PX3A7-15 Statistical Physics

23/24

Department
Physics
Level
Undergraduate Level 3
Module leader
Gareth Alexander
Credit value
15
Module duration
10 weeks
Assessment
100% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

The collective behaviour of large numbers of interacting components in a system can lead to the emergence of novel structures and patterns. Phase transitions, the configurations taken up by polymers, and stock market trends are examples. This module looks at how we classify this behaviour, how the different classes of behaviour come about, and how we model it quantitatively.

We will start by revising statistical mechanics which is the natural starting point for describing how patterns are nucleated and grow from initial fluctuations. We will discuss how collective behaviour can be related to order parameters and how these can change across phase transitions.

Module web page

Module aims

The module should illustrate the important concepts of statistical physics using simple examples. It should give an appreciation of the fundamental role played by fluctuations in nature.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

Review of the fundamental principles underlying conventional statistical mechanics and thermodynamics

Phase Separation. Entropy of mixing, Interfacial tension, Cahn-Hilliard equation

Ising model. Mean field theory, solution in 1D

Landau's theory of phase transitions. Ferromagnets, Liquid crystals, dynamics

Polymers. Persistence length, elasticity, Flory theory

Brownian motion. Thermal motion, equipartition, motion of a Brownian particle; diffusion, Smoluchowski equation; correlation functions, fluctuations

Learning outcomes

By the end of the module, students should be able to:

- Work with equilibrium thermodynamics
- Describe the statistical mechanics of long chain molecules (polymers)
- Work with the Landau theory of phase transitions
- Characterise fluctuations statistically

Indicative reading list

F. Mandl, Statistical Physics, Wiley David Chandler, Introduction to Modern Statistical Mechanics, OUP P-G de Gennes Scaling Concepts in Polymer Physics, Cornell Univ. Press G Rowlands, Non-Linear Phenomena in Science and Engineering, Ellis Horwood James P. Sethna Statistical mechanics: entropy, order parameters, and complexity OUP 2007

View reading list on Talis Aspire

Subject specific skills

Knowledge of mathematics and physics. Skills in modelling, reasoning, thinking

Transferable skills

Analytical, communication, problem-solving, self-study

Study

Study time

Type	Required
Lectures	30 sessions of 1 hour (20%)
Total	150 hours

Type	Required
Private study	120 hours (80%)
Total	150 hours

Private study description

Reading, working on problems

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group B1

	Weighting	Study time
In-person Examination Answer 3 questions	100%	

- Answerbook Pink (12 page)
- Students may use a calculator

Feedback on assessment

Personal tutor, group feedback

Past exam papers for PX3A7

Availability

Courses

This module is Option list A for:

- UMAA-G100 Undergraduate Mathematics (BSc)
  - Year 3 of G100 Mathematics
  - Year 3 of G100 Mathematics

    - Year 3 of G100 Mathematics
- Year 3 of UMAA-G103 Undergraduate Mathematics (MMath)
- Year 4 of UMAA-G101 Undergraduate Mathematics with Intercalated Year
- UPXA-F300 Undergraduate Physics (BSc)
    - Year 3 of F300 Physics
    - Year 3 of F300 Physics
    - Year 3 of F300 Physics
- UPXA-F303 Undergraduate Physics (MPhys)
    - Year 3 of F300 Physics
    - Year 3 of F303 Physics (MPhys)
- Year 3 of UPXA-F3FA Undergraduate Physics with Astrophysics (MPhys)

This module is Option list B for:

- UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)
    - Year 4 of G105 Mathematics (MMath) with Intercalated Year
    - Year 5 of G105 Mathematics (MMath) with Intercalated Year
- UMAA-G103 Undergraduate Mathematics (MMath)
    - Year 3 of G103 Mathematics (MMath)
    - Year 3 of G103 Mathematics (MMath)
    - Year 4 of G103 Mathematics (MMath)
    - Year 4 of G103 Mathematics (MMath)
- Year 4 of UMAA-G106 Undergraduate Mathematics (MMath) with Study in Europe
- UPXA-GF13 Undergraduate Mathematics and Physics (BSc)
    - Year 3 of GF13 Mathematics and Physics
    - Year 3 of GF13 Mathematics and Physics
- UPXA-FG31 Undergraduate Mathematics and Physics (MMathPhys)
    - Year 3 of FG31 Mathematics and Physics (MMathPhys)
    - Year 3 of FG31 Mathematics and Physics (MMathPhys)
- Year 4 of UPXA-GF14 Undergraduate Mathematics and Physics (with Intercalated Year)