

General Relativity II

Curvature and Einstein equations: Sources of gravity: the energy momentum tensor. Fluids and conservation laws, sound waves, gravitational perturbations and Jeans-instability, the basics of gravitational collapse. Relativistic fluids and covariant conservation of the energy momentum tensor. Geometry: curvature, Bianchi identities and Einstein equations, the Newtonian limit. The Einstein-Hilbert action.

Basics of stellar evolution. Relativistic stars: White dwarfs (a prelude). Relativistic Hydrostatic equilibrium and the Tolman-Oppenheimer-Volkov equations. Compact stars: neutron stars and pulsars. Supernovae, type II and Ia, standard candles. Bounds on maximum masses. Black Holes as end points of stellar evolution. Rotations and frame dragging (Thirring effect) . Astrophysical Black-Holes, accretion disks and jets. Quasars and X-ray sources.

Black holes: Schwarzschild black holes, event horizon and innermost circular orbits. Gravitational collapse to a B.H. Kruskal and other coordinate systems. Hawking radiation, information paradox, primordial black holes. Spinning black holes: the Kerr metric, ergospheres, Penrose processes, charged black holes.

Linearized gravity with and without sources. Gravitational waves: the quadrupole formula, experiments and observations. The Taylor-Hulse pulsar and gravitational radiation. Ligo and gravitational waves from collapsing compact stars.

Cosmology: Friedmann-Robertson-Walker cosmologies, Matter and Radiation: equations of state and cosmological evolution. . The Big Bang: age and size of the Universe, particle horizons. A (very) brief history of the Universe: connection with particle physics. Horizon and flatness problems of standard Big Bang cosmology.

Inflation and the Cosmological constant: deSitter space-time. Solutions to the horizon and flatness problem. A (very) brief excursion into quantum field theory and inflation . Generation of primordial fluctuations, Cosmic microwave background radiation: origin of temperature anisotropies. The growth of gravitational perturbations in expanding cosmologies. The origin of galaxy formation. Primordial gravitational waves from inflation.