Printable page generated Thursday, 3 Apr 2025, 15:38

Module guide

1 Introduction

This guide explains the aims of SM880 *Quantum and statistical mechanics of matter*, how to study the module, how you will be assessed, how to get help, and arrangements around accessibility.

The primary aim of this module is to teach you about the quantum and statistical mechanics of matter through their application to atomic, molecular and statistical physics. The quantum and statistical mechanics of interacting systems underpins those subjects.

SM880 *Quantum and statistical mechanics of matter* will introduce you to advanced techniques related to quantum mechanics and statistical mechanics. Quantum mechanics tends to become important when looking at very small objects. This happens because there are bigger gaps between energy levels in objects on the nanoscale, which mean that quantum effects are obvious (in larger, human-sized objects, energy levels are so close that they appear to be continuous). Statistical mechanics is an important tool when large numbers of particles such as electrons can be found in a system so that the individual behaviour of the particles becomes less important than their average behaviour (especially if they are interacting).

The module concentrates on systems of matter where interactions are key. Interactions can make quantum mechanical and statistical mechanical systems non-trivial so that new behaviours emerge. You will apply the advanced techniques of quantum and statistical mechanics to the properties of atoms and molecules interacting with fields and radiation, and to condensed matter systems such as metals and Bose–Einstein condensates.

Interacting systems have very different properties than their non-interacting counterparts. For example, a solid has very different properties to a gas, but gases and solids can be made up of exactly the same atoms. Quantum effects can make these differences even more extreme. For example, collective quantum effects can lead to superconductors, superfluids and Bose–Einstein condensates; strange states of matter which can flow without resistance.

Abilities gained by studying quantum and statistical mechanics provide a foundation from which you can study other advanced subjects in physics. They are also transferable skills that are important for tasks in many types of analytical work and employment. You can log the skills you learn and track your progress towards your study goals using The Open University's (OU's) FutureYOU tool. For more information on the opportunities and skills provided by studying physics, visit the Science skills and careers website. For further guidance, you can contact Careers and Employability Services including booking an individual Careers consultation.

Assumed knowledge

The module materials assume an initial level of mathematics and physics knowledge, similar to a BSc physics or applied mathematics degree containing some study of quantum mechanics at 2:2 level or above, or equivalent grades in level 3 modules within the OU MPhys degree (especially study of level 3 electromagnetism and quantum mechanics modules).

SM880 is part of the Master of Physics (MPhys), and MSc Mathematics qualifications at the OU. It can also be studied as part of MSc Open. It is a Master's level module in terms of its complexity and should ordinarily be studied at the Master's stage of a qualification pathway (in either the MPhys or an MSc). For more information about qualifications, visit the Physics, astronomy and planetary science and Mathematics and statistics websites.

Tips for studying postgraduate physics modules

We highlight the importance of:

- preparing for study, managing your time effectively and making steady progress to keep up with the module
- spending significant time and effort on problem sheets
- getting support from tutors and other students, and not being afraid to ask for help
- using revision resources.

2 Studying SM880

Your learning will be guided by the module website. Each week, it will direct you to certain tasks, including reading book chapters, watching videos, or undertaking a tutor-marked assignment (TMA). You will also be provided with opportunities for self-assessment, practice and consolidation, and further reading. The weeks are grouped into three parts associated with TMAs 01–03, respectively, followed by a revision period.

2.1 Resources

The components of the module that are related to your learning are described in this section (except the TMAs and end-of-module exam, which are described in Section 3).

The module website

The home page of the module website features a study planner that indicates the tasks you should undertake each week. Use this to keep track of your progress. It will also indicate when you need to start and complete TMAs. Your study is separated into module-directed and student-directed tasks. Each week, you should aim to spend approximately 5.5 hours on module-directed learning and 4.5 hours on student-directed learning.

Spending time on student-directed learning is as important as module-directed learning. For example, problem sheets are provided so that you can self-assess your knowledge and understanding. You may even wish to work through a previously studied Unit from SM880 again if you found it particularly challenging. You can also work through other problems provided in the textbooks.

The module website also hosts forums where you can discuss the module with other students, tutors and the OU academics that run the module. This is a good place to ask specific questions about module topics, and also offers an opportunity for you to try to help other students by answering their questions.

The books

You will study from two set textbooks:

- Physics of Atoms and Molecules, 2nd Edition. B.H. Bransden and C.J. Joachain. Pearson Education Limited. ISBN-10: 0-582-35692-X, ISBN-13: 978-0-582-35692-4. (2003).
- Topics in Statistical Mechanics, 2nd Edition. Brian Cowan. ISBN: 978-1-78634-990-3 (2001).

You are expected to purchase your own copy of Physics of Atoms and Molecules by Bransden and Joachain. An eBook of Topics in Statistical Physics will be provided for you: see the Online module textbooks page in the Resources area.

Note that Parts 1 and 2 of these notes are written to correspond to the page numbers of the Soft Cover 2nd Edition of Bransden and Joachain. The 1st Edition of Bransden and Joachain has a different structure and is not compatible with these notes. Part 3 of these notes are written to correspond to the 2nd Edition of Cowan. Note, the 1st Edition of Cowan has a slightly different structure.

