SYLLABUS for the LECTURES ON GENERAL RELATIVITY

Prof. Paweł Nurowski
Centre for Theoretical Physics PAN

- Pre-Einstein spacetimes; manifolds, affine spaces.
- Tensors, tensor densities, pseudotensors.
- Tensor fields on manifolds; forms and the Maurer-Cartan theorem.
- Representation-valued forms. Covariant derivative; covariant exterior differential. Connection and curvature. Autoparallels.
- Newtonian gravity a'la Cartan.
- Elements of Riemannian geometry: Riemannian manifolds, geodesics, Levi-Civita connection; Riemann, Weyl and Ricci tensors.
- Einstein's gravity and its field equations: energy momentum tensors; Bianchi identities and their consequences; cosmological constant and the Einstein Universe; linearization of Einstein's equations;
- Predictions of Einstein's linearized gravity: linearized gravitational waves and their influence on a cloud of dust.
- Symmetries in General Relativity: Lie derivatives, Killing vectors and solutions to the Einstein's field equations of (anti) de Sitter.
- Spherical symmetry: Schwarzschild solution; Reisner-Nordstoroem solution.
- Basic properties of the Schwarzschild solution: its maximal analytic extension, Kruskal diagram, radial free fall, geodesics in Schwarzschild spacetime, perihelion advance, deflection of light.
- How field equations influence equations of motion.
- Spherical stars: Oppenheimer-Volkoff equation.
- Discussion of the Kerr solution.
- Cosmological models: Bianchi models and Friedman-Lemaitre-Robertson-Walker paradigm.