SOSE 2016
"INTRODUCTION TO GENERAL RELATIVITY AND COSMOLOGY"

WILKENS, LIBESKIND & WOJNO, YOUAKIM

Kontakt:

Prof Dr. Martin Wilkens (MW)
Institut für Physik, Universität Potsdam (2.085)
mwilkens@uni-potsdam.de
Tel: 0331 977 1706

Dr. Noam Libeskind (NL):
Leibniz Institute für Astrophysik (Schwarzschildhaus: 1-17)
nlibeskind@aip.de
Tel: 0331 7499 641

Hr. Kris Youakim (KY)
Leibniz Institute für Astrophysik
kyouakim@aip.de

Fr. Jen Wojno (JW)
Leibniz Institute für Astrophysik
jwojno@aip.de

Sprache/Language: Depending on Audience either English or German.

Bücher/Literature: 1. Hartle "Gravity – An Introduction to Einsteins General Relativity" (highly recommended); 2. Zee "Gravity in a nutshell" (well – the nutshell bind some 1000 pages . . . but is highly recommended); 3. Fließbach "Allgemeine Relativitätstheorie"; 4. D'Inverno: "Einführung in die Relativitätstheorie"
Kommentierte Literaturliste auf der Kurs-Webseite http://www.quantum.physik.uni-potsdam.de/teaching/

Date	Content	Teacher
Mon 4.4.	I. Intro und Übersicht; II. Newton Prinzipien II.1 Raum-Zeit (Bezugsystem), II.2 Himmelsmechanik	MW/JW
Tue 5.4.	II.3 Stoßmechanik, II.4 Nicht-Grav Kräfte II.5 Newton Feldtheorie, II.6 Newton Kosmologie	MW/JW
Wed 6.4.	III. Spez Rel; III.1 Prinzipien III.2 Poincaré, Lotra, Minkowski	MW/JW
Thur 7.4.	III.3 Tensoralgebra im Flachen III.4 Energie-Impuls-Tensor	MW/JW
Fri 8.4.	Präsenzübung Laplace-Stern, Rotierende Bezugssysteme, Rindler-Raumzeit	MW/JW
Week of 11.4	**Manifold, vectors and gradients** *Manifolds:* The Plane R^2, curved spaces S^1, S^2, S^n Coordinate transformations Scalar fields, Curves, parameterized surfaces Vectors, gradients *Transformations laws:* Notation Vector, gradient transformations Duality of Vectors and gradients Directional derivative	NIL
Week of 18.4 (NL→NYC?)	**Tensors and Metrics** Tensors Tensor transformations Levi-Cevita ϵ^{ijk} 3-vector identities Euclidean two and three dimensional metrics Calculating arc length Scalar products, vector magnitude Raising and lowering operations Signature of the metric	NIL
Week of 25.4	**Exercises** Tensors manipulation	JW/KY
Week of 2.5	**Special Relativity in tensor format** Minkowski space-time Axioms of Special relativity Space-time diagrams Poincare and Lorentz Groups Lorentz Boosts, transformation matrix Length contractions Relativistic dynamics 4-momentum, Forces, Energy-momentum conservation photons	NIL

Date	Content	Teacher
Week of 9.5 (NL→Italy?)	**Maxwells Equations in Tensor Form** Internal Structure Equations (in vector format) Source Equations(in vector format) Lorentz Force(in vector format) Charge Conservation(in vector format) The Faraday Tensor Internal Structure Equations (in tensor format) Source Equations(in tensor format) Lorentz Force(in tensor format) Charge Conservation(in tensor format)	NIL
Week of 16.5	**Exercises** Map projections: Cylindrical and Mercator maps	JW/KY
Week 23.5	**The equivalence principle** Inertial mass and the principle of equivalence Free fall Locally inertial frames Geodesics Co-variant acceleration	NIL
Week 30.5	**Covariant Derivatives** Non-Euclidean Geometry, basis vectors The covariant derivative Derivatives of tensors Gradient of the metric Covariant directional derivative Newtons law (tensor format) **Worked out example:** "Twin paradox"	NIL
Week of 6.6 (NL→Haifa?)	**Exercises**	JW/KY
Week of 13.6	**Field Equations** Curvature, intrinsic and extrinsic geometry Geodesic deviation Riemann Curvature Tensor Analogy with EM "Derivation of the field equation"	NIL
Week of 20.6	**Least Action Principle** Hilbert and Least Action principle Einstein Field equations **Spherically Symmetric Space time:** Schwarzschild Metric	NIL

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Week of 27.6	**Exercises**	JW/KY
Week of 4.7 (NL→Vietnam?)	**Orbits** Noether's Theorem Orbits in Schwarzschild space Symmetries and conserved quantities Orbits in the Equatorial plane Precession of Mercury: Newtonian Solution, Relativistic correction Deflection of star light: Newtonian Solution, Relativistic correction	NIL
Week of 11.7	**Black Holes** Falling into a black hole gravitational redshift Light cones inside and outside Schwarzschild radius Black hole energy temperature, Hawking Radiation	NIL
Week of 18.7	**Exercises**	JW/KY
Week of 25.7	BLOCK SEMINAR 1000-1800 COSMOLOGY	MW/JW
Mon 25.7.	**Cosmological Models** FLRW Metric, Homogeneous and isotropic spaces, Stress-emergy tensor, Evolution equations, Comsmological equation of state, Matter dominated solution, radiation dominated solution, cosmological constant, $k = 0$, flat universe, $k = \pm 1$ solution	MW/JW
Tue 26.7.	**The Expanding Universe**, Redshift, Observable quantities, Radial coordinate, Angular diameter distance, Proper motion distance, Luminosity distance,Cosmic Distance Measures (Parallax, cluster surveys, standard candles)	MW/NIL
Wed 27.7.	**Thermal History of the universe**, Equilibrium Particle distributions, Energy and entropy density, Temperature evolution, Decoupling and freeze-out, Neutrino decoupling, particle distribution after decoupling, Entropy considerations, Background Neutrino temperature, recombination, primordial nucelo-synthesis, n-p ratio, Light element synthesis, ^{4} He abundance	MW/NIL
Thur 28.7.	Student presentations	MW/NIL
Fri 29.7	Student presentations	MW/NIL