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模拟三维粘性流动的显式多重网格算法

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AN EXPLICIT MULTI-GRID TECHNIQUE FOR THREE-DiMENSIONAL VISCOUS FLOW SIMULATION

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摘要 提出一种模拟三维粘性流动的显小多重网格算法。该算法以Ｎｉ与Ｊｏｈｎｓｏｎ所提出的二维多重网格技术为基础,采用ＭａｃＣｏｒｍａｃｋ显式格式结合空间变时间步长推进,分别在细、粗网格层上对雷诺平均Ｎ－Ｓ方程进行交替求解。在多重网格计算过程中,以最细网格层上新、旧迭代解来近似通量的时间导数。建立了新的多重网格迭代格式。该格式避免了Ｎｉ的原型格式对Ｊａｃｏｂｉａｎ矩阵的附加计算。从而节约了大量机时,较大程度地提高了收敛速度。应用所建立的算法模拟了非轴对称二元收缩、扩张长喷管的内部流动,并同实验数据进行了对比,两者相吻合,表明所建立的算法是可靠的。

关键词： 多重网格算法　显式格式　Ｎ－Ｓ方程　二元喷管　激波诱导分离流

Abstract： An implicit multi-grid technique for computing three-dimensional algorithm proposed by Ni and Johnson,where the Reynolds-averaged Navier-Stokes equations are solved, consecutively,from the-gine;levels through the coarse ones,using MacConT1ack's two-step explicit scheme,in conjunction with the spaee-varying time-marching proeedure. An iteration scheme is constructed using the residue between the solution in two time step to approx-imate the time derivative of the fluxes,so that the additional computations on the Jocobian matrices presisted in Ni's original scheme can be eliminated.The scheme wiIl thus reduee the CPU time substantially,and accelerate significantly the convergence.The technique developed isemployed to simulate the internal flows of nonaxisymmetric,two一dimensional,convergingd*verging nozzles.Numerical results are found in good agreement with the available experimental data,revealing high reliability of the developed technique in complex flow simulation。

Keywords： multiple-grid algorithm   explicit scheme   N-S equations   2-D nozzles

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