6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

# A HIGH ORDER HYBRID MIMETIC DISCRETIZATION ON CURVILINEAR QUADRILATERAL MESHES FOR COMPLEX GEOMETRIES

**Y. Zhang[1], V. Jain[1], A. Palha[2] and M. Gerritsma[1]**

[1] Delft University of Technology, Mekelweg 2, 2628 CD Delft, Netherlands,
Y.Zhang-14@tudelft.nl, V.Jain@tudelft.nl, M.I.Gerritsma@tudelft.nl
[2] Eindhoven University of Technology, 5612 AZ Eindhoven, Netherlands, A.Palha@tue.nl

**Keywords**: *Curvilinear meshes, De Rham Complex, Mimetic Discretizations, Hybridization, Algebraic Dual Spaces*

Curvilinear quadrilateral (hexahedral) meshes can also follow complex geometries. In these meshes, high order mimetic discretizations using polynomial function spaces that satisfy the de Rham complex can be constructed [1]. Mimetic discretizations distinguish differential relations and constitutive relations encoded in physical problems and make use of discrete unknowns that no longer only represent nodal values, but also can represent integral values. These features enable discretizations of differential operators using incidence matrices. Incidence matrices (consisting of -1, 0, 1) only depend on the topology of the mesh and, therefore do not change from element to element if topologies of meshes in elements are the same. This brings a big advantage for discretizations in complex geometries.

In this talk, we will also extend mimetic discretizations in two ways:

- Hybridization. Elements are first made to be discontinuous. Lagrange multipliers are then introduced in-between elements to impose continuity. This is a weaker way but to impose still strong continuity. This provides great freedom on domain decomposition and significantly benefits the solvability of discrete systems.
- We use algebraic dual spaces [2]. By using these recently developed algebraic dual spaces, sparser, topology-dependent-only, finite-difference-like discrete matrices can be obtained. This considerably simplifies applications of the methods especially in complex geometries and benefits the solvability of discrete systems even more. This is also beneficial for the hybridization.

Several examples of applications for, i.e. Poisson problems [3], vector Laplacian problems, elasticity problems and Stokes problems will be presented.

## REFERENCES

[1] J. Kreeft, A. Palha, M. Gerritsma, Mimetic framework on curvilinear quadrilaterals of arbitrary order, arXiv:1111.4304, 2011.

[2] V. Jain, Y. Zhang, A. Palha and M. Gerritsma, Construction and application of algebraic dual polynomial representations for finite element methods, arXiv:1712.09472, 2017.

[3] Y. Zhang, V. Jain, A. Palha, M. Gerritsma, The discrete Steklov-Poincar operator using algebraic dual polynomials, under preparation.