PHYS304

Quantum Physics II

S2 Day 2014

Physics and Astronomy

Contents

General Information

Unit convenor and teaching staff
Unit Convenor
Jason Twamley
jason.twamley@mq.edu.au
Contact via jason.twamley@mq.edu.au
E6B 2.612
Thursdays 10--11am; other times by appointment.

Lecturer
Thomas Volz
thomas.volz@mq.edu.au
Contact via thomas.volz@mq.edu.au
E6B2.609

Project Coordinator
Daniel Terno
daniel.terno@mq.edu.au
Contact via daniel.terno@mq.edu.au
E6B 2.715

Credit points
3

Prerequisites
PHYS301(Cr) and MATH235(P)

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, it provides a set of rules that apply to all physical phenomena: the universe as a whole is governed by the laws of quantum mechanics. Quantum mechanics is a theory of information: what information we can gain about the physical world, what the restrictions are on what we can gain, and how this information can be manipulated. This unit looks at quantum mechanics in greater depth than PHYS301. After an introduction to Hilbert Space we cover the basic mathematic structure of quantum mechanics including Dirac notation, linear operators, Unitary operators and the generalization to continuous spaces. We cover the foundations of quantum mechanics, including the Heisenberg and Schrodinger picture, Tensor products and an introduction to the density operator. The Harmonic Oscillator is covered in some detail using both the position and operator methods. Elements of angular momentum are covered and the time evolution of a spin-1/2 system is detailed. Quantum optics is introduced, a topic which has widespread applications, and 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:

Obtain a more advanced understanding of the workings of the quantum world

Be able to use the acquired knowledge to solve problems in quantum mechanics

Understand applications of quantum science to more advanced topics e.g quantum optics.

Assessment Tasks

Name	Weighting	Due
Weekly Exercises	25%	14/11/14
QM in Modern Physics	15%	19/9/14
Final Project	15%	14/11/2014
Final Examination	45%	29/11/14

Weekly Exercises

Due: **14/11/14**
Weighting: **25%**

1 moderate question each week to stay current with the lecture material

On successful completion you will be able to:

- Obtain a more advanced understanding of the workings of the quantum world
- Be able to use the acquired knowledge to solve problems in quantum mechanics

QM in Modern Physics

Due: **19/9/14**
Weighting: **15%**

Directed Reading PROJECTS in small groups on an assigned popular QM topic. Summarising in a report (<5page) and oral presentation (<15 mins).

Contribution statements must accompany each written submission.

On successful completion you will be able to:

- Obtain a more advanced understanding of the workings of the quantum world
- Be able to use the acquired knowledge to solve problems in quantum mechanics
- Understand applications of quantum science to more advanced topics e.g quantum optics.

Final Project

Due: **14/11/2014**
Weighting: **15%**

One Final three week PROJECT (group work), with written (<10pages) and oral presentation (<15 mins).

Contribution statements must accompany each project.

On successful completion you will be able to:

- Obtain a more advanced understanding of the workings of the quantum world
- Be able to use the acquired knowledge to solve problems in quantum mechanics
- Understand applications of quantum science to more advanced topics e.g quantum optics.

Final Examination

Due: **29/11/14**
Weighting: **45%**

Final Exam

On successful completion you will be able to:

- Obtain a more advanced understanding of the workings of the quantum world
- Be able to use the acquired knowledge to solve problems in quantum mechanics

Delivery and Resources

Lectures/Videos

Various Lecture Demonstrations

Unit Schedule

Lectures:

Mon: 16:00-18:00 W5C 312

Fri: 9-10 W5C 210

Tute:

Thur: 14:00-15:00 CB3 312

Learning and Teaching Activities

Lectures

Lectures

Personal Reading

Reading textbook and associated texts/websites

Final Project

Groupwork: final project about a topic related to quantum mechanics

Directed Reading and Presentation

Groupwork: directed reading on a popular topic in modern QM and presentation

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central.

