

圆柱绕流三维不稳定性的低维Galerkin法分析

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摘要 利用低维Galerkin方法及Floquet稳定性分析理论, 计算分析了圆柱绕流的三维线性不稳定性. 分析中构造了能较好描述尾迹区流动的周向基函数, 建立了完备的合理的基函数组, 改进了计算机算法. 结果证实圆柱二维周期流对展向小扰动为不稳定的, 正确地预计了出现三维长波不稳定性的临界雷诺数 $Re_c = 190$; 扰动展向波长为 $\lambda_c = 3.6d$. 对雷诺数 Re 为 180, 190 两种工况下的圆柱三维绕流流场的计算进一步证实了这种流动的整体不稳定性. 本文所预计的临界值比Noack等人的结果更为精确, 与Barkley等人的DNS解一致, 与Williamson的实验相符.

关键词 [圆柱绕流](#) [三维线性不稳定性](#) [Galerkin方法](#) [Floquet稳定性](#)

分类号

THREE-DIMENSIONAL STABILITY ANALYSIS OF THE PERIODIC WAKE BEHIND A CIRCULAR CYLINDER BY LOW-DIMENSIONAL GALERKIN METHOD

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Abstract

Three-dimensional linear instability of flow past a circular cylinder is analyzed by means of a low-dimensional Galerkin method and Floquet instability theory. Some improvements on the construction of the azimuthal modes and calculation algorithm in the present analysis are made. The present results show that the ideal two-dimensional periodic flow around the cylinder is unstable with respect to a small spanwise disturbance. It has long-wavelength instability and the critical Reynolds number predicted is $Re_c = 190$; the spanwise wavelength is $\lambda_c = 3.6d$. The calculation of the three-dimensional flow field around the cylinder for two cases of Reynolds number $Re = 180, 190$ further confirms the overall instability of this flow. The predicted critical values in this paper are more precise than those of Noack et al., and are in good agreement with the DNS results of Barkley and the experimental results of Williamson.

Key words [three-dimensional stability](#) [cylinder wake](#) [Galerkin method](#) [Floquet stability](#)

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