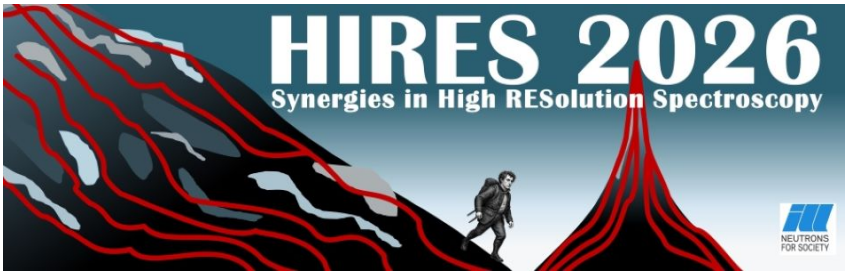

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NSE as a Tool for Understanding the Dynamics of Self-Organizing Water–Monoalcohol Mixtures Toward Green Solvent Design

Surfactant-free microemulsions (SFME) are an emerging class of self-organized ternary liquids that develop mesoscale structure without conventional surfactants. Understanding their phase behavior and dynamics is crucial for applications in drug delivery, extraction, and chemical engineering.

In ternary mixtures, SFME formation arises from a delicate interplay of molecular architecture, hydrotropic interactions, and collective nanoscale dynamics. Here, we combine Neutron Spin Echo (NSE) spectroscopy with complementary PFG-NMR measurements to probe these dynamics across three representative systems: octanol–ethanol–water, 2-ethylhexanol–ethanol–water, and ethyl acetate–sodium salicylate–water. Together, these methods link structural organization with diffusive dynamics across multiple timescales. NSE resolves the q-dependent evolution of diffusion, enabling us to identify transient species and quantify characteristic aggregation lifetimes and correlation lengths. This integrated approach provides a direct comparison of how linear versus branched alcohols and non-ionic versus ionic hydrotropes modulate nanoscale dynamics.

In a SFME system, NSE measurements capture the shift in dynamics as the system transitions from pre-Ouzo aggregates (oil-in-water) to reverse aggregates (water-in-oil), providing insights into the motion of individual species across q-scales. The incoherent signal reflects NMR-like behavior, while the coherent signal highlights collective dynamics associated with aggregate formation.

Overall, NSE combined with complementary techniques reveals how molecular architecture and intermolecular forces control diffusion, aggregation lifetimes, and the emergence or suppression of structure in SFME systems.

Session

Soft Condensed Matter

Primary authors: Mr MALAYIL KALATHIL, Firoz (PostDoc Researcher); HOFFMANN, Ingo (ILL); PLAZANET, Marie (Laboratoire Interdisciplinaire de Physique)

Co-authors: ALBA-SIMIONESCO, Christiane (LLB); PREVOST, Sylvain (Institut Laue-Langevin); ZEMB, Thomas (CEA/ICSM)

Presenter: Mr MALAYIL KALATHIL, Firoz (PostDoc Researcher)

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