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Limoncello and the art of mixing water and oil

Whoever tried to prepare homemade mayonnaise, knows how much energy input the formation of water/oil emulsions require. In addition to that, in order to provide stability to the emulsion, the presence of components which stabilize the system are required. This role is played by some of proteins and the lecithin contained in the egg yolk, for the case of mayonnaise. In most of other
emulsions, surfactants and polymers are used to prov ide stability to the emulsion.

In a different approach, meta-stable emulsions can be prepared when three liquids, two partly miscible liquids (water and oil) and a common solvent, such as ethanol, are mixed. Close to the phase-separation boundary, strong composition fluctuations take place. In this portion of the phase diagram, called 'Ouzo region', the formation of 100-1000 nm sized oil rich domains are found. The name
'Ouzo' derives from the famous Greek liquor, which exhibits a typical opalescence when diluted with water, due to the formation of anethole (the oil) rich droplets.

In this contribution, we focus on Limoncello, the famous Italian liquor based on lemon essential oils. In contrast to similar, 'Ouzo-like' systems, Limoncello shows and exceptional stability. Small-angle neutron scattering was used to probe the microscopic structure of Limoncello, revealing the presence of self-emulsified submicrometer small droplets, whose size shows only little variation in a large range of composition and temperature. These findings open two fundamental questions to be addresses in forthcoming studies: what are the physical forces leading to the formation of oil domains with such an exceptional size and what is the mechanism guaranteeing a long term stability to Limoncello systems.

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