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Numerical investigation of three-dimensional transonic flows of Bethe-Zel'dovich-Thompson fluids PAOLA CINNELLA, Universita' di Lecce, CHRISTOPHE CORRE, ENSAM, Paris, France — Bethe-Zel'dovich-Thompson (BZT) fluids are fluids of the retrograde type (i.e. that superheat when expanded), which exhibit a region of negative values of the Fundamental Derivative of Gasdynamics Γ. As a consequence, they display, in the transonic and supersonic regime, nonclassical gasdynamic behaviours, such as rarefaction shock waves and mixed shock/fan waves. The peculiar properties of BZT fluids have received increased interest in recent years because of the possibility of enhancing turbine efficiency in Organic Rankine Cycles (ORCs). The present research provides for the first time a detailed investigation of transonic BZT flows past a 3D configuration, representative of an isolated turbine blade with infinite tip leakage, namely, the ONERA M-6 wing. Since BZT phenomena mainly affect the inviscid flow behavior, the analysis is restricted to the Euler equations, completed by the realistic Martin-Hou equation of state. The governing equations are solved numerically using a structured flow-solver based on a third-order accurate centred scheme. The results are validated through systematic comparisons with an unstructured multidimensional upwind solver. An investigation of the flow patterns for several choices of the upstream thermodynamic conditions is provided, showing the complexity of the 3D aerodynamics of BZT fluids, and confirming the advantages in terms of improved aerodynamic performance already demonstrated for 2D configurations.

Paola Cinnella
Universita' di Lecce

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