Temperature Oscillations and Flow Dynamics in Turbulent Thermal Convection

Xia Ke-Qing

Department of Physics, The ChineseUniversity of Hong Kong

Abstract: We report an experimental study of three-dimensional structure of the low-frequency temperature oscillations in a cylindrical Rayleigh-Bénard (RB) convection cell of aspect ratio one. It is found that the hot and cold thermal plumes are not emitted periodically nor alternatively, but continuously and randomly, from the top and bottom plates. We further identify a horizontal sloshing motion of the large-scale circulation and found that the oscillation of the temperature field does not originate from boundary layers, but rather is a result of the horizontal motion of the hot ascending and cold descending fluids being modulated by the twisting oscillation near the top and bottom plates and the sloshing motion in the bulk flow field [1]. By studying the correlations between temperatures measured at different horizontal and vertical locations, we further reveal the relationship between the sloshing and the torsional modes of the large-scale circulation [2].

Reference

1. H.-D. Xi, S.-Q. Zhou, Q. Zhou, T.-S. Chan and K.-Q. Xia, "Origin of the temperature oscillation in turbulent thermal convection", Physical Review Letters. 102, Art. No. 044503 (2009).
2. Q. Zhou, H.-D. Xi, S.-Q. Zhou, C. Sun, and K.-Q. Xia, "Oscillations of the large-scale circulation in turbulent Rayleigh-Bénard convection: the sloshing mode and its relationship with the torsional mode", J. Fluid Mech. 630, Page No. 367-390 (2009).

Acknowledgement

Work supported by the Research Grants Council of Hong Kong SAR (Project Nos. CUHK 404307 and 404409).

TDLAS 技术在超声速燃烧中的应用

余西龙 李飞 林鑫 顾洪斌 陈立红 张新宇

中国科学院力学研究所高温气体重点实验室，北京 100190

摘要: 可调谐二极管激光吸收光谱技术（TDLAS）,作为一种先进的非接触激光诊断技术,已经广泛应用在燃烧与气动测量。这种技术的突出优点是高灵敏度、响应快、结构相对简单以及相对造价低廉，已经成为测量温度和组分分压的有效手段。本文介绍我们所建立的可调谐二极管激光吸收光谱诊断系统以及利用此系统进行发动机燃烧室温度、组分浓度和气流速度测量的实验结果。还介绍了所发展的高敏感的探测技术-波长调制光谱(WMS, Wavelength Modulation Spectroscopy)的 2f 诊断技术。同时为了将 TDLAS 应用于非均匀流场测量，还尝试了同光路多频空间分辨测量的初步验证。最后对未来可调谐二极管激光吸收光谱技术应用于燃烧诊断与流体测量进行了展望。

关键词: 超声速燃烧；可调谐激光吸收光谱；温度；组分密度；速度；燃烧效率；波长调制光谱；空间分辨