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Direct numerical simulation of turbulent flows over curved walls with adverse pressure gradient ABHIRAM AITHAL, ANTONINO FERRANTE, University of Washington, Seattle — Flow separation over curved walls with adverse pressure gradient (APG) occurs in many aerodynamic applications. However, the physical mechanisms of turbulence over curved bodies with APG are not yet well understood and the wall models employed in Reynolds-averaged Navier-Stokes (RANS) and large-eddy simulations (LES) for such flows need to be improved. In order to provide the necessary statistics for the validation of such models and explain the physical mechanisms of such flows, we have performed direct numerical simulations (DNS) over curved walls with APG. First, we have developed a fully-explicit and direct pressure-correction method to solve the incompressible NS equations in orthogonal curvilinear coordinates called FastRK3. FastRK3 is a three-stage, third-order Runge-Kutta projection-method which requires solving the Poisson equation for pressure only once per time step. Then, we have verified and validated FastRK3 with several test-cases and against available experiments. Last, we have performed a DNS study of the turbulent separated flow over a curved ramp and studied the dynamics of its turbulence kinetic energy.

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