



PHYS3140

Advanced Quantum Mechanics and Quantum Optics

Session 2, In person-scheduled-weekday, North Ryde 2023

School of Mathematical and Physical Sciences

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General Information

Unit convenor and teaching staff

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Credit points

10

Prerequisites

PHYS303 or PHYS3130 or PHYS2030

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/PHYS2030 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.

General Assessment Information

Requirement to pass this unit

To pass this unit you must obtain 50% or more in the final mark.

Hurdle Assessments

There are no hurdle assessments in this unit.

Late Assessment Submission Penalty

Unless a Special Consideration request has been submitted and approved, a 5% penalty (of the total possible mark of the task) will be applied for each day a written report or presentation assessment is not submitted, up until the 7th day (including weekends). After the 7th day, a grade of '0' will be awarded even if the assessment is submitted. The submission time for all uploaded assessments is **11:55 pm**. A 1-hour grace period will be provided to students who experience a technical concern.

For any late submission of time-sensitive tasks, such as scheduled tests/exams, performance assessments/presentations, and/or scheduled practical assessments/labs, please apply for [Special Consideration](#).

Special Consideration

The [Special Consideration Policy](#) aims to support students who have been impacted by short-term circumstances or events that are serious, unavoidable and significantly disruptive, and which may affect their performance in assessment. If you experience circumstances or events that affect your ability to complete the assessments in this unit on time, please inform the convenor and submit a Special Consideration request through ask.mq.edu.au.

Assessment Tasks

| Name | Weighting | Hurdle | Due |
|---------------------------------|-----------|--------|-----------------------|
| Final exam | 50% | No | S2 examination period |
| Assignments | 25% | No | Throughout semester |
| Midsession exam | 25% | No | Week 7 |

Final exam

Assessment Type ¹: Examination

Indicative Time on Task ²: 20 hours

Due: **S2 examination 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.

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.

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

Lectures/SGTAs

Lectures will run in a blended Lecture/SGTA format

Methods of Communication

We will communicate with you via your university email or through announcements on iLearn. Queries to convenors can either be placed on the iLearn discussion board or sent to phys3140@mq.edu.au from your **university email** address.

COVID Information

- Given that the COVID situation can change rapidly, remove any specific text, direct students to the COVID FAQs on the MQ website and remind them to check the page regularly:
- Therefore, consider adding: For the latest information on the University's response to COVID-19, please refer to the Coronavirus infection page on the Macquarie website: <https://www.mq.edu.au/about/coronavirus-faqs>. Remember to check this page regularly in case the information and requirements change during semester. If there are any changes to this unit in relation to COVID, these will be communicated via iLearn.

Policies and Procedures

Macquarie University policies and procedures are accessible from [Policy Central \(https://policies.mq.edu.au\)](https://policies.mq.edu.au). 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](#)
- [Assessment Procedure](#)
- [Complaints Resolution Procedure for Students and Members of the Public](#)
- [Special Consideration Policy](#)

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

To find other policies relating to Teaching and Learning, visit [Policy Central \(https://policies.mq.edu.au\)](https://policies.mq.edu.au) and use the [search tool](#).

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: <https://students.mq.edu.au/admin/other-resources/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

Academic Integrity

At Macquarie, we believe [academic integrity](#) – honesty, respect, trust, responsibility, fairness and courage – is at the core of learning, teaching and research. We recognise that meeting the expectations required to complete your assessments can be challenging. So, we offer you a range of resources and services to help you reach your potential, including free [online writing and maths support](#), [academic skills development](#) and [wellbeing consultations](#).

Student Support

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

The Writing Centre

The [Writing Centre](#) provides resources to develop your English language proficiency, academic writing, and communication skills.

- [Workshops](#)
- [Chat with a WriteWISE peer writing leader](#)
- [Access StudyWISE](#)
- [Upload an assignment to Studiosity](#)
- [Complete the 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

Macquarie University offers a range of [Student Support Services](#) including:

- [IT Support](#)
- [Accessibility and disability support](#) with study
- Mental health [support](#)
- [Safety support](#) to respond to bullying, harassment, sexual harassment and sexual assault
- [Social support including information about finances, tenancy and legal issues](#)
- [Student Advocacy](#) provides independent advice on MQ policies, procedures, and processes

Student Enquiries

Got a question? Ask us via [AskMQ](#), or contact [Service Connect](#).

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.

Changes from Previous Offering

We value student feedback to be able to continually improve the way we offer our units. As such we encourage students to provide constructive feedback via student surveys, to the teaching staff directly, or via the FSE Student Experience & Feedback link in the iLearn page.

The content and assessment activities have been adapted based on previous student feedback.