



2019 Lecture Week 3, September 15-20 **Timetable**

	Groups	15 (Sun)	16 (Mon)	17 (Tue)	18 (Wed)	19 (Thu)	20 (Fri)
9:00-	All		Exp.15: Thermal Noise I  <b>M. Heurs</b>	Exp.16: Thermal Noise II  <b>M. Heurs</b>	Exp.17: Laser cooling & trapping, and Bose-Einstein condensation  <b>R. Dubessy</b>	Rel.Geo.6: Hydrology  <b>M. Marcos</b>	Rel.13: Calculating and observing the shadow of a black hole  <b>V. Perlick</b>
10:30-	All		Coffee Break				
11:00-	Parallel session recommended for QF		DA-St.3: Introduction to compact binaries GW150914  <b>T. Dent</b>	ST.3: SPACE MISSIONS FROM AN IDEA TO A SPACE MISSION  <b>J.Große</b>	Exp.18: Gaussian Optics and DWS  <b>B. Willke</b>	Ele.3: Introduction to Ansys HFSS, FDTD  <b>C.Monka-Ewe</b>	Rel.Geo.7: Height System and Gravity Field Recovery  <b>M.Weigelt</b>
	Parallel session recommended for IMPRS			DA-St.4: Parameter estimation for LIGO-Virgo sources  <b>T. Dent</b>		Exp.19: TFs, Bode etc.  <b>J. Lough</b>	Exp.20: Control Systems  <b>J. Lough</b>
12:30-	All		Coffee Break				
14:00-	All		Project Work Introduction  <b>B. Willke J.Große</b>	<b>Project Work</b>			Project Work Presentation
15:30-	All		Coffee Break				
16:00-	All		<b>Project Work</b>				Departure
18:00-	All	Arrival	<b>Project Work</b>				
19:00-	All	Dinner Break and social hours					



## Contents of Experimental lectures

### **Lecture 15 : Thermal Noise I (Michèle Heurs AEI)**

- Fluctuation – Dissipation Theorem
- Viscous damping
- Brownian noise
- Thermo-elastic noise

### **Lecture 16 : Laser cooling & trapping, and Bose-Einstein condensation (Romain Dubessy CNRS)**

- Atom-light-interaction
- Rotating wave approximation
- Light shifts
- Optical Bloch equations
- Spontaneous force optical molasses
- Doppler temperature
- MOT
- BEC

### **Lecture 17: Thermal Noise II (Michèle Heurs AEI)**

- Thermo-refractive noise
- Coating noise
- Suspension noise
- Cooling

### **Lecture 18: Gaussian Optics and DWS (Benno Willke AEI)**

- Paraxial wave equation and solutions
- Fundamental mode
  - Beam waist, Rayleigh range, divergence, radius of curvature, Gouy phase
- Hermite – Gaussian modes, orthogonal basis
- Non-planar Fabry-Perot cavities
  - Degenerate vs. non-degenerate
  - Mode spectrum of plane – confocal – spherical FP
- Imaging with Gaussian beams
- Differential wave front sensing, angle+lateral

### **Lecture 19: TFs, Bode etc. (James Lough AEI)**

- Linear time-invariant systems
- SISO, MIMO, MISO
- Impulse response, step response
- Frequency response , transfer function
- Bode diagram, Nyquist diagram
- Pole-zero models, partial fractions
- State space models

### **Lecture 20: Control Systems (James Lough AEI)**



- Laplace transform
- Plant, sensor, filter, actuator
- Loop transfer function, closed, open
- Roll-off and stability, gain and phase margin
- Compensation filters
- Error signals in interferometers
- Locking of interferometers
- In-loop / out-of-loop discrepancies

## Contents of Data Analysis and Statistics lectures

### **Lecture 4: Parameter estimation (Thomas Dent University of Santiago de Compostela)**

- Detection in Gaussian noise  
(ex. Sinusoid)
- Simple vs composite hypothesis
- Parameter estimation, marginalization

### **Lecture 3: Compact binary GW sources, basic physics of GW150914 (Thomas Dent University of Santiago de Compostela)**

- Quadrupole formula for CBC
- Newtonian chirp, emission peanut
- Basic physics paper calculations

## Contents of Relativistic Geodesy lecture

### **Lecture 6 :Hydrology (Marta Marcos UBI)**

### **Lecture 7: Height System and Gravity Field Recovery (Matthias Weigelt LUH)**

## Contents of Satellite Design lecture



### **Lecture 3 : SPACE MISSIONS FROM AN IDEA TO A SPACE MISSION (Jens Große DLR )**

- How is a space project set up? (Project Phases, Reviews, what needs to be defined in which phase)
- Requirements definition and verification
- Systems Engineering approach
- Role of science team in design and implementation phase
- Examples from the BECCAL or MAIUS project

## Contents of Microwave Engineering lectures

### **Lecture 3 : Introduction to Ansys HFSS, FDTD (Carsten Monka-Ewe (TBC) IHF TUBS)**