Sub-Hinze bubble production in turbulence

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Liquid-gas flows play a central role in the transfert of low solubility gases, such as CO2, from the atmosphere to the ocean [1][2]. Indeed, when a wave breaks, it traps large volumes of air that will fragment and generate sub-millimetric bubbles. This fragmentation dynamics is controlled by the Weber number We, the ratio between inertial force and capillary force. A critical break up size, the Kolmogorov-Hinze scale d_h corresponding to a Weber of order unity separates stable bubbles ($d \ll d_h$) from bubbles that will surely break ($d \gg d_h$). The sub-Hinze bubbles in particular rise slower to the surface, and dissolve faster into the ocean. However, the understanding of sub-millimetric bubble productions remains challenging: these bubbles are produced from the break up of much larger ones, throughout highly non-linear processes [3],[4],[5]. We use direct numerical simulations in both homogeneous isotropic turbulence and in an extensional flow to built a population model, going from the fate of individual filaments to the multi-scale break-up statistics of large bubbles in turbulence. Combining numerical and experimental, I will show how that sub-Hinze bubble size distribution originates from the break-up of gas filaments, on a timescale controlled by capillarity instability.

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