Mathematical methods for kinetic and fluid equations, 7.5 hp

Course period:
November 2, 2015 - March 11, 2016

Last day for application:
November 2, 2015

Course leader / Address for applications:
Håkan Andreasson / hand@chalmers.se

Course description (Advertisement for Ph.D. students):
The main purpose of this course is to present mathematical results for kinetic and fluid equations such as the Vlasov-Poisson system, the Vlasov-Maxwell system, the Euler equation and the Euler-Poisson system. These equations appear e.g. in plasma physics, astrophysics and engineering.

We will meet once a week for approximately 14 weeks. There will be homework assignments and a written exam at the end of the course. The exact schedule will be determined before the course start.

Responsible department and other participation departments/organisations:
Mathematics Department

Teachers:
Håkan Andreasson, hand@chalmers.se
Simone Calogero, calogero@chalmers.se

Examiner:
Håkan Andreasson

Mathematical models for kinetic and fluid equations, 7.5 hp

1. Confirmation
The syllabus was confirmed by the Head of the Department of XXX 200X-XX-XX, 200X-XX-XX.

Disciplinary domain: Science
Department in charge: Department of Mathematical Sciences
Main field of study: Mathematics

2. Position in the educational system
Elective course; third-cycle education

3. Entry requirements
The student should have taken a course in PDE. For the second part of the course, which starts in Lp 3, a course in functional analysis is recommended.

4. Course content
The main purpose of this course is to present mathematical results for kinetic and fluid equations such as the Vlasov-Poisson system, the Vlasov-Maxwell system, the Euler equation and the Euler-Poisson system. These equations appear e.g. in plasma physics, astrophysics and engineering.

In the first part of the course the Cauchy problem for the Vlasov-Poisson system and the Vlasov-Maxwell system will be presented. In particular, the celebrated global existence result for the Vlasov-Poisson system will be proved. On the contrary, it will be shown that there are solutions of the relativistic Vlasov-Poisson system which blow up in finite time. The important question of global existence for the Vlasov-Maxwell system is still open, but some partial results will be discussed.

The second part of the course deals with the existence of steady states for the Euler-Poisson system and the Vlasov-Poisson system by variational methods. In the latter case this result together with the global existence from the first part implies stability of these steady states. In the fluid case it will be shown that there exist solutions which blow up in finite time and thus stability does not follow as in the kinetic case. Some open problems will also be discussed.

5. Outcomes

After completion of the course the Ph.D. student is expected to be able to:

- Understand, and be able to apply, general methods for the analysis of partial differential equations
- Have sufficient background for doing research in the field.

6. Required reading
Material will be handed out.

7. Assessment
Passing grade requires a passing grade on the homework and the final written exam.

A Ph.D. student who has failed a test twice has the right to change examiners, if it is possible. A written application should be sent to the Department.

In cases where a course has been discontinued or major changes have been made a Ph.D. should be guaranteed at least three examination occasions (including the ordinary examination occasion) during a time of at least one year from the last time the course was given.

8. Grading scale
The grading scale comprises Fail, (U), Pass (G)

9. Course Evaluation
The course evaluation is carried out together with the Ph.D. students at the end of the course, and is followed by an individual, anonymous survey. The results and possible changes in the course will be shared with the students who participated in the evaluation and to those who are beginning the course.

10. Language of instruction
The language of instruction is English.