



航空学报 » 1989, Vol. 10 » Issue (9) : 490-496 DOI:

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多重网格法求解二元跨音速欧拉流

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CALCULATION OF TWO-DIMENSIONAL TRANSONIC FLOW OF EULER EQUATIONS WITH MULTIGRID METHOD

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摘要

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摘要

近年来,采用时间相关欧拉方程或N-S方程求解跨音速流得到了迅速发展。为了获得二元或三元复杂形体正确的表面气动参数和足够高分辨率的流场物理特性,必须采用十分细密的网格,因而导致计算时间成倍增长。为此,除继续发展各种差分格式,探讨各种自适应网格技术外,运用多重网格技术加速收敛过程得到了国外普遍关注并取得了一定的成功。国内也已有采用多重网格法解跨音速欧拉流的文章,然而均局限于两重网格的计算。为探索多重网格法和焓阻尼技术对加速收敛的作用,我们以NACA0012翼型的跨音速流动为例,采用MacCormack两步显式格式进行了数值实验。

关键词: 跨音速流 欧拉方程 数值计算

Abstract:

The Euler equations of the two-dimensional transonic flow around airfoils are solved by the finite volume method with Mac-Cormack explicit scheme. The boundary conditions on the airfoil surface are derived directly using the momentum equations on the mesh cell in the present paper. The new conditions are of the same two-order accuracy with the difference formulas in the flow field, and avoid to computing numerically the coordinate derivatives, which generally have the large errors. The no-reflected far-field conditions are used as well. The convergence rates are effectively improved when the enthalpy damping is included. According to the multigrid principle, an explicit multigrid scheme is devised to accelerate the convergence of the calculations of Euler equations. The four-level multigrid algorithm is used, and the convergence processes are dramatically changed. The satisfied results of the typical transonic flows on NACA0012 airfoil are obtained.

Keywords: transonic flow Euler equation numerical calculation

Received 1987-12-29;

引用本文:

刘胜;包芸;刘松龄. 多重网格法求解二元跨音速欧拉流[J]. 航空学报, 1989, 10(9): 490-496.DOI:

Liu Sheng; Bao Yun; Liu Songling. CALCULATION OF TWO-DIMENSIONAL TRANSONIC FLOW OF EULER EQUATIONS WITH MULTIGRID METHOD[J]. Acta Aeronautica et Astronautica Sinica, 1989, 10(9): 490-496.DOI:

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