Neutron diffraction studies of liquids at high pressure

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To date, the intrinsic strengths of neutron diffraction for non-crystalline structure have remained largely unexploited at high pressure. However, activity has been increasing over recent years, most notably at the PEARL diffractometer at ISIS spallation neutron source. These studies have included characterisations of amorphous ice [1, 2], liquid water [3] and silicate glasses [4]. Measurements of GeO_2 have also been conducted at the ILL reactor source [5].

Two of us (MG & MGT) have been heavily involved in the PEARL developments, and are now working to achieve similar capabilities on the SNAP diffractometer at SNS, Oak Ridge. SNAP was originally conceived as a single-crystal instrument, but has already demonstrated an aptitude for non-crystalline measurents. In addition, SNAP provides access to low *Q* data not readily available on PEARL, and tests of its eliptical focusing guide have suggested that higher conditions of P and T may be achievable.

We will present a neutron diffraction study of deuterated ammonia-water (dihydrate) solutions up to their room temperature freezing pressure. The liquid structure under these conditions is relevant to the deep subterannean ocean believed to exist on Titan [6]. In the near future, we hope to extend these capabilities to high temperature, permitting measurements of liquid structure to substantially higher pressures.

[1] Nelmes *et al*. (2007) *Nat. Phys*. **2**, 414–418. [2] Klotz *et al*. (2005) *J. Phys. Cond. Matt*. **17**, S967-S974. [3] Strässle *et al*. (2006) *Phys. Rev. Lett*. **96**, 067801. [4] Wilding *et al*. (2009) **20**, *J. Phys. Cond. Matt*. **20**, 244122. [5] Drewitt *et al*. (2010) **81**, 014202. [6] Grasset *et al*. (2000) *Planet. & Space Sci*. **48**, 617.

The potential feasibility of chlorinic photosynthesis on extrasolar planets

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The modern search for life-bearing exoplanets emphasizes the potential detection of O_2 and O_3 absorption spectra in exoplanetary atmospheres as ideal signatures of biology. However, oxygenic photosynthesis may not arise ubiquitously in exoplanetary biospheres. Alternative evolutionary paths may yield planetary atmospheres tinted with the waste products of other dominant metabolisms, including potentially exotic biochemistries. This paper defines *chlorinic photosynthesis* (CPS) as biologically-mediated halogenation of aqueous Cl^- coupled with assimilatory CO_2 fixation. This hypothetical metabolism appears to be feasible both energetically and physically, and could potentially evolve under conditions approximating the terrestrial Paleoarchean. It is hypothesized that an exoplanetary biosphere in which chlorinic photosynthesis dominates primary production would tend to evolve a strongly oxidizing, halogen-enriched atmosphere over geologic time. Expectations of the chemical attributes of exoplanetary biospheres should include consideration of chlorinic environments in addition to oxic or methanic atmospheres. It is recommended that astronomical observations of exoplanetary outgoing thermal emission spectra consider signs of halogenated chemical species as likely indicators of the presence of a chlorinic biosphere. Planets favoring the evolution of CPS would probably receive equivalent or greater surface UV flux than is produced by the Sun, promoting stronger abiotic UV photo-oxidation of aqueous halides than occurred during Earth's Archean eon, and imposing stronger selection pressures on endemic life to accommodate and utilize photolytic halogens. Ocean-bearing planets of stars with equivalent or greater bulk metallicities than the Sun should especially favor the evolution of chlorinic biospheres, because of the higher relative seawater abundances of Cl, Br and I that such planets would tend to host. Directed searches for chlorinic worlds should probably focus on A, F and G0-G2 spectral class stars having bulk metallicities of +0.0 Dex or greater.