航空学报 » 2001, Vol. 22 » Issue (4) :293-297 DOI:

边界层中湍动能和耗散能最大的尺度分量特征研究

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CHARACTERISTICS OF SCALE COMPONENTS HAVING MAXIMAL DYNAMIC ENERGY AND DISSIPATION ENERGY IN SMOOTH TURBULENT BOUNDARY LAYER

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摘要 阐述了利用离散正交小波理论分析 1 -D湍流测试信号的方法,使用热线风速仪,在 3个雷诺数下,分别测量了光滑壁面湍流边界层的速度和加速度信号。运用所述方法分析了边界层测试信号,给出了最大湍动能密度和最大耗散能密度及其对应尺度沿 y+ 的分布曲线,并且给出该尺度分量的发生频率沿 y+ 分布曲线。分析可见 :两种最大能量密度的无量纲尺度沿 y+分布具有雷诺相似性,其发生频率随着雷诺数增加而增加,但是最大湍动能密度尺度的频率沿 y+基本是一常数;无量纲的最大湍动能密度沿 y+在边界层小部分区域具有雷诺相似性,而无量纲的最大耗散能密度沿 y+ 在整个边界层内具有雷诺相似性

关键词： 湍流 边界层 小波分析 正交分解 湍动能 耗散率

Abstract： A general processing method is set forth that the di screte orthogonal wavelet theory is used to analyze the 1-D turbulent signal, mainly including decomposition of the pulse velocity and pulse acceleration signals into different scale components. It is got about the profile curves of magnitude and frequency of the scale components having the max turbulent dynamic energy density, and it is also to do so for other scale components having max turbulent dissipation energy density. Under three Reynold numbers the instantaneous velocity and acceleration signals are measured using hot-wire anemometry in a smooth turbulent boundary layer, and then analyzed using the above method. It is concluded that the profile curves (along y+) of non-dimensional quantity of the two scale lengths have no relation with Reynold number in the boundary layer, that their occurring frequency increases with Reynold numbers, but the frequency of the scale component having the max turbulent dynamic energy density is a constant along y+.

Keywords： turbulence w av elet or thog onal analy sis tur bulent dy namic energ y turbulent dissipatio n

Received 2000-05-22; published 2001-08-25

引用本文:

宫武旗;黄淑娟;徐忠. 边界层中湍动能和耗散能最大的尺度分量特征研究[J]. 航空学报, 2001, 22(4): 293-297.

GONG Wu-qi;HUANG Shu-juan;XU Zhong. CHARACTERISTICS OF SCALE COMPONENTS HAVING MAXIMAL DYNAMIC ENERGY AND DISSIPATION ENERGY IN SMOOTH TURBULENT BOUNDARY LAYER[J]. Acta Aeronautica et Astronautica Sinica, 2001, 22(4): 293-297.