

Module title		Abbreviation
Radio Astronomical Interferometry		11-RAI-Int-211-mo1
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	--
Contents		
<p>1) Motivation and Background</p> <p>a) History of radio astronomy</p> <p>b) The role and development of radio interferometry</p> <p>c) Applications of radio interferometry and scientific topics of special interest</p> <p>d) Summary of important concepts in radio astronomy</p> <p>II) Fundamental Concepts</p> <p>1. Fourier optics</p> <p>a) The concept of telescope aperture</p> <p>b) Convolution and Fourier Theorems</p> <p>c) (Radio) telescopes as spatial filters</p> <p>2. Interferometry</p> <p>a) The Michelson interferometer</p> <p>b) The two-element interferometer</p> <p>c) The visibility function</p> <p>d) The influence of limited bandwidth e) Spatial frequencies in interferometry</p> <p>f) Coordinate systems</p> <p>3. Aperture Synthesis by Radio Interferometric Arrays</p> <p>a) The concept of (u, v) coverage</p> <p>b) Simple configurations and transit arrays</p> <p>c) Tracking arrays and Earth-rotation synthesis</p> <p>d) VLBI arrays</p> <p>e) Antenna separations and geometry</p> <p>4. Receiver Response</p> <p>a) Heterodyne frequency conversion</p> <p>b) Interferometer sensitivity</p> <p>c) Sampling, weighting, gridding</p> <p>d) Bandwidth smearing</p> <p>c) Calibration</p> <p>5. Image reconstruction</p> <p>a) CLEAN and alternative imaging algorithms</p> <p>b) Image defects</p> <p>c) Self calibration</p> <p>6. Digital Beamforming</p> <p>II I. Special Applications and Challenges</p> <p>a) surveys and Wide-Field Imaging</p> <p>b) Very Long Baseline Interferometry</p> <p>c) Spectroscopy in Radio Interferometry</p> <p>d) Polarisation in Radio Interferometry</p> <p>e) Time-Domain Science in Radio Interferometry</p> <p>f) Low-frequency Challenges Interferometry</p> <p>g) Big Data in Radio Interferometry</p> <p>h) Interferometry and Geodesy</p> <p>IV) Technical realization: Current and Upcoming Radio Interferometers</p>		

1. Low-frequency arrays: LOFAR, GMRT, ASKAP, APERTIF/WSRT, LWA, MWA
2. Centimeter-Band Arrays: JVLA, MERLIN, ATCA, MeerKAT, VLBA, EVN, LBA, JVN, VERA, AVN
3. (Sub-) Millimeter Arrays: ALMA, NOEMA, GMVA, EHT
4. The Future: SKA

Intended learning outcomes

The goal of the course is the transfer of knowledge and competence in the radio interferometrical method, providing a foundation for independent research.

Concepts are taught in connection to practical examples from modern astronomy including recent measurements of radio interferometers.

Students shall gain the following specific competences: Understanding of the concept of radio interferometrical observations and their calibration.

Processing and interpretation of raw data. data reduction and analysis, applications and understanding of established algorithms.

Handling of large data volumes. The course makes use of general concepts and teaches special programming concepts that are of wide use beyond astronomy.

Courses (type, number of weekly contact hours, language – if other than German)

V (3) + R (1)

Module taught in: English

Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus)

- a) written examination (approx. 90 to 120 minutes) or
- b) oral examination of one candidate each (approx. 30 minutes) or
- c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or
- d) project report (approx. 8 to 10 pages) or
- e) presentation/talk (approx. 30 minutes).

If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.

Language of assessment: English

Assessment offered: In the semester in which the course is offered and in the subsequent semester

Allocation of places

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Additional information

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Workload

180 h

Teaching cycle

Teaching cycle: every year, after announcement

Referred to in LPO I (examination regulations for teaching-degree programmes)

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Module appears in

Master's degree (1 major) Physics International (2020)

exchange program Physics (2023)

Master's degree (1 major) Physics International (2024)