

GENERAL RELATIVITY

NPAC

I/ Introduction to GR

II/ Special Relativity

- Brief review of salient features of Special Relativity (metric signature $(- + ++)$)
- Curvilinear coordinates
- geodesics

III/ Physics with gravitational forces: tensors, vectors, and general covariance

- Curvature Covariant differentiation, Riemann tensor
- Parallel transport
- geodesics and geodesic deviation

IV/ Einstein equations

- Spherical bodies and Schwarzschild spacetime
- Symmetries and Lie Derivatives
- Particle trajectories
- Newtonian limit of GR, and tests of GR in the solar system

V/ Black holes

- Schwarzschild black hole
- Coordinate choices.
- Other black holes.

VI/ Stars and Gravitational collapse.

- The Tolman Oppenheimer Volkov equation
- Neutron stars

VII/ Linearized GR and Gravitational waves

- Obtaining the wave equation
- polarization and number of degrees of freedom carried by GWs
- Interactions of a GW with a detector

VIII/ GWs from binary black holes and neutron stars

- GWs from binaries on Keplerian orbits; orders of magnitude
- Rate of energy loss: the quadrupole formula.
- LIGO-Virgo results and determining the properties of the source.
- Introduction to ‘standard sirens’

IX/ Cosmology

- Universe on large scales; FLRW metric
- Solutions of the Friedmann equation
- Thermal history of the universe
- Dark energy and dark matter