Université Paris Diderot (Paris 7)

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GENERAL RELATIVTY

NPAC

I/ Introduction to GR

II/ Special Relativity

- Brief review (metric signature $(-+++)$)
- Curvilinear coordinates
- geodesics

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

- Curvature: Covariant differentiation, Parallel transport,
- geodesics and geodesic deviation; Riemann, Ricci and Einstein tensors

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, stars and gravitational collapse.

- Schwarzschild black hole; coordinate choices.
- Other black holes.
- Neutron stars and the Toleman Oppenheimer Volkov equation

VI/ 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 GW detector/interferometer.

VII/ GWs from binary black holes and neutron stars

- GWs from binaries; orders of magnitude
- Rate of energy loss: the quadrupole formula.
- LIGO-Virgo detections of GWs from different systems.

VIII/ Cosmology

- Universe on large scales; FLRW metric; redshift; Hubble constant.
- Friedmann equations and matter content of universe. ΛCDM model.
- Modified gravity vs dark energy

IX/ Cosmology with gravitational waves

- Introduction to 'standard sirens'
- Measuring the Hubble constant with GWs
- Early universe cosmology from the stochastic background of GWs