**Module title**
Quantum Information and Quantum Computing

**Abbreviation**
11-QIC-161-m01

**Module coordinator**
Managing Director of the Institute of Theoretical Physics and Astrophysics

**Module offered by**
Faculty of Physics and Astronomy

**ECTS**
6

**Method of grading**
numerical grade

**Only after succ. compl. of module(s)**
11-QM2 or 11-TFK

**Duration**
1 semester

**Module level**
graduate

**Other prerequisites**
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### Contents
1. Brief summary of classical information theory
2. Quantum theory seen from the perspective of information theory
3. Composite systems and the Schmidt decomposition
4. Entanglement measures
5. Quantum operations, POVMs, and the theorems of Kraus and Stinespring
6. Quantum gates and quantum computers
7. Elements of the theory of decoherence

### Intended learning outcomes
The students acquire a comprehensive understanding of quantum states and density matrices beyond the usual textbook interpretation. They learn how to safely handle tensor products and multipartite quantum systems. The main topics of the lecture include basic mathematical concepts of quantum information theory and the limits of quantum computing arising from decoherence.

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

V (3) + R (1)
Module taught in: German or 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)

- written examination (approx. 90 to 120 minutes) or oral examination of one candidate each (approx. 30 minutes)
- or oral examination in groups (groups of 2, approx. 30 minutes per candidate) or project report (approx. 8 to 10 pages) or 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.

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

Language of assessment: German and/or English

### Allocation of places
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### Additional information
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### Referred to in LPO I (examination regulations for teaching-degree programmes)
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### Module appears in
- Master's degree (1 major) Mathematics (2016)
- Master's degree (1 major) Physics (2016)
- Master's degree (1 major) Nanostructure Technology (2016)
- Master's degree (1 major) Mathematical Physics (2016)
- Master's degree (1 major) Computational Mathematics (2016)
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<tr>
<th>Module description</th>
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<tbody>
<tr>
<td>Master's teaching degree Gymnasium MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2016)</td>
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<td>Supplementary course MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2016)</td>
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<tr>
<td>Master's degree (1 major) Computational Mathematics (2019)</td>
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<td>Master's degree (1 major) Mathematics (2019)</td>
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