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

Academic Honesty Policy http://mq.edu.au/policy/docs/academic_honesty/policy.html

Assessment Policy http://mq.edu.au/policy/docs/assessment/policy.html

Grading Policy http://mq.edu.au/policy/docs/grading/policy.html

Grade Appeal Policy http://mq.edu.au/policy/docs/gradeappeal/policy.html

Grievance Management Policy http://mq.edu.au/policy/docs/grievance_management/policy.html

Disruption to Studies Policy http://www.mq.edu.au/policy/docs/disruption_studies/policy.html *The Disruption to Studies Policy is effective from March 3 2014 and replaces the Special Consideration Policy.*

In addition, a number of other policies can be found in the Learning and Teaching Category of 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/support/student_conduct/

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 improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

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

IT Help

For help with University computer systems and technology, visit http://informatics.mq.edu.au/help/.

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

Graduate Capabilities

Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

Learning outcome

- Understand applications of quantum science to more advanced topics e.g quantum optics.

Learning and teaching activities

- Reading textbook and associated texts/websites
- Groupwork: final project about a topic related to quantum mechanics

Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Learning outcomes

- Obtain a more advanced understanding of the workings of the quantum world
- Be able to use the acquired knowledge to solve problems in quantum mechanics
- Understand applications of quantum science to more advanced topics e.g quantum optics.

Assessment tasks

- Weekly Exercises

- QM in Modern Physics
- Final Project
- Final Examination

Learning and teaching activities

- Lectures
- Reading textbook and associated texts/websites
- Groupwork: final project about a topic related to quantum mechanics
- Groupwork: directed reading on a popular topic in modern QM and presentation

Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcomes

- Obtain a more advanced understanding of the workings of the quantum world
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- Weekly Exercises
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- Lectures
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Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- Obtain a more advanced understanding of the workings of the quantum world
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Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcomes

- Obtain a more advanced understanding of the workings of the quantum world
- Be able to use the acquired knowledge to solve problems in quantum mechanics
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Assessment tasks

- Weekly Exercises
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Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

Learning outcomes

- Obtain a more advanced understanding of the workings of the quantum world
- Be able to use the acquired knowledge to solve problems in quantum mechanics
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Assessment tasks

- QM in Modern Physics
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- Lectures
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Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

Learning outcomes

- Obtain a more advanced understanding of the workings of the quantum world
- Be able to use the acquired knowledge to solve problems in quantum mechanics
- Understand applications of quantum science to more advanced topics e.g quantum optics.

Assessment tasks

- QM in Modern Physics
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- Lectures
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- Groupwork: directed reading on a popular topic in modern QM and presentation

Engaged and Ethical Local and Global citizens

As local citizens our graduates will be aware of indigenous perspectives and of the nation's historical context. They will be engaged with the challenges of contemporary society and with knowledge and ideas. We want our graduates to have respect for diversity, to be open-minded, sensitive to others and inclusive, and to be open to other cultures and perspectives: they should have a level of cultural literacy. Our graduates should be aware of disadvantage and social justice, and be willing to participate to help create a wiser and better society.

This graduate capability is supported by:

Learning outcome

- Understand applications of quantum science to more advanced topics e.g quantum optics.

Assessment tasks

- QM in Modern Physics
- Final Project

Learning and teaching activities

- Reading textbook and associated texts/websites
- Groupwork: final project about a topic related to quantum mechanics
- Groupwork: directed reading on a popular topic in modern QM and presentation

Socially and Environmentally Active and Responsible

We want our graduates to be aware of and have respect for self and others; to be able to work with others as a leader and a team player; to have a sense of connectedness with others and country; and to have a sense of mutual obligation. Our graduates should be informed and active participants in moving society towards sustainability.

This graduate capability is supported by:

Learning outcome

- Understand applications of quantum science to more advanced topics e.g quantum optics.

Learning and teaching activities

- Reading textbook and associated texts/websites
- Groupwork: final project about a topic related to quantum mechanics

Group Work : Contribution Statements

We will assign a mark to each group's work. That will the mark you receive, plus or minus an adjustment that will be determined as follows: We will ask each member of the group to indicate the relative amount of effort each person contributed to the successful completion of the assessed group activity. If someone in the group stands out as being a conspicuous over-contributor or under-contributor to the group effort, that person's mark will be adjusted upward or downward as appropriate.

Changes since First Published

Date	Description
28/02/2014	The Description was updated.