Experimental Report

Proposal: **9-10-1317** **Council:** 10/2012

Title: Magnetic Microemulsions as TunableNanomagnets

This proposal is a new proposal

Researh Area: Chemistry

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Samples: (Ho(AOT)3, Ce(AOT)3, Co(AOT)2 and Mn(AOT)2 see proposal - water - alkane (heptane)

Instrument	Req. Days	All. Days	From	To
D11	2	2	31/03/2013	02/04/2013

Abstract:

Control of sub-micron sized particles is of increasing interest as there is clear evidence that small atomic clusters (n = 10-1000 atoms) exhibit novel hybrid properties between the molecular and bulk solid-state limits. Through SANS and SQUID magnetometry we recently showed that quantum effects can be observed in nanoparticle-free ferrofluids through the design of magnetic micelles and microemulsions from magneto-surfactants1. Such systems bridge the gap between molecular nanomagnets (n <30) and magnetic nanoparticles (MNPs) (n = 100-1000)2, allowing controlled values of n and combining magnetic ordering with properties such as low-density, and electric insulation. This is a significant step forward as the advantage of employing these microemulsions over nanoparticle containing ferrofluids is in situ tunability through careful control of surfactant type, mixture ratio, and composite volume fractions: the proposal aims to explore this tunability.

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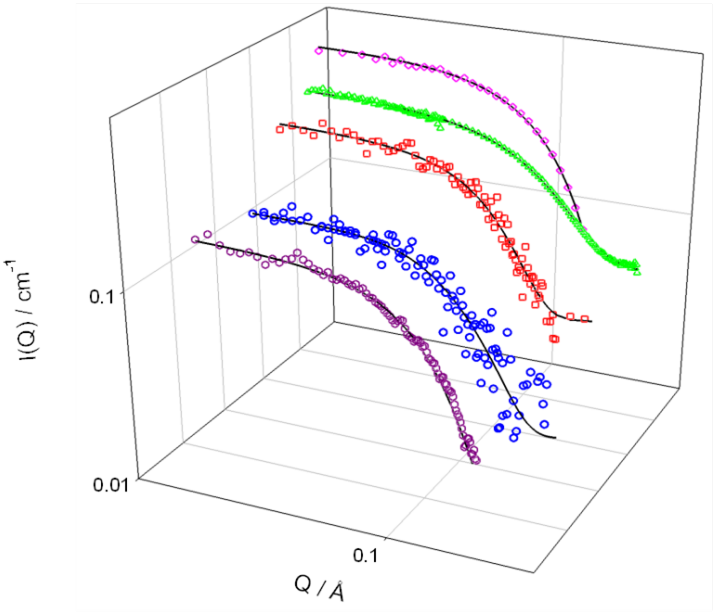

Figure 1: SANS profiles for surfactants in n-d_{-16} heptane at 1.0 wt% at 25 °C. Lines through the data are fits (parameters in *Supporting Information, Table S1*). $Co(AOT)_2$ is at 0. 5 wt% due to phase separation at higher concentrations. Na(AOT) (○), $Co(AOT)_2$ (○), $Mn(AOT)_2$ (□), $Ce(AOT)_3$ (△) $Ho(AOT)_3$ (◊).

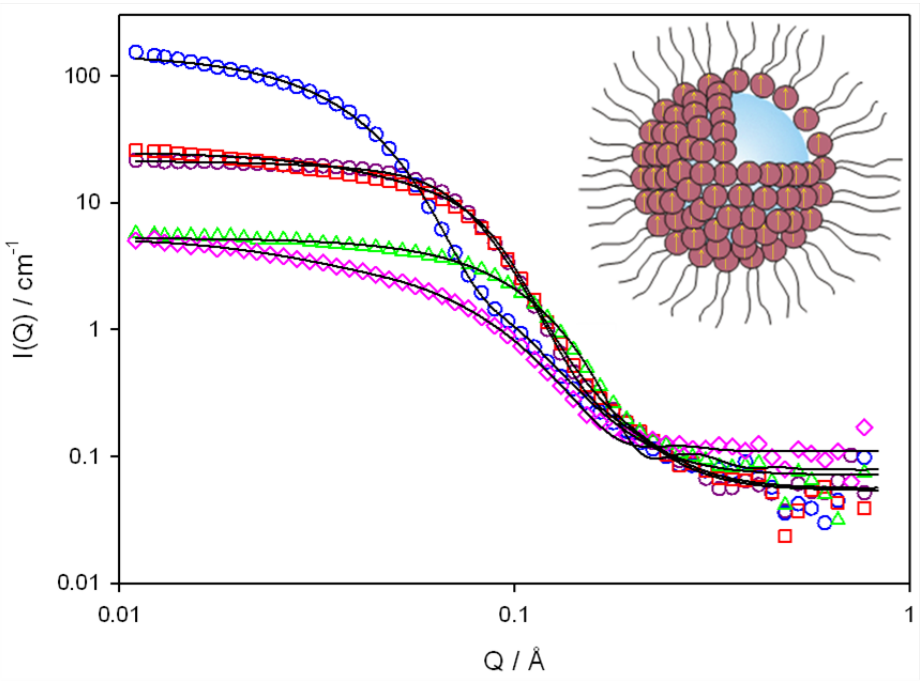

Figure 3: SANS profiles for D_2O-in-heptane microemulsions at 25 °C. Lines are model fits (parameters in *Supporting information, Table S2)*. Na(AOT) (○), $Co(AOT)_2$ (○), $Mn(AOT)_2$ (□) $Ce(AOT)_3$ (△), $Ho(AOT)_3$ (◊). Inset is a schematic of a typical microemulsion droplet with aligning spins in a magnetic field.

We have synthesized the first anionic magnetic surfactants, which stabilize magnetic reversed micelles and microemulsions. More importantly, these surfactants have also enabled the first stable nanoparticle-free ferrofluids. The observed superparamagnetic behaviour not only suggests potential for new biomedical strategies, but also provides a new way to investigate evolution from molecular through to bulk solid-state magnetic limits.