

# Multiscale methods, fall 2011

## Multiscale methods (Introduction to mathematical physics), fall 2011

### Lecturer

[Paolo Muratore-Ginanneschi](#)

### Scope

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### Type

Advanced studies

### Prerequisites

The course is intended for undergraduate students of mathematics, physics and chemistry and mathematical biology. Prior courses in advanced calculus and linear algebra are required (Analyysi I-II, Vektorianalyysi and Lineaarialgebra 1, or Mapu 1-2).

### Description and contents

The scope of the course is to give a practical introduction to methods of perturbation theory of wide use in theoretical and mathematical physics and mathematical biology. In order to illustrate the use of these techniques the second part of the course will focus on specific problems discussed in recent research papers.

### Lectures

Weeks 36-42 and 44-50, Tuesday 14-16 in room C123. Two hours of exercise classes per week.

Notice: last two lectures

Friday 02.12 at 14-16 in C123

Friday 09.12 at 14-16 in B321

### Exams

Exam projects can be based on research articles using multi-scale perturbation theory. Besides those available from Pavliotis's web-page, research articles of interest may be:

- M. Vergassola and M. Avellaneda, Scalar Transport in Compressible Flow, *Physica D*, 106 (1997) 148-166 [arXiv:chao-dyn/9612001](#)
- A. Mazzino, S. Musacchio, A. Vulpiani, Multiple-scale analysis and renormalization for pre-asymptotic scalar transport, *Phys. Rev. E* 71, 011113 (2005), [arXiv:nlin/0412004](#).
- L. Biferale, A. Crisanti, M. Vergassola, A. Vulpiani, Eddy diffusivities in scalar transport, *Phys. Fluids* 7, 2725 (1995), [cond-mat/9412115](#)
- Avellaneda, M. & Majda, A. J. An integral representation and bounds on the effective diffusivity in passive advection by laminar and turbulent flows *Com. Math. Phys.*, 1991, 138, 339-391

### Lecture Notes

The lecture notes cover and sometimes integrate the material expounded in the lectures. They also give bibliographic references for the same topics.

Lectures 1-10
<a href="#">Lecture_01-02</a> : Motivating examples
<a href="#">Lecture_02</a> : Functional Analysis Background
<a href="#">Lecture_03</a> : Two-scale convergence
<a href="#">Lecture_04</a> : Elements of Ito calculus

### Bibliography

- Course lecture notes
- Pavliotis, G. A. & Stuart, A. M. [Multiscale methods: averaging and homogenization](#) Springer, 2008, 53, 307 (further info [here](#))

- Berglund, N. & Gentz, B. [Noise-induced phenomena in slow-fast dynamical systems: a sample-paths approach](#) Birkhäuser, 2006, 276

## Registration

Did you forget to register? [What to do.](#)

## Exercise groups

Group	Day	Time	Place	Instructor
1.	On Fridays	10-12 a. m.	CK107	Seyedali Zahabi