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# Incoherent waves v.s. coherent structures in turbulence: Fourier phase analysis

**J.F. Panis** (1,3), F. Sahraoui (2), G. Belmont (2), L. Rezeau (1,2), F. Levrier (3), E. Falgarone (3)

(1) Université Pierre et Marie Curie-Paris6, 4 place Jussieu, Paris, F-75005 France [panis@lra.ens.fr] ; (2) CNRS, UMR 8639 CETP/IPSL, 10-12 avenue de l'Europe, Vélizy-Villacoublay, F-78140 France ; (3) École normale supérieure, UMR 8112 LERMA, 24 rue Lhomond, Paris, F-75005 France

Whenever one observes turbulence and wishes to interpret it, one needs to know to what extent the spectrum is due to incoherent waves or to a set of coherent structures. This information is not included in the Fourier spectrum itself but in the phases, which contain at least the same amount of information as the amplitudes do. This information is also necessary if one is interested in studying the nature of the nonlinear interactions in turbulent signals. Despite all these fundamental applications, very limited work has been devoted to this issue. The reason is that, because of their dependence on an arbitrary origin, phases usually appear completely mixed, making them seldom used.

We present a method to quantitatively estimate phase coherence and apply it to turbulent signals. We show it is possible to get rid of the 2Pi ambiguity in the phase determination by directly computing phase gradients in Fourier space. After precisely defining phase coherence, we propose an index to quantify it and compute it for various turbulent data sets. We make a multi-scale computation of this index to estimate the range of coherence of the structures and evaluate intermittency. After validating the new method on synthetic data, we present preliminary results based on Cluster magnetosheath data and on interstellar medium data, and some comparisons with other methods of phase coherence analyses. From a theoretical point of view, the present studies are of a first interest to fix the validity limits of different approaches of space plasma turbulence: weak/wave turbulence, coherent structures...