PHYS3140

Advanced Quantum Mechanics and Quantum Optics

Session 2, Special circumstance 2020

Department of Physics and Astronomy

Contents

Notice

As part of Phase 3 of our return to campus plan, most units will now run tutorials, seminars and ot her small group learning activities on campus for the second half-year, while keeping an online ver sion available for those students unable to return or those who choose to continue their studies onli ne.

To check the availability of face-to-face and onlin e activities for your unit, please go to timetable vi ewer. To check detailed information on unit asses sments visit your unit's iLearn space or consult yo ur unit convenor.

General Information

Unit convenor and teaching staff
Alexei Gilchrist
alexei.gilchrist@mq.edu.au

Thomas Volz
thomas.volz@mq.edu.au

Credit points
10

Prerequisites
PHYS303 or PHYS3130

Corequisites

Co-badged status

Unit description
Quantum mechanics is perhaps the most fundamental of all theories of modern physics. While its consequences are most readily seen in the microscopic world of elementary particles, atoms and molecules; quantum mechanics provides a set of rules that apply to all physical phenomena: the universe as a whole is governed by its laws. This unit looks at quantum mechanics in greater depth than PHYS3130 and from a more foundational perspective. After introducing the postulates of quantum theory, we consider the basic mathematical structures including Hilbert Space, the Dirac notation, linear operators, spectral theory and measurements. Tools for the description of multiple systems and statistical combinations of systems are introduced allowing the exploration of entanglement - arguably the most dramatic departure from classical physics. In the second half of the unit Quantum Optics is introduced, which has widespread applications and has played a central role in testing quantum mechanics and exploring its meaning. In this section we cover quantization of the optical field, introduce coherent states and describe the physics behind the quantum interaction of light and atoms.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

ULO1: describe and apply the Hilbert space formalism of quantum mechanics.

ULO2: model the combination and removal of physical systems.

ULO3: use density operators to describe the statistical properties of quantum mechanics.

ULO4: explain how measurements are described and used in quantum mechanics.

Assessment Tasks

Name	Weighting	Hurdle	Due
Midsession exam	25%	No	Week 7
Final exam	50%	No	S2 Exam Period
Assignments	25%	No	Throughout Semester

Midsession exam

Assessment Type [1]: Quiz/Test
Indicative Time on Task [2]: 15 hours
Due: **Week 7**
Weighting: **25%**

Exam on the content from the first half of the unit.

On successful completion you will be able to:

- describe and apply the Hilbert space formalism of quantum mechanics.
- model the combination and removal of physical systems.
- use density operators to describe the statistical properties of quantum mechanics.
- explain how measurements are described and used in quantum mechanics.

Final exam

Assessment Type [1]: Examination
Indicative Time on Task [2]: 20 hours
Due: **S2 Exam Period**
Weighting: **50%**

Exam in the University Examination period.

On successful completion you will be able to:

- describe and apply the Hilbert space formalism of quantum mechanics.
- model the combination and removal of physical systems.
- use density operators to describe the statistical properties of quantum mechanics.
- explain how measurements are described and used in quantum mechanics.

Assignments

Assessment Type [1]: Problem set
Indicative Time on Task [2]: 36 hours
Due: **Throughout Semester**
Weighting: **25%**

Weekly problem-solving assignments

On successful completion you will be able to:

- describe and apply the Hilbert space formalism of quantum mechanics.
- model the combination and removal of physical systems.
- use density operators to describe the statistical properties of quantum mechanics.
- explain how measurements are described and used in quantum mechanics.

---

[1] If you need help with your assignment, please contact:

- the academic teaching staff in your unit for guidance in understanding or completing this type of assessment
- the Writing Centre for academic skills support.

[2] Indicative time-on-task is an estimate of the time required for completion of the assessment task and is subject to individual variation

Delivery and Resources

Unit material will be delivered via lectures and preprepared study material. Training resources for problem solving will also be available, and regular assessment tasks to gauge progress of understanding.

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-centr

al). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Grade Appeal Policy
- Complaint Management Procedure for Students and Members of the Public
- Special Consideration Policy *(**Note:** The Special Consideration Policy is effective from 4 December 2017 and replaces the Disruption to Studies Policy.)*

Students seeking more policy resources can visit the Student Policy Gateway (https://students.mq.edu.au/support/study/student-policy-gateway). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

If you would like to see all the policies relevant to Learning and Teaching visit Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central).

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/study/getting-started/student-conduct

Results

Results published on platform other than eStudent, (eg. iLearn, Coursera etc.) or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au or if you are a Global MBA student contact globalmba.support@mq.edu.au

Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to help you improve your marks and take control of your study.

- Getting help with your assignment
- Workshops
- StudyWise
- Academic Integrity Module

The Library provides online and face to face support to help you find and use relevant information resources.

- Subject and Research Guides
- Ask a Librarian

Student Services and Support

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

If you are a Global MBA student contact globalmba.support@mq.edu.au

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.