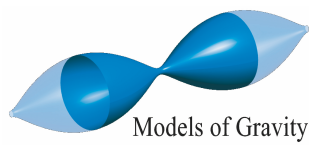


2019 Lecture Week 1, March 3-8 **Timetable**

	Groups	3 (Sun)	4 (Mon)	5 (Tue)	6 (Wed)	7 (Thu)	8 (Fri)	
9:00-	All		Exp.1: GWs and their effect K. Danzmann	Rela.Geo.1: Height Systems and Clock Measurements I J.Müller	Exp.3: lfo and DC Readout B. Willke	Exp.4: Optical Resonators H. Lück	Exp.5:lfo Noise Sources H. Lück	
10:30-	All	Coffee Break						
11:00-	Parallel session for PhD Students		Rel-a.1: Special Relativity Reminder A. Shoom	Rel-a.2: Tensor Analysis in Special Relativity I S. Kumar	Rel-a.3: Tensor Analysis in Special Relativity II S. Kumar	Rel-a.4: Curved Spacetimes I A. Shoom	Rel-a.5: Curved Spacetimes II A. Shoom	
	Parallel session for Postdocs		Rel-b.1: Galileo satellites, clocks, gravitational redshift and further clock effects S. Herrmann	Rel-b.2: Neutron stars J. Kunz	Rel-b.3: Quasi normal modes J.L. Blazquez	Rel-b.4: Charged perfect fluids near Black Holes A. Trova	Rel-b.5: Gravitational lensing in the presence of plasma V. Perlick	
12:30-	All	Coffee Break						
14:00-	All		Exp.2: Modulation B. Willke	Rela.Geo.2: Towards general relativistic geodesy C. Lämmerzahl	Rela.Geo.3: Space gravity observations for ocean climate studies M.Weigelt	Rela.Geo.4:Att itude Determination and Control J.Große	13:30 Departure and Excursion to ZARM Bremen	
15:30-	All	Coffee Break						
16:00-	All		Q&A, Students and Postdocs Presentation					
18:00-	All	Arrival	Break					
19:00-	All	Dinner Break and social hours						



Contents of Relativistic Geodesy lectures

Lecture 1 : Height Systems and Clock Measurements (Jürgen Müller IfE)

- Classical height system and Geoid
- Clock measurements on height systems

Lecture 2 : Towards general relativistic geodesy (Claus Lämmerzahl ZARM Bremen)

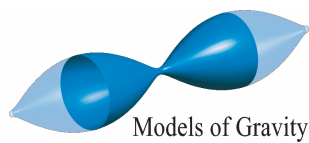
- A relativistic geodesy with optical clocks and fibre networks
- The notion(s) of geoid and of height
- Geodetic network with the combination of clocks, fibers and GNSS

Lecture 3: Space gravity observations for ocean climate studies (Matthias Weigelt IfE)

- The Earth's climate
- Ocean mass changes – the GRACE mission and other observing systems
- The Earth's geoid and the ocean mean dynamic topography
- Observation with future space gravity

Lecture 4: Attitude Determination and Control (Jens Große DLR Bremen)

- Disturbances on space crafts
- Passive and active attitude control
- Inertial sensors
- Drag-free operation



Models of Gravity



Contents of Experimental lectures

Lecture 1 : Gravitational Waves and their effect (Karsten Danzmann AEI)

- Linearisation of Einstein Field Equations
- GWs in TT gauge
- Propagation of light along geodesic
- Travel time of light in almost flat metric
- Phase evolution of EM wave in ifo arm
- Short arms, matched arms
- Phasor diagrams

Lecture 2 : Modulation (Benno Willke AEI)

- Amplitude modulation (AM)
- AM sidebands in phasor picture
- Phase modulation (PM)
- PM sidebands in phasor picture
- AM direct detection
- PM detection via homodyne and heterodyne
- Square law detectors

Lecture 3: Interferometer and DC Readout (Benno Willke AEI)

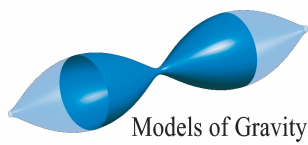
- Phase relations at beamsplitter
- Electrical field at ifo output
- Bright, mid, dark fringe detection
- Error signal generation with local oscillator
- Schnupp, external, internal modulation
- DC readout

Lecture 4: Optical Resonators (Harald Lück AEI)

- Phase relations in plane-plane Fabry Perot
- Converging infinite series, resonance
- Overcoupling, undercoupling, matching
- Phase response in reflection and transmission
- Finesse, FSR, storage time
- Pound-Drever-Hall detection
- Electro-optic modulators

Lecture 5: Interferometer Noise Sources (Harald Lück AEI)

- Optical transfer function
- Generic sensitivity curve
- Noise projections
- Seismic noise, vibration isolation
- Control system noise
- Thermal noise
- Shot noise
- Laser noise



Contents of Basic Relativity lectures (Parallel with Advanced Relativity)

Lecture 1 : Special relativity reminder (Andrey Shoom AEI)

- Time dilation etc.
- Minkowski diagrams
- Lorentz transformation

Lecture 2 : Tensor Analysis in Special Relativity I (Jan Steinhoff AEI)

- Covariant vectors, one-forms
- Tensors

Lecture 3 : Tensor Analysis in Special Relativity II (Jan Steinhoff AEI)

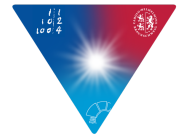
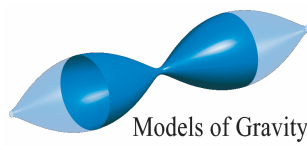
- Derivatives
- Stress-energy tensor

Lecture 4 : Curved Spacetimes I (Andrey Shoom AEI)

- Christoffel symbols
- Covariant derivatives
- Parallel transport

Lecture 5 : Curved Spacetimes II (Andrey Shoom AEI)

- Geodesics
- Riemann tensor, Ricci tensor
- Local Lorentz Systems



Contents of Advanced Relativity lectures (Parallel with Basic Relativity)

Lecture 1 : Galileo satellites, clocks, gravitational redshift and further clock effects (Sven Hermann ZARM Bremen)

- GNSS clock and orbit products
- Standard relativistic corrections in GNSS
- Refinement of relativistic corrections
- Testing relativity with Galileo satellites

Lecture 2 : Neutron stars (Jutta Kunz Uni Oldenburg)

- Static and rotating neutron stars in GR
- Universal relations: I-Love-Q, ...
- Alternative Theories

Lecture 3 : Quasi normal modes (Jose Luis Blazquez Uni Oldenburg)

- Quasinormal modes of black holes and neutron stars with scalar fields.
- Perturbation theory.
- Spectrum, instabilities and universal relations. Comparison of different modified theories of gravity with General Relativity.

Lecture 4 : Charged perfect fluids near Black Holes (Audrey Trova ZARM Bremen)

- Accretion Disk, Accretion Process
- Analytic Treatment : The thick disk model ("Polish Donough: uncharged fluid")
- Analytic Treatment : Models of charged perfect fluid

Lecture 5 : Gravitational lensing in the presence of plasma (Volker Perlick ZARM Bremen)

- Equation of motion for light rays in a pressure-free non-magnetised plasma
- Influence of a plasma on the bending angle
- Influence of a plasma on the shadow of a black hole