Einladung zum Vortrag

Statistical symmetries in turbulence – a basis for turbulence scaling laws and a new paradigm for turbulence modeling

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Classical text-book knowledge proclaims that symmetries of fluid mechanics, in particular Galilean transformation, lie at the heart of classical physics. Based on this one may easily recognize, that these important properties also carry over to the statistical description of turbulence, i.e. to the Reynolds stress transport equations and its generalization, the multi-point correlation equations (MPCE). Interesting enough, the MPCE admit a much larger set of symmetries, in fact infinite dimensional, subsequently named statistical symmetries.

Most important, theses new symmetries have important consequences for our understanding of turbulent scaling laws. The symmetries form the essential foundation to construct exact solutions to the infinite set of MPCE, which in turn are identified as classical and new turbulent scaling laws. Various examples will presented such as scaling laws for decaying turbulence and further various classical and new shear flow scaling laws including the familiar log-law. Even new scaling have been forecasted from the symmetries and in turn validated by DNS of the Navier-Stokes equations.

Interesting enough, for decades turbulence modelers have implicitly recognized at least one of statistical symmetries as this is the basis for the usual log-law which has been employed for calibrating essentially all engineering turbulence models. The credit for first explicitly mentioning this may be given to R. Kraichnan in the context of the DIA model. An obvious conclusion is to generally make turbulence models consistent with the new statistical symmetries at least as far as possible.

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