Detecting Massive Black Holes via Attometry—Gravitational Wave Astronomy Begins

MONDAY 11:15 AM    ROOM: America’s Ballroom (2nd Level)

Keith Riles, Ph.D., University of Michigan, Ann Arbor

In their first observing run, the two detectors of the Advanced Laser Interferometer Gravitational-Wave Observatory (Advanced LIGO) simultaneously observed transient gravitational-wave signals. The detected waveforms indicated the inspiral and merger of pairs of massive black holes more than 1 billion years ago. These discoveries marked the first direct detections of gravitational waves and the first observations of binary black hole mergers. Ironically but perhaps not surprisingly, the detection of these cataclysmic events so far away depended on measuring distance changes between mirrors at the attometer level. The first gravitational-wave discoveries and the instruments that made them possible are presented.

Professor Riles carries out research into the fundamental forces of nature, working in both gravitational wave and elementary particle physics. He leads the Michigan Gravitational Wave Group and is a member of the LIGO Scientific Collaboration (LSC), which in September 2015 discovered gravitational waves from the merger of two massive black holes. This $300 million project, led by Caltech and MIT, operates 4-km Michelson laser interferometers at sites in Hanford, Washington and Livingston, Louisiana. These interferometers are designed to measure minute disturbances in space itself to a relative precision better than 1 part in a billion trillion (10^{-21}). Transient “ripples in space” can emanate from violent but distant astrophysical phenomena, including colliding black holes or neutron stars and supernovae.

Using LIGO data, the Michigan Gravitational Wave Group has placed upper limits on longer-lived but still weaker (<10^{-24}) ripples from unknown, rapidly spinning neutron stars in the Milky Way. Searches are now under way for gravitational waves emitted by isolated neutron stars using an algorithm called PowerFlux for binary neutron stars, using an algorithm called TwoSpect. Both programs were developed by the University of Michigan group. In addition, the group has carried out extensive work on LIGO detector characterization, including calibration, and on detector commissioning.

Professor Riles has also spent part of his research time in recent years studying the physics potential and the detector requirements of a future linear electron-positron collider with a center of mass energy of 350 GeV and higher.