

Morphological analysis of contorted fluid structures

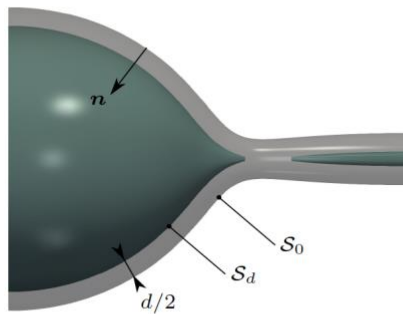
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Turbulence of heterogeneous fluids (non-miscible fluids separated by an interface) are encountered in several natural and industrial situations. Most of available theoretical descriptions of such flows generally apply to the dispersed regime, when one phase is much more abundant than the other. When the two-phases are found in similar proportions (the dense regime), the shapes of fluid structures are much more contorted and cannot simply be described in terms of e.g. drop/bubble diameter distribution.

Here, we introduce two morphological descriptors of complex (i.e. non-spherical and non-convex) fluid structures. They both originate from the field of heterogeneous materials where they are widely used for characterizing the microstructure of e.g. porous media, composite material, fractal aggregates, etc. The first one is based on the two-point statistics of the phase indicator function (which is simply defined as being 1 in one fluid, and 0 elsewhere), while the second is referred to as the Minkowski functionals of parallel sets (obtained after morphological erosion/dilation of the original system). For both case, the observable depends on a morphological parameter (the scale) and contain many important information about the system content, shape, morphology and topology. The theory underlying these tools and some numerical applications in dense liquid-gas flows will be presented.

Minkowski Functionals

Dumouchel et al. 2017, 2021, 2022
Thiesset et al. ILASS Paris 2019



Phase indicator (2 pts) statistics

Thiesset et al. ILASS Paris 2019,
Thiesset et al. JFM 2020, 2021)

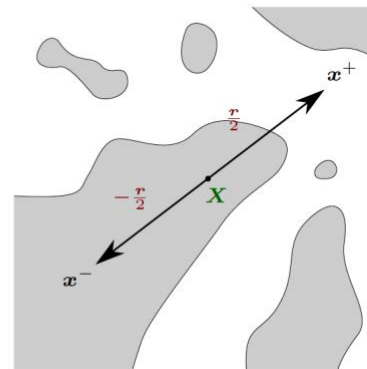


Figure 1. Abstract representation of the Minkowski functional and the two-point statistics of the phase indicator function.

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