SK2905 Superconductivity and other quantum liquids, 7.5 credits
Autumn 2020

Introduction
The main part of this course will cover fundamental theoretical models and applications of superconductivity. Towards the end of the course, it will also cover other quantum liquids (like superfluid He) and quantum gases (like Bose-Einstein condensates).

Intended learning outcomes
After finished course, the student should be able to:

- apply basic theory and concepts of superconductivity (1)
- analyze and evaluate superconducting applications (2)
- apply basic concepts for other quantum liquids (3)

Course content
Physical properties of superconductors, London theory, vortices in type-II superconductors, vortex dynamics, Bean's model, Josephson junctions, quantum interference, SQUID, Ginzburg-Landau theory, BCS theory, applications of superconductivity, introduction to other types of quantum fluids (superfluid helium and Bose-Einstein condensates)

Examination
The examination in the course consists officially of two parts – a written exam (TEN1) and hand-in assignments (INL1). A minimum grade of E is required on each part to obtain a final degree in the course.

Written exam, 4.5 credits (TEN1)
Due to the corona pandemic, the written exam is this year replaced with a combination of quizzes in Canvas, group hand-in problems and an oral exam. This part examines mainly learning outcome 1 but also part of learning outcome 3.

Quizzes in Canvas
The course is divided into 4 modules (three modules on superconductivity and one module on other quantum liquids and gases). After each module, there will be a quiz in Canvas on the fundamental knowledge in the module.

To pass the quizzes, each student must obtain at least 80% correct on each of them.

Hand-in problems
After each module, there are a number of hand-in problems that first should be attempted individually and then self-assessed within a group of students, before they are handed in through Canvas for final grading. When handing in the problems in Canvas, each group must also hand in a signed list, where the contribution to the problem solving of each student is clarified.

In addition, each student in the group must have made serious attempts to solve the problems as assessed by the other group members. The number of serious attempts will affect the highest possible grade that a student can obtain during the oral exam. For a possible A or B grade, serious attempts on at least 16 problems are required, for a possible C or D grade, serious attempts on at least 12 problems are required and for a possible E grade, serious attempts on at least 8 problems are required.

To pass the hand-in problems, each group must have at least 16 correctly solved problems. To pass the hand-in problems, each student must have made a serious attempt on at least 8 problems (grade E). For higher grades, a larger number of attempted problems are required.

Oral exam
At the end of the course, there will be an individual oral examination. To be eligible to take the oral exam, each student must have
i) passed all the quizzes in Canvas
ii) passed the group hand-in problems with at least 16 correct solutions
iii) seriously attempted to solve at least 8 of the hand-in problems (max grade E), at least 12 problems (max grade C) or at least 16 problems (all grades possible)

You register for the oral exam in Canvas. The time slots are 30 minutes, but the examination is in most cases expected to take about 15 minutes.

When you arrive to the oral exam, you will be asked to first state for which grade you want to be examined. You will then mainly obtain questions on that grade level, but a few questions on a lower grade level can also occur. The questions will be about proofs from the book and problems solved in the hand-in assignments. All problems and proofs are beforehand assigned a grade level of A, C or E and it is up to you to make a self-assessment to what level you will be able to answer questions on the oral exam. You cannot get a higher grade than you ask for.

Grading criteria on TEN1
Grade A: Correctly explain more than 75% of grade A problems/proofs and have no errors on lower grade problems/proofs.
Grade B: Correctly explain all grade C problems/proofs and at least 30% of grade A problems/proofs.
Grade C: Correctly explain more than 75% of grade C problems/proofs and have no errors on lower grade problems/proofs.
Grade D: Correctly explain all grade E problems/proofs and at least 30% of grade C problems/proofs.
Grade E: Correctly explain more than 75% of grade E problems/proofs.
Grade F: Less than 75% of the grade E problems/proofs are correctly explained.

Students opting for grade B are allowed to 3 times ask for another question when examined on grade A questions and students opting for grade D are allowed to 3 times ask for another question when examined on grade C questions.

Each student has also the right for one oral re-examination in the course. The date for such a re-examination is earliest on January 25 and latest on April 12, 2021 and the date and time is decided on individual basis.

Hand-in assignments, 3.0 credits (INL1)
There are two hand-in assignments in the course – the first one is a group hand-in work that examines learning outcome (2) and the second one is an individual hand-in work that examines learning outcome (3).

Part A – group hand-in work to evaluate a superconducting application
You will make a group evaluation of a suggested superconducting applications, which should result in a written report (2-3 pages) where the group argue whether or not it is reasonable for a company or an organization to engage in developing or using the application. The evaluation must include two parts:
• A correct technical evaluation about how superconductors can be used for the suggested application including both advantages and disadvantages.
• A correct societal analysis of the use of the suggested application, considering the following parts: competing technologies, environmental, health, safety and economical aspects. Details are not required, but important factors should be found and the argumentation must be correct.

Part B – individual hand-in work to describe one detailed aspect of another quantum liquids
You will individually search for and find material about one specific aspect of a non-superconductor quantum liquid or quantum gas. This work should be reported in a short

written review (2-3 pages) where you explain the phenomena in a pedagogic way.

Grading criteria on INL1
Each report is assessed on a 10 point scale, where the assessment starts from 10 points and deductions of points are made for each error according to the following scheme:

Incorrect or misleading arguments: - 5p
Missing vital information: - 3p
Unstructured report: - 2p
Missing important information: - 2p
Unstructured argumentation: - 2 p
Missing conclusions: - 2p
No or incorrect references: - 1p
Missing useful information: - 1p
Repeated syntax, spelling or layout errors: - 1p
Repeated misses in presentation of tables, figures or data: - 1p
Minor syntax, spelling or layout errors: - 0.5p
Misses in presentation of tables, figures or data: - 0.5p

The grading is based on the total number of points on the two reports.
Grade A: Minimum 19 points
Grade B: 18-18.5 points
Grade C: 16-17.5 points
Grade D: 15-15.5 points
Grade E: 14-14.5 points
Grade FX: 13-13.5 points
Grade F: Less than 13 points

Final grading
The final grading in the course is given according to the following table:

TEN1 grade	INL1 grade	Final grade		TEN1 grade	INL1 grade	Final grade		TEN1 grade	INL1 grade	Final grade
A	A,B	A		B	D,E	C		D	B,C	C
A	C,D	B		C	A,B	B		D	D,E	D
A	E	C		C	C,D	C		E	A	C
B	A	A		C	E	D		E	B,C	D
B	B,C	B		D	A	B		E	D,E	E

Textbook and course material
M. Andersson, “Introduction to applied superconductivity”, compendia, KTH (can be downloaded in parts from Canvas).
Other material made available through Canvas.

Teacher
Examiner and course responsible teacher: Magnus Andersson, magnusan@kth.se

Course management
All relevant information about this year’s course can be found in the KTH Learning Management System (Canvas).

For administrative issues, please contact the course expedition at Albanova:
kursexp@physics.kth.se