Statistical Analysis of Particle Clusters in Turbulent Supersonic Jet Flows

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This work investigates the clustering of inertial particles in an under-expanded, supersonic jet flow. Data stems from a direct numerical simulation based on a two-way coupling model, i.e. the particles' effects on the fluid motion are considered.

The presentation focuses on two main aspects of the clustering phenomenology in the turbulent region beyond the jet's potential core: the preferential particle concentration and the agglomeration-separation process. The analysis is performed by means of a technique based on the Finite-Size Lyapunov Exponents (FSLEs), a mathematical tool applied to evaluate trajectory separation rate in dynamical systems.

The global particle distribution shows a striking correlation with the local flow topology, which is in turn characterized by the invariants of the fluid velocity gradient tensor. Furthermore, there is evidence of a dependence between the values of the FSLEs and the local Kolmogorov timescales, resulting in an interesting self-similarity of the FSLEs mean profiles computed for different values of the scale-parameter.