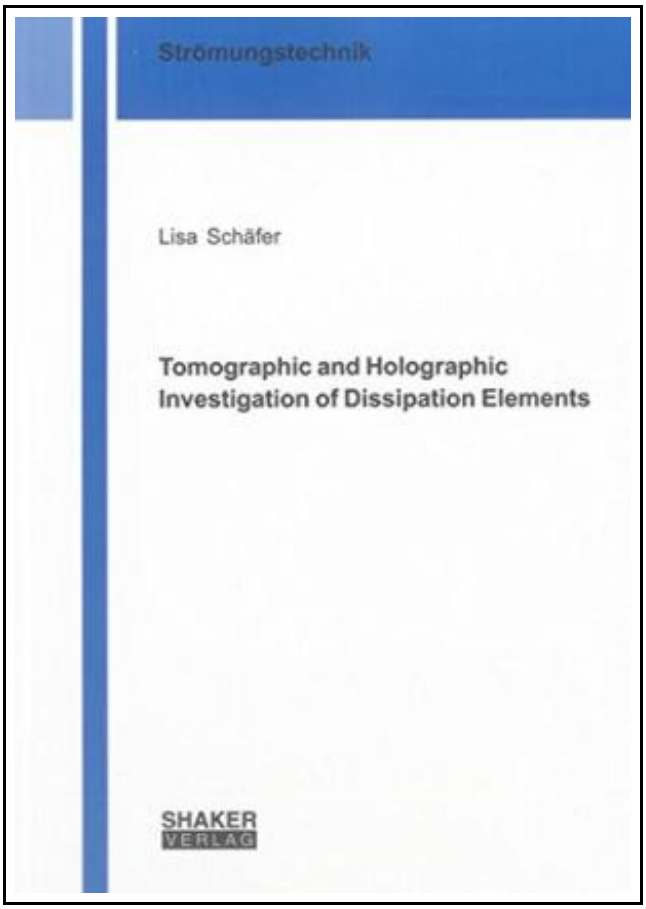
Tomographic and Holographic Investigation of Dissipation Elements



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TOMOGRAPHIC AND HOLOGRAPHIC INVESTIGATION OF DISSIPATION ELEMENTS

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Shaker Verlag Aug 2012, 2012. Buch. Book Condition: Neu. Neuware - This doctoral thesis evolved in the frame of the joint proposal 'Geometrical Structure of Small-Scale Turbulence'. The central subject of this proposal is the analysis of turbulent fields by so-called 'dissipation elements' as introduced by Wang & Peters (JFM, 2006). This novel method determines the local minimum and maximum points of a fluctuating scalar field via gradient trajectories starting from every grid point in the direction of the steepest ascending and descending scalar gradients. Relying on gradient trajectories, a dissipation element is defined as the region of all the grid points the trajectories of which share the same pair of maximum and minimum points. Since these elements are space-filling, characteristics of the entire turbulent field can be derived from dissipation element related statistics. The procedure has also been successfully applied to various DNS fields, i.a., using the fluctuations of the three velocity components and the kinetic energy as scalar fields (Wang & Peters, JFM, 2008). According to the joint proposal, this thesis discusses the experimental validation of the statistical properties of dissipation elements derived from DNS, comprising the identification and development of an adequate three-dimensional, three-component measurement technique. Subject of the experimental investigation is a fully developed turbulent channel flow. To provide this reference flow a special Eiffel-type wind tunnel is constructed and reference measurements by two-dimensional, two-component (2D2C) particle-image velocimetry (PIV) and laser-Doppler velocimetry (LDV) are performed to proof the quality of the flow. The three-dimensional velocity distribution within the core region of the channel flow is measured by means of tomographic and holographic particle-image velocimetry (PIV). Based on these measurements the two volumetric measurement techniques are juxtaposed with respect to their capability to detect dissipation elements, i.e. small-scale, instantaneous, turbulent structures. In case of the tomographic PIV...

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