2021 Lecture Week 1, April 12-16 und 19-22

	12 (Mon)	13 (Tue)	14 (Wed)	15 (Thr)	16 (Fri)	19 (Mon)	20 (Tue)	21(Wed)	22 (Thu)
12:30	Welcome **K.Danzmann S.Bruns F.Kawazoe** and Participants introduction	Rel1: Special Relativity Reminder I **A.Shoom**	Rel2: Special Relativity Reminder II **A.Shoom**	DA1: Basics of Probability Theory **W. Kastaun**	QM 2:Quanta of energy and angular momentum **K. Hammerer**	OC2: Optical Clocks 2 **C. Lisdat**	Rel 4: Tensor Analysis in Special Relativity II **J.Steinhoff**	LI5: Modulations by GW in Interferometers **B. Willke**	Geo2: Height Measurement II **M. Weigelt**
13:15	Break								
13:30	LI1: GWs and their effect I **M.Otto**	LI2: GWs and their effect II **K. Danzmann**	LI3: History of GW detection efforts in Hannover **K. Danzmann**	DA2: Signal Processing **F. Ohme**	LI4: Phase- and amplitude modulation **B. Willke**	Rel 3: Tensor Analysis in Special Relativity I **J.Steinhoff**	Geo1: Height Measurement I **M. Weigelt**	DA4: Binary Mergers **N. Krishnendu**	DA5: The Gravitational-Wave Catalog **N. Krishnendu**
14:15	Break								
14:30	QM 1:Wave Mechanics **K. Hammerer**	Q&A and Participants Presentation	Q&A and Participants Presentation	Q&A and Participants Presentation	OC1: Optical Clocks 1 **C.Lisdat**	Q&A and Participants Presentation	DA3: Parameter Estimation **F. Ohme**	Q&A and Participants Presentation	WrapUp **S.Bruns F.Kawazoe**
15:15	Break								End of LW 1
15:30 - 16:15	Q&A and Participants Presentation	End of day	End of day	End of day	Q&A and Participants Presentation	End of day	Q&A and Participants Presentation	End of day	

Contents of Relativistic Geodesy lectures:

Lecture 1 : Introduction (TBC) (M. Weigelt IfE, QuantumFrontiers, TerraQ)

- Details coming soon

Lecture 2 : Introduction (TBC) (M. Weigelt IfE, QuantumFrontiers, TerraQ)

- Details coming soon

Contents of Laser Interferometry Lectures

Lecture 1 : Gravitational Waves and their effect I (Markus Otto AEI, IMPRS)

- Linearisation of Einstein Field Equations
- GWs in TT gauge
- Propagation of light along geodesic
- Travel time of light in almost flat metric

Lecture 2 : Gravitational Waves and their effect II (Karsten Danzmann AEI, IMPRS, QuantumFrontiers, TerraQ)

- Phase evolution of EM wave in ifo arm
- Short arms, matched arms
- Phasor diagrams

Lecture 3: History and Future of GW detection efforts in AEI (Karsten Danzmann AEI, IMPRS, QuantumFrontiers, TerraQ)

- Foundation AEI
- Bar Detectors
- Laser Interferometry
- Nobel Prize
- Third Generation Detectors

- Gravitational Wave Detectors in Space

Lecture 4 : Phase- and amplitude modulation (Benno Willke AEI, IMPRS, QuantumFrontiers)

- Amplitude modulation (AM)
- AM sidebands in phasor picture
- Phase modulation (PM)
- PM sidebands in phasor picture

Lecture 5 : Modulations by GW in Interferometers (Benno Willke AEI, IMPRS, QuantumFrontiers)

- AM direct detection
- PM detection via homodyne and heterodyne
- Square law detectors

Contents of Relativity lectures

Lecture 1 : Special Relativity Reminder I (Andrey Shoom AEI, IMPRS)

- Time dilation etc.
- Exercise

Lecture 2 : Special Relativity Reminder II (Andrey Shoom AEI, IMPRS)

- Minkowski diagrams
- Lorentz transformation
- Exercise

Lecture 3 : Tensor Analysis in Special Relativity I (Jan Steinhoff AEI, IMPRS)

- Covariant vectors, one-forms
- Exercise

Lecture 4 : Tensor Analysis in Special Relativity II (Jan Steinhoff AEI, IMPRS)

- Tensors
- Exercise

Contents of Quantum Mechanics Lectures

Lecture 1 : Wave Mechanics (Klemens Hammerer ITP, QuantumFrontiers)

- Matter waves
- Schrödinger wave function and its interpretation
- Schrödinger equation
- Solution of Schrödinger equation for selected problems in one dimension

Lecture 2 : Quanta of energy and angular momentum (Klemens Hammerer ITP, QuantumFrontiers)

- Bound states and quantized energies
- Quantization of angular momentum
- Electronic structure of atoms

Contents of Optical Clock Lectures

Lecture 1 : Optical Clocks 1 (TBC) (Christian Lisdat PTB,QuantumFrontiers, TerraQ)

- Details coming soon

Lecture 2 : Optical Clocks 2 (TBC) (Christian Lisdat PTB,QuantumFrontiers, TerraQ)

- Details coming soon

Contents of Data Analysis and Statistics Lectures

Lecture 1 : Probability Theory (Wolfgang Kastaun AEI, IMPRS)

- Bayesian concept of probability
- Priors, Posteriors, Bayes Theorem
- Likelihoods and evidences
- Probability densities, credible intervals
- Multidimensional parameters and marginalization

Lecture 2 : Signal Processing (N.N. AEI)

- Stationary, Gaussian noise and the noise spectral density
- Fourier transform of signals and noise
- Optimal filter
- Signal-to-noise ratio
- Matched-filter searches

Lecture 3 : Parameter Estimation (N.N. AEI)

- Optimal filter in the Bayesian context
- Likelihood, prior and posterior for time-series signals in Gaussian noise
- Practical examples: likelihood calculations in python and stochastic
- Sampling

Lecture 4 : Binary Mergers (N.N. AEI)

- Properties of black hole binaries and their effects on the gravitational-wave signal
- The inverse problem: extracting source parameters from
- Gravitational-wave signals
- Examples: finding basic properties of GW150914
- Additional effects in binary neutron-star mergers

Lecture 5 : The Gravitational-Wave Catalog (N.N. AEI)

- Current gravitational-wave observations
- Using the Gravitational Wave Open Science Center
- Highlight observations

Participants Introductions

- New members in relevant institutes and universities have the chance to very shortly introduce themselves.

Questions and Answers, and Participants presentation

- Participants except lectures make 5 minutes presentation with or without slides about their research.