Universal Reynolds number of transition, self-organized criticality and turbulence modeling.

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A high-Re turbulent flow involves velocity fluctuations excited in an extremely broad interval of wave numbers $k > \Lambda_f$ where $\Lambda_f$ is a relatively small set of the wave-vectors where energy is pumped into fluid by external forces, instabilities etc. Iterative averaging over small-scale velocity fluctuations leads to an infinite number of “relevant” scale-dependent coupling constants (Reynolds numbers) $Re_n(k) = O(1)$, which is a part of “turbulence problem”.

We have found that in the infrared limit $k \rightarrow \Lambda_{f}$, the Reynolds numbers $Re(k) \rightarrow Re_{tr}$ where $Re_{tr}$ is the recently numerically and experimentally discovered universal Reynolds number of “smooth” transition from Gaussian to anomalous statistics of spatial velocity derivatives.

Therefore, the large-scale velocity field in a high-Reynolds number turbulent flow is marginally stable with the “dressed” Re-number equal to that at the transition point. This effect is called “self-organized criticality”. The calculated relation $Re(\Lambda_{f}) = Re_{tr}$ “selects” the lowest - order non-linearity as the only relevant one leading to effective equations for large-scale features of high - Re turbulent flows widely used in engineering design.

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Please join us for refreshments beforehand, outside Room 3-370

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