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Turbulence via information field dynamics

Torsten A. Enßlin

Max Planck Institute for Astrophysics
Karl-Schwarzschild Str. 1, 85741 Garching, Germany
email: ensslin@mpa-garching.mpg.de

Abstract. Turbulent flows exhibit scale-free regimes, for which information on the statistical properties of the dynamics exists for many length-scales. The simulation of turbulent systems can benefit from the inclusion of such information on sub-grid process. How can statistical information about the flow on small scales be optimally incorporated into simulation schemes? Information field dynamics (IFD) is a novel information theoretical framework to design schemes that exploit such statistical knowledge on sub-grid flow fluctuations.

Keywords. Information theory, field theory, simulations, turbulence

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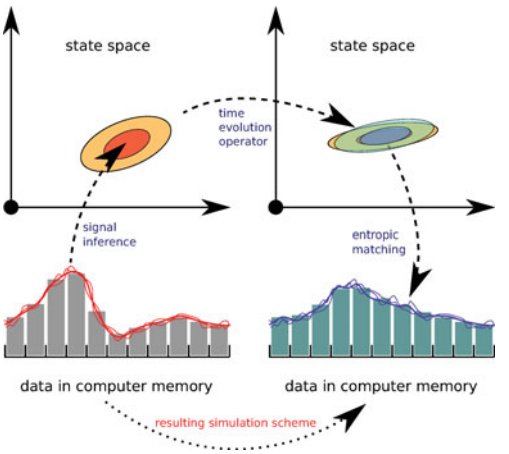
IFD is a theoretical framework to construct information optimal field simulation schemes (Enßlin 2013). IFD permits the information fusion of the dynamical equations, statistical properties, and relevant observational data of a system. This is performed via information field theory (IFT, Enßlin 2009) and a maximum entropy-based optimal coding. The concept of IFD is illustrated below.

Data in computer memory is regarded as resulting from a field measurement process *(bottom left)*. The ensemble of field states consistent with this data and other information can be reconstructed from this with the help of IFT *(top left)*. The time evolution operator of the field dynamics produces the time evolved field ensemble *(top right)*. This is then represented by data in computer memory via entropic matching of the two distribution functions *(bottom right)*. The transformation rule relating initial and updated data is then the desired simulation scheme (bottom arrow), which incorporates the continuous field dynamics and available statistical knowledge information-optimally.



The operability of the IFD scheme has been demonstrated for a thermally excited Klein-Gordon field (Enßlin 2013) as well as for stochastic network dynamics (Ramalho *et al.* 2013). Application to hydrodynamics and plasma physics are in preparation.

References

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