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3D Vortices Structure Monitoring in Turbulent Flows by Digital Speckle Photography

Nikita A. Fomin, Andrey V. Krauklis, Elena I. Lavinskaya

HMTI, Minsk, Belarus

3D vortices structure in complex turbulent flows is reconstructed using computerized speckle tomography. Multiprojectional digital speckle photography (DSP) is based on the computer aided acquisition and evaluation of time evolution of dynamic speckle patterns and allows the instantaneous quantitative derivation of a 2D map of deflection angles of the light passing through the flow under study. Both macro and micro scales of vorticity in compressible flow are visualized and quantitatively characterized with the applied DSP techniques. The macro structures are reconstructed using Radon integral transform. The microscale turbulence structures are determined by using the 3-D density correlation functions evaluated with Erbeck-Merzkirch integral transforms. With high density speckle photography data the precision of the turbulence microscale determination using this integral transform for the isotropic turbulence is rather higher. For non-isotropic turbulence the evaluation would require a more correct conversion using multi-angular probing and convolution of Radon and Erbeck-Merzkirch integral transforms.

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