Singularities, Turbulence and Instantons

Rainer Grauer*[1]

[1]Institute for Theoretical Physics I, Ruhr-University Bochum (RUB) – Gebäude NB 7/123
Universitätsstr. 150 D 44801 Bochum, Germany

Abstract

It is evident that coherent nearly singular structures play a dominant role in understanding the anomalous scaling behavior in turbulent systems. We ask the question, which role these singular structures play in turbulence statistics. More than 15 years ago, for certain turbulent systems the door for attacking this issue was opened by getting access to the probability density function to rare and strong fluctuations by the instanton approach. We address the question whether one can identify instantons in direct numerical simulations of the stochastically driven Burgers equation. For this purpose, we first solve the instanton equations using the Chernykh∼Stepanov method [2001]. These results are then compared to direct numerical simulations by introducing a filtering technique to extract prescribed rare events from massive data sets of realizations.

In addition, we solve the issue why earlier simulations by Gotoh [1999] were in disagreement with the asymptotic prediction of the instanton method and demonstrate that this approach is capable to describe the probability distribution of velocity differences for various Reynolds numbers. Finally, we will present and discuss first results on the instanton solution for vorticity in 3D Navier∼Stokes turbulence.

*Speaker