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# European Numerical Mathematics and Advanced Applications Conference 2019

30th sep - 4th okt 2019, Egmond aan Zee, The Netherlands


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15:45 Isogeometric Analysis and Fluid Structure Interaction (Part 3)
Chair: Anotida Madzvamuse

15:45 (25 mins) **A minimal set of unisolvent weights for high-order Whitney forms on simplices**
*Ana Alonso Rodriguez, Ludovico Bruni Bruno, Francesca Rapetti*
Abstract: Whitney elements on simplices are widely used finite elements in computational electromagnetics (see [2] and [1]) as they offer the simplest construction of polynomial discrete differential forms on simplicial complexes. In the lowest order case (that is, coefficients are polynomials of degree one), the associated degrees of freedom are the integrals of such k-forms on the k-simplices of the mesh and consequently bear some physical information. However, the classical degrees of freedom used for high order Whitney forms (see, e.g., [4]), the so-called moments, lack this meaning. For this reason, in [5] an alternative set of degrees of freedom, which we refer to as weights, is introduced. Namely, such degrees of freedom read as the integrals of k-forms on the small k-simplices that are built upon the principal lattice of the elements. In [3] it is proved that this set of weights induces unisolvent degrees of freedom. However they are redundant: their number exceeds the dimension of the space of differential forms. In this work, we show that a particular subset of this weights with cardinality equal to the dimension of the space of differential forms is still unisolvent.

16:10 (25 mins) **Goal-Oriented A Posteriori Error Estimates for Elliptic Problems discretized by the Discontinuous Galerkin Method**
*Ondřej Bartoš, V. Dolejší*
Abstract: We deal with the numerical solution of linear elliptic problems using the discontinuous Galerkin method with focus on the goal-oriented a posteriori error estimates. The aim is to estimate the error of the quantity of interest represented by a linear functional. The abstract error estimate is based on the knowledge of the (exact) solution z of the dual problem corresponding to the primal one. In order to de_ne a computable estimate, the dual solution z has to be replaced by its approximation z+ h and the remaining term represented by di_erence z  z+ h is usually neglected. In this presentation we propose an approach which estimates the neglected term. Consequently, we are able to derive a guaranteed error estimate. This type of estimates are known for the conforming _nite element approximation but it is new in the framework of discontinuous Galerkin method. Moreover, we introduce an e_cient implementation approach allowing a simultaneous solution of the primal and dual problems. Finally, several numerical examples will be presented.

16:35 (25 mins) **Monotonicity considerations for stabilized DG cut cell schemes for the unsteady advection equation**
*Florian Streitbürger, Christian Engwer, Sandra May, Andreas Nüßing*
Abstract: For solving unsteady hyperbolic conservation laws on cut cell meshes, the so called small cell problem is a big issue: one would like to use a time step that is chosen with respect to the background mesh and use the same time step on the potentially arbitrarily small cut cells as well. For explicit time stepping schemes this leads to instabilities. In a recent preprint [arXiv:1906.05642], we propose penalty terms for stabilizing a DG space discretization to overcome this issue for the unsteady linear advection equation. The usage of the proposed stabilization terms results in stable schemes of first and second order in one and two space dimensions. In one dimension, for piecewise constant data in space and explicit Euler in time, the stabilized scheme can even be shown to be monotone. In this contribution, we will examine the conditions for monotonicity in more detail.

17:00 (25 mins) **Finite Element Approximation of the Spectrum of the Curl Operator**
*Ana Alonso Rodriguez, Jessika Camano, Rodolfo Rodriguez, Alberto Valli, Pablo Venegas*
Abstract: The presentation concerns the formulation and analysis of the eigenvalue problem for the curl operator in a multiply connected domain and its numerical approximation by means of finite elements. Different boundary conditions that render the curl operator self-adjoint are taken into account. I will focus on those boundary conditions that in particular impose $[\rm curl} \, [\bf u} \cdot [\bf n}=0$. In the case of a multiply connected domain, different contributions from co-homology spaces distinguish different self-adjoint extensions. This distinction can be made by imposing the vanishing of the line integrals on suitable homological cycles lying on the boundary. A saddle-point variational formulation is devised and analyzed, and a finite element numerical scheme is proposed. It is proved that eigenvalues and eigenfunctions are efficiently approximated and some numerical results are presented in order to assess the performance of the method.

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