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Invariant solutions organizing turbulence in pipe flow experiments SEBASTIAN ALTMEYER, JAKOB KHNEN, MARKUS SCHANER, BJRN HOF, Institute of Science and Technology — A large number of unstable invariant solutions, e.g. traveling waves (TWs) or (relative-) periodic orbits, has been discovered and numerically studied in recent years for pipe flow. The proposed role of such states as building blocks of turbulence is however less clear and so far only limited experimental evidence has been provided. In experiments we used a modulated pipe segment to impose a certain symmetry on the experimental velocity field and in the non-modulated downstream pipe traveling waves could be observed persisting for many wavelengths. Measured velocity fields (PIV) were used as initial conditions for a numerical Newton search and converged to the exact invariant traveling wave solutions. All the experimentally observed TW's correspond to lower branch states that are close to the laminar turbulent boundary (edge). Correspondingly in the experiments as the waves proceeded downstream flows would typically relaminarize but occasionally the TW's would grow to turbulence. The latter observation confirms the relevance of these invariant states for the transition process.

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