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THE ONE-DIMENSIONAL TURBULENCE ASPECTS OF INTERNAL FORCED CONVECTIVE FLOWS

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Normally, the multi-scale phenomenology of turbulence is treated numerically by the filtering of the small scales. Nonetheless, the statistical treatment of turbulence also allows the determination of statistical moments of the flow by resorting to a large variety of models. One of these models is the One-Dimensional Turbulence (ODT) [1].

When discussing internal forced convection flows, two widely applicable cases can be mentioned: incompressible flow with constant fluid properties, and low Mach number flows with heat transfer and variable fluid properties. Focusing on flows with one homogeneous dimension, i.e., pipes or channel flows, these cases are presented based on the applicable divergence condition of the velocity field. This condition grants the flow a dominant 1-D or 2-D character, giving the one-dimensional assumption of the turbulence more, or less accuracy, respectively. This is a geometric analysis. However, the 1-D character of the turbulence may also arise from a parametric analysis, depending on the number of nondimensional parameters governing the relation between the small and large scales, e.g., the skin friction coefficient.

Various examples regarding how the ODT model can be applied in the two cases at discussion are provided. Results presented in [2, 3] are reinterpreted with the purpose of the discussion presented here. In comparison to the reference DNS results [4, 5], ODT is capable of reasonably reproducing some statistical moments with a minimum degree of empiricism at only a fraction of the computational cost. In what could maybe be considered as an advantage in comparison to DNS, some concepts obtained by the consistent modeling of the flow in ODT could offer fundamental insights into the dynamics of turbulence.

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