QUANTITATIVE EVALUATION OF FLOW STRUCTURE WITH SHOCKS BY DIGITAL SPECKLE PHOTOGRAPHY

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Both holographic and speckle interferometry are line-of-sight methods which are sensitive to density variations in fluid flow under the study. The information obtained from line-of- sight optical measurements consists of the averaged data along the optical path. The general principles for measuring the light retardation using by holographic interferometry (HI) and light deflection angles by speckle photography (SP) are shown in Fig. 1. An expanded, parallel beam of laser light is transmitted through the test section. An interferometric pattern produced when transmitted wavefront interferes with a reference wave is recorded in the case of holography. A similar interferometric pattern produced due to multiple interference in diffuse laser light behind a ground glass illuminated by the object wave is recorded in speckle photography. At the reconstruction stage, the complex interference pattern of the object waves is reconstructed in HI, and the more simple "standard" Young's interferometric fringes are reconstructed in SP. The first one is a good means of large structure visualization in a complex flow, whereas the second one is used for a large amount of experimental data accumulation using computer-aided optical data acquisition systems, with the aim of subsequent statistical flowfield analysis and turbulence parameters determination

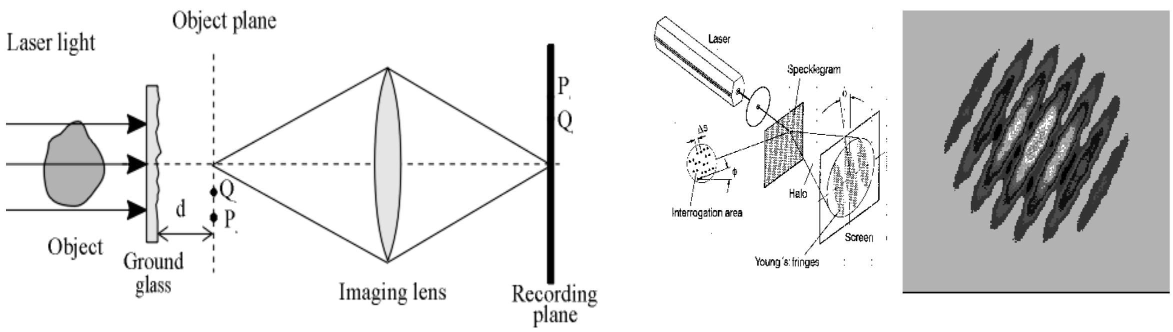

Fig. 1. Scheme of speckle-photography technique

The described above approach allows reconstructing macro and micro spatial structures of the turbulent scalar (density) field in compressible. The macro structures are reconstructed using direct numerical simulation of flow patterns and comparison with holographic interferometry data and by using CAT with Radon integral transform. The microscale turbulence structures are determined by using the 3-D density correlation functions evaluated with Erbeck-Merzkirch integral transforms. Evaluation procedure using this integral transform is referred to ill-posed mathematical problems and care must be taken while performing such calculations. 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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