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P-adaptive LDG method applied to LES of parallel blade-vortex interaction on NACA23012 airfoil

Antonella Abbà[1]

[1] Dipartimento di Scienze e Tecnologie Aerospaziali, Politecnico di Milano, 20156 Milano, Italy, antonella.abba@polimi.it

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In the common approach to Large Eddy Simulation (LES), the mesh resolution defines the threshold between the resolved and the unresolved scales. On the other hand, in a turbulent unsteady flows, turbulence scales change in time and in space and cannot be easily estimated a priori. Moreover, although the increase of the available computational resources, LES is still computationally very expensive. For all these reasons, an adaptive LES, where the resolution is automatically adapted to the flow conditions, would solve the problems. The Local Discontinuous Galerkin method represents a high fidelity tool particularly suitable for adaptive LES. Indeed in LDG framework the polynomial degree can varies in time and space throughout the computational domain, adapting the resolution to the local structures of the flow and preserving high accuracy and good performances in parallel computing. For all these reasons a numerical code developed in the LDG framework [1], associated to a refinement indicator based on the structure function especially suitable for LES [3], and a sophisticated dynamic anisotropic subgrid scale model [2] represents an optimal tool for the LES of complex unsteady turbulent flows.

The p-adaptive LES approach, with the polynomial order adapted locally in space and dynamically in time, has been applied to the simulation of turbulent flows of aeronautical and practical interest. In particular the attention is here devoted to the simulation of parallel blade vortex interaction with a NACA23012 airfoil. The focus is to deeply understand the mechanism of load generation related to the pressure field, on the interaction between the impinging vortex and the three dimensional structures in boundary layer and wake.

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