Individual Units are designed to be read within the time scheduled in the study calendar (typically 2-3 weeks). When you study a Unit, you should work through the notes including understanding the examples it contains, before working through the exercises (provided separately) in conjunction with the material from the set textbook. The notes and set textbooks cover the knowledge required by the module, but working through them alone will not develop the necessary ability to apply this knowledge. Therefore, it is vital that you also engage with the problem sheets as provided by the module website if you are to succeed in your assessments.

Tutors and tutorials

You will be allocated a module tutor who will mark your TMAs and will be able to provide help with SM880. You should not hesitate to contact your tutor about any academic question that you have relating to SM880.

There are multiple tutorials spread throughout the module. Tutor-group tutorials will consist of a smaller number of students assigned to the same tutor. They will focus on things like tailored feedback on TMAs. There will also be larger cluster or module-wide tutorials that include problem-solving workshops.

You should do your best to attend all of your tutorials.

Practice and consolidation

Exercise sheets are provided throughout the module. They allow you to develop your understanding and practise your problem-solving abilities. Other practice and consolidation resources include tutorials and video lectures.

Getting help

If you need help with studying the module, you can contact your tutor or you can ask a question on the module forums. For more general help, queries and advice, you can contact your student support team via the Contact the OU website.

2.2 Computer investigations

At the time of writing, we anticipate that there may be computer investigations related to Part 2 of SM880 (Units 6 and 7). Further information will be distributed closer to the time when those will be studied. If accessibility requirements mean that you are unable to carry out these investigations, an alternative equivalent resource will be provided.

3 Assessment

In SM880 there are several assessments that contribute to your module result; Table 1 explains how they are weighted.

Table 1 Assessment weightings for SM880.

Assessment	Weighting (%)
TMA 01	2
TMA 02	20
TMA 03	2
Exam	76

TMAs 01 and 03

TMAs 01 and 03 are a crucial way to get expert feedback on your learning. Each of these TMAs consists of both short and long questions and a group work or evaluation question. The exam-style questions will help you prepare for the final examination.

You may submit your TMA answers as scanned or photographed handwritten work. Alternatively, you can submit mathematically typeset work in PDF or Word format. Note that if you are submitting typeset answers, it is important to not be tempted to skip steps in your working – these intermediate steps receive marks in the exam, and your tutor will provide feedback based on them.

Important information about TMA 01

You will perform a group activity in TMA 01. Your tutor will assist in assigning you to groups.

Collaborative work on this module should be conducted within the University's systems. You should use the discussion forums and tools that are suggested in the module materials. Avoid using third-party tools or products, such as social media platforms, for collaborative tasks.

The OU Social Media Policy covers behaviour on all forms of social media.

TMA 02

TMA 02 is a summative TMA associated with Part 2 of the module.

Note

TMA 02 is an important assessment worth 20% of the available marks for the module.

TMA 02 may include an online computing activity. If this is the case, and you cannot perform the online computing activity for accessibility reasons, an alternative activity will be provided that covers the same physics and learning outcomes.

Examination

Parts 1 and 3 of SM880 are assessed by a final remote exam of 3 hours (plus a contingency period for assembling your answers and uploading your finished work).

General information on remote exams is available in the Exam arrangements handbook.

Submitting assessments

For information about special circumstances relating to TMA submission, please see the Assessment Handbook.

Information on how to scan, photograph or otherwise capture your answers and submit them is given on the Student guidance for preparing and submitting TMAs page of the Mathematics and Statistics website.

Plagiarism

Each assessment includes a plagiarism warning. Make sure you read and understand this warning.

Note that for TMA 01 you will be expected to plan and perform the experiment in a small group and although you may discuss your results and conclusions with your group, you must prepare your TMA individually.

4 Module learning outcomes

The module learning outcomes for SM880 are given in Table 2 alongside the assessment method(s).

Table 2 SM880 learning outcomes.

Outcome	Description	Assessment method(s)
Knowledge and understanding		
KU1	Understand the fundamental concepts, principles, theories and language used in quantum and statistical mechanics, and their roles in matter.	Examination and TMA 02
KU2	Understand accuracy and approximation in quantum and statistical mechanics.	Examination and TMA 02
KU3	Gain knowledge of quantum and statistical physics of matter, at the forefront of the discipline.	Examination and TMA 02
Cognitive skills		
CS1	Use and apply conceptual understanding of quantum and statistical mechanics of matter to devise and sustain arguments and solve problems in familiar and unfamiliar contexts.	Examination and TMA 02
CS2	Synthesise scientific information from set texts presented in a variety of ways.	TMA 01, TMA 02, TMA 03
CS3	Apply the methods and techniques of quantum and statistical mechanics – to review, consolidate, and extend your knowledge and understanding.	Examination and TMA 03
Key skills		
KS1	Work effectively with others to explore aspects of physics, enhance your learning and achieve joint outcomes.	TMA 01
KS2	Select and apply quantitative methods appropriate to quantum and statistical mechanics.	Examination

5 Accessibility

Please see the Accessibility guide for detailed descriptions of the specific accessibility provisions in this module.

The OU Library also provides accessibility support, which can be sought by contacting the Library Helpdesk.

6 Contributors

Academic module contributors and design

Module contributors in alphabetical order are: Silvia Bergamini, Jimena Gorfinkiel, James Hague (Chair), Andrew James and Calum MacCormick. Module design was led by James Hague in collaboration with the module team.

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