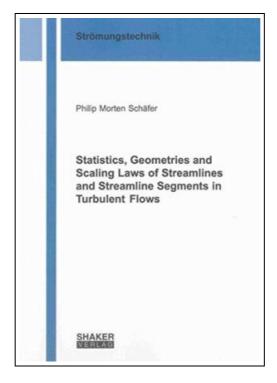
# Statistics, Geometries and Scaling Laws of Streamlines and Streamline Segments in Turbulent Flows



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## STATISTICS, GEOMETRIES AND SCALING LAWS OF STREAMLINES AND STREAMLINE SEGMENTS IN TURBULENT FLOWS



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Shaker Verlag Apr 2013, 2013. Buch. Condition: Neu. Neuware - In this thesis turbulent flow fields are theoretically analyzed from a geometric point of view. The objects of interest are streamlines based on instantaneous realizations of homogeneous incompressible turbulent flow fields. First, streamlines are treated as parameterized space curves which are locally characterized by different measures of the streamline curvature. In particular, three different measures are statistically analyzed and moments of their probability density functions (pdf) are related to characteristic length scales of turbulent flows. The scaling of the tails of the pdfs are related to stagnation points in the flow field where locally curvatures assume very large values. In a next step, the a-priori infinitely long streamlines are partitioned into streamline segments based on local extrema of the absolute value of the velocity field u. It is shown that all end points of the ensemble of streamlines segments define an extremal surface in space which also contains all zero gradient points of the instantaneous kinetic energy field k=u 2 /2. Stagnation points which are a subclass of the local minimum points are treated separately as they are critical points of the velocity field. The theory of streamline segments is connected by the extremal surface to the one of dissipation elements previously introduced for different turbulent scalar fields as dissipation elements end and begin in zero gradient points of the underlying scalar field. The extremal surface is treated by means of a level-set approach and the corresponding displacement speed is derived based on the Navier-Stokes equations. Streamline segments are then parameterized by their arclength I and the velocity difference between their end points . The two parameters are random variables and their joint as well as marginal distributions are analyzed based on four different direct numerical simulations (DNS) at various...

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