WINTER SCHOOL ON NUMERICAL METHODS

PART I: HYPERBOLIC EQUATIONS AND APPLICATIONS

Lecturers

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Dates

From Monday 4th February to Friday 15th February 2013

Venue

University of Trento, Via Mesiano, 77, I-38123 Trento, ITALY

SUMMARY

This second part of the winter school on advanced numerical methods consists of a structured intensive two-week programme of theoretical lectures and computer laboratory exercises on advanced numerical methods for hyperbolic partial differential equations with applications in engineering and science. Special emphasis is put on numerical methods that are able to handle very complex geometries. In particular, unstructured Finite Volume and discontinuous Galerkin schemes as well as mesh-free particle methods are presented. Aspects of modern high performance computing are illustrated by an introduction to parallel programming via the MPI standard.
The course is primarily designed for PhD students and post-doctoral researchers in applied mathematics, engineering, physics, computer science and other scientific disciplines. The course may also be of interest to senior researchers in industry and research laboratories, as well as to senior academics. The lectures on the theory will be supplemented with laboratory-based exercises to provide hands-on experience to all participants on the practical aspects of numerical methods for hyperbolic problems and applications using the library NUMERICA and MATLAB programs specially designed for the course.

CONTENTS

WEEK 1:

Theoretical aspects of hyperbolic conservation laws. Review of basic numerical concepts for hyperbolic equations. Finite volume methods for one-dimensional systems. Godunov's method. The Riemann problem for linear systems. The Riemann problem for the shallow water equations. Approximate Riemann solvers. Godunov-type finite volume methods for non-linear systems. Centred numerical fluxes. Construction of higher order non-oscillatory methods via non-linear schemes: TVD, ENO and WENO reconstruction procedures. Discontinuous Galerkin Finite Element methods for one-dimensional problems. Robust and accurate discretization of source terms: stiff and non-stiff cases. The well-balanced property and numerical methods for non-conservative hyperbolic systems. Extension to multiple space dimensions.

WEEK 2:

The second week is dedicated to the extension of the methods introduced in the first week to complex geometries using unstructured triangular meshes in two space dimensions and using mesh-free approaches.

Mesh-based algorithms: Unstructured meshes for two-dimensional geometries. High-order reconstruction on unstructured meshes in multiple space dimensions. High Order Finite volume and discontinuous Galerkin finite element methods on unstructured meshes. Applications to the shallow water equations and the Euler equations of compressible gas dynamics.

Mesh-free algorithms: Introduction to particle methods. Guidelines for implementation of smooth particle hydrodynamics (SPH) based on the Riemann solvers introduced in the first week.

High Performance Computing: Parallelization of the above-mentioned methods using the MPI (Message Passing Interface) standard.

At the end of the second week, the course is rounded-off by advanced seminar-style lectures with outlooks on the following topics: extension to 3D tetrahedral meshes, compressible multi-phase flows, electromagnetic, acoustic and seismic wave propagation.

ABOUT TRENTO AND THE DOLOMITES

The historical city of Trento is situated in the autonomous Italian region of Trentino - Alto-Adige, close to the world-famous mountains called *Dolomites*. Trento is very easy to reach by car or train from Austria (150 km south of Innsbruck) and from Verona (90 km north of Verona). The nearest and most convenient airport is Verona Airport, 15 minutes from the Verona train station. The region around Trento is of extraordinary beauty, with its unique mountains and lakes that offer the participants many exciting outdoor activities like skiing, hiking or climbing.

COST

Students and post-docs: € 900; Senior academics: € 1500; Others: € 1800 (free of "VAT tax" as art. 10 DPR 633/72). When booked **together** with **Part I** of the Winter School "Numerical Methods for Free-Surface Hydrodynamics", a general **discount** of **33 %** applies to the cost of the second part. Members of BAW (*Bundesanstalt für Wasserbau*) and IAHR get an additional discount of 20%. The fees cover lectures, laboratory exercises, lecturing material and demonstration programs in MATLAB as well as a full version of the FORTRAN library NUMERICA. Furthermore, the course fee includes the coffee breaks and one social event (dinner).

REGISTRATION AND ADMINISTRATIVE INFORMATION

Participants must register online at http://events.unitn.it/en/nm2013.

For further information on registration and payment, please e-mail to:
Claudia Fraizingher (dicaphd@ing.unitn.it)
Tel. +39 0461 28 2670 Fax. +39 0461 28 2672

Once accepted for the course you can proceed to make the necessary arrangements for attending the course, such as travelling arrangements, hotels, etc. Payment of the course fees to the University of Trento must made by 7th January 2013. Once the payment has been made please send a copy of the receipt via fax or e-mail to the course secretary (see above).

Payment must be made either online (by credit card) or by bank transfer to:

Unicredit SpA
Via Galilelo Galilei, 1 – 38122 TRENTO (Italy)
Account holder's name: Università degli Studi di Trento
c/c 000100841899 - abi 02008 cab 01820
IBAN: IT08X0200801820000100841899
SWIFT/BIC Code: UNCRITM10HV

Bank transfers must be net of all bank charges and must specify the name of the participant and the subject "in order to NUMHYP course".