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: Ifo and DC Readout **B. Willke**	Exp.4: Optical Resonators **H. Lück**	Exp.5:Ifo Noise Sources **H. Lück**
10:30-	All		Coffee Break				
11:00-	Parallel session for PhD Students		Rel-a.1: Introduction to Special Relativity **A. Shoom**	Rel-a.2: Introduction to General relativity **A. Shoom**	Rel-a.3: Applications of GR **A. Shoom**	Rel-a.4: Introduction to Cosmology I **S. Kumar**	Rel-a.5: Introduction to Cosmology II **S. Kumar**
	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:Attitude 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	Q&A, Students and Postdocs Presentation	Q&A, Students and Postdocs Presentation	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

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 : Introduction to Special relativity (Andrey Shoom AEI)

- Galilean and Lorentz transformations.
- Einstein's postulates. Space-time.

- Relativistic kinematics.
- Optical effects.
- Relativistic dynamics.
- Some “paradoxes”.

Lecture 2 :Introduction to General Relativity (GR) (Andrey Shoom AEI)

- Space-time manifold.
- Equivalence principle
- Einstein’s equations.
- Physics in curved space-time.

Lecture 3 : Applications of GR (Andrey Shoom AEI)

- Schwarzschild black hole (BH.
- Kerr BH.
- Gravitational radiation.

Lecture 4 :Introduction to Cosmology I (Sumit Kumar AEI)

- Friedmann and continuity equations
- Various distance measures in cosmology
- Accelerated expansion of the Universe

Lecture 5 : Introduction to cosmology II (Sumit Kumar AEI)

- Basic data analysis techniques for cosmology
- Using SN data to constrain Hubble parameter

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 Donugh: 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