concepts of space and time and the theory of gravity. I will emphasize the triality between observation, theory and technology.

- The first era I will take to end with the Third Law of Johannes Kepler.
- The second era proceeds through Galileo Galilei, Isaac Newton and James Clerk Maxwell, leading to a conundrum, which was partially resolved by Einstein's theory of special relativity.
- The third and present era fully resolves the conundrum, starting with the invention of space-time by Hermann Minkowski and the subsequent development of general relativity, particularly by Einstein, Marcel Grossman and David Hilbert.

I will discuss the prediction of gravitational waves (and who seems to have been the first to predict them!), and the seeming impossibility of ever detecting them. Over a period of forty years, experimenters built a series of terrestrial detectors, never detecting any kind of signal until now. A huge technological and theoretical effort was required to upgrade the detectors and to properly analyze the phenomena that might create a detectable signal. I will end by discussing prospects for the future, which probably require building the detectors in space. I will attempt to keep the discussion at the most elementary level possible.

Refreshments served at 3:00 p.m.
in the Math Dept. COMMON ROOM, Thackeray 705