Syllabus - Fermi Lectures (2019-2020)

"Large Scale Facilities and the Frontiers of Physics"

Barry C Barish

Week 1: Introduction to Physics of the Universe

An overview of the physics of the universe: matter and space; the fundamental constituents of nature; and the role of large-scale experimental facilities.

Week 2. Elementary Particles

An overview of elementary particle physics, the development of the Standard Model, the major large-scale experiments and the big questions for the future.

Week 3: Particle Accelerators

Particle Accelerators from the Cyclotron to the Large Hadron Collider and the technologies and ideas for the Accelerators of the future.

Week 4: The Higgs Boson

The large-scale LHC experiments; the physics and search for the Higgs; the discovery; and future studies of the Higgs Boson and Phenomena.

Week 5. The Future of Particle Physics

Proposed future large facilities for particle physics, and their scientific goals.

Week 6: Neutrinos

The physics of the neutrino, neutrino properties; and the role of neutrinos in particle physics and astroparticle physics.

Week 7: Neutrino Oscillations

Large-scale neutrino experiments from long baseline experiments to experiments studying the properties of the neutrino.

Week 8: Dark Matter

The evidence for dark matter; the properties of dark matter; proposed supersymmetric particles, axions and the experimental direct and indirect searches.

Week 8: Gravitational Waves

Einstein's theory of General Relativity and the prediction of gravitational waves, the historical development theoretically and early experimental probes.

Week 9: Gravitational Waves

The development of suspended mass interferometers, the discovery of gravitational waves and the initial science.

Week 9: Gravitational Waves

Gravitational waves: testing General Relativity, Gravitational Wave Astronomy and analyzing gravitational wave data.

Week 10. Gravitational Waves

The future of gravitational wave science, next generation instruments and the scientific prospects.

Week 11. Gravitational Waves

Gravitational wave astronomy; multimessenger astronomy; and LISA for studying gravitational waves in space.

Week 12 Topics in Astrophysics and large-scale surveys

The new astronomy with the large-scale survey instruments like LSST will be discussed.

Week 13: An Introduction to Cosmology and the Early Universe

An introduction to the non-static universe and the emergence of observational cosmology; the hot Big Bang Theory and experimentally probes of the Early Universe

Week 14: Dark Energy

The evidence for dark energy and the large-scale experimental probes.

Week 15: The Future

Ideas, proposals and speculations on large-scale experimental probes for the future of fundamental physics.