Imperial College London

Module Specification (Curriculum Review)

Basic details

		Earliest cohort	Latest cohort
UID		Cohorts covered	2024-25	

Long title: Quantum Theory of Matter

New code: PHYS70018

New short title:

Brief description of module *(approx. 600 chars.)*: This course is an introduction to superfluidity and superconductivity, seen in liquid helium, ultracold atomic gases and electronics materials. The course covers the key concepts behind these two phenomena as well as recent developments in topological states of matter which revealed the existence of Majorana fermions in unconventional superconductors.

353 characters

Available as a standalone module/ short course? N

Statutory details

	ECTS	CATS	Non-credit
Credit value	7.5	15	N

HECOS codes:

FHEQ level: Level 7

Allocation of study hours

	Hours	
Lectures	26	
Group teaching	10	*Incl. seminars, tutorials, problem classes.*
Lab/ practical	0	
Other scheduled	11	*Incl. project supervision, fieldwork, external visits.*
Independent study	140.5	*Incl. wider reading/ practice, follow-up work, completion of assessments, revisions.*
Placement	0	*Incl. work-based learning and study that occurs overseas.*
Total hours	187.5	
ECTS ratio	25.00	

Project/placement activity

Is placement activity allowed? No

Module delivery

Delivery mode: Taught/ Campus

Delivery term:

Other:

Other: Term 2, exam in term 3

Ownership

Primary department: Physics

Additional teaching departments	None
Delivery campus	South Kensington

Collaborative delivery

Collaborative delivery?	N
External institution	N/A
External department	N/A
External campus	N/A

Associated staff

Role	CID	Given name	Surname
Module Leader		Derek	Lee
Module Leader		Frank	Schindler

Learning and teaching

Module description

Learning outcomes	At the end of the course, the student should: (1) understand the phenomenology of superfluids and conventional superconductors, including Ginzburg-Landau theory (2) understand the basic formalism of second quantisation (2) understand the microscopic theory of neutral superfluids: Bogoliubov theory (3) understand the BSC theory of superconductors (4) understand the Bogoliubov-de-Gennes formalisms for quasiparticles in superconductors (5) understand examples in topological superconductors, e.g. Majorana fermions in Kitaev chain and p+ip superconductors
Module content	1.Phenomenology of neutral superfluids (liquid helium, ultracold gases): superfluidity, quantised vorticity 2.Phenomenology of conventional superconductors: Meissner effect, vortex lattices, dc Josephson effect2.Microscopic theory of superfluids and superconductors a.Second quantisation using sound waves as the canonical example b.Microscopic theory of quantum Bose fluid: Bogoliubov theory c.Microscopic theory of superconductors BCS theory for conventional (s-wave) superconductors Bogoliubov-de Gennes theory of BSC quasiparticles 3.Topological superconductivity:
Learning and Teaching Approach	Lectures complemented by office hours and rapid feedback sessions to assist learning via problem sheets.

Assessment Strategy	Final written exam of 2 hours.
Feedback	Rapid feedback session weekly with a demonstrator to assist with the problem sheets as well as lecture content.
Reading list	• J Annett, "Superconductivity, superfluidity and condensates" (OUP) • Bernevig & Hughes, “Topological insulators and topological superconductors”.□

Quality assurance

Date of first approval	
Date of last revision	
Date of this approval	
Module leader	Derek Lee

Office use only

QA Lead	
Department staff	
Date of collection	
Date exported	
Date imported	

Notes/ comments

Template version 16/06/2017

Programme structure

Associated modules

UID	Legacy code	Module title	Requisite type

Assessment details

Grading method	Numeric	Pass mark	50%

Assessments

Assessment type	Assessment description	Weighting	Pass mark	Must pass?
			50%	
Examination	2 hour written examination.	100%	50%	N