DESCRIPTION OF BOUNDARY LAYER TRANSITION WITH THE DIRECTED PERCOLATION THEORY

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Pomeau was the first who described the dynamics of laminar-turbulent transition by a system of coupled oscillators [6]. Thereby he formulated a statistical description of this highly complex and unsteady phenomenon. He also realized that his statistic approach of coupled oscillators corresponds directly to the percolation theory.
Using the percolation theory has the big advantage that a simple description of complex phase transitions with only three critical exponents is possible. This means that if an experiment fulfills the conditions of the theory it can be assigned to an universality class of percolation using these unique exponents. Following the percolation theory, each cell in the flow field can only have two states which can propagate downstream. According to this the whole information of the system can be reduced to this on and off states.
Until the last decade the experimental evidence for this theory could not be given. The spatio-temporal intermittency, which occurs in the transition, could not be captured sufficiently well. Since measurement techniques have become more accurate nowadays it is possible to capture the transition with much higher temporal and at the same time spatial resolution. For this reason, there are many new experiments which underline the presumptions of Pomeau [1, 2, 3, 4, 5, 7, 8].

In order to give another evidence that the percolation theory is capable of describing the laminar-turbulent transition such change of state of flow is investigated in a transient boundary layer. The boundary layer is investigated by means of high speed stereoscopic PIV (HS-PIV), like it is shown in figure 1. The high spatio-temporal resolution enables capturing the dynamics of the transient area sufficiently well. In this way, it is possible to extract the critical exponents for percolation analysis accurately.
In this presentation, the results of the evaluation are presented and are compared to the (2+1)D directed percolation class which is a suitable model for the present boundary layer on flat plates without external driving forces like e.g. pressure gradients.

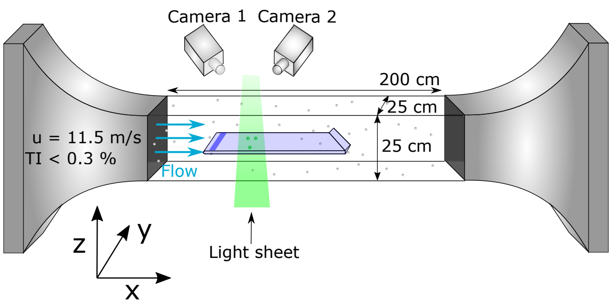

Figure 1. Exemplary experimental setup for HS-PIV measurement of a flat plate's boundary layer in a wind tunnel. The light sheet is adjusted parallel to the surface in a region where the transition can be observed.

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