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Magnetic Properties of Bis-Lanthanoates: Probing Dimer Formation in Crystalline, Liquid and Glassy Compounds Using SQUID Magnetometry

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Abstract : Magnetic ionic liquids (MILs) are a class of ionic liquid incorporating one or more magnetic atoms into the anion or cation of the ionic liquid, endowing the ionic liquid with magnetic properties alongside the existing properties of ionic liquids. MILs have applications in e.g. fluid-fluid separations, electrochemistry, and polymer chemistry. In this study three different types of Bis-Lanthanoates, that exist in different phases, have been synthesised and characterised (Ln = lanthanide): 1) imidazolium lanthanide acetate – [C4Mim]2[Ln2(OAc)8] – forms a crystalline solid at room temperature, 2) phosphonium lanthanide acetate – [P666 14]2[Ln2(OAc)8] – is in a solid glassy state, and 3) phosphonium lanthanide octanoate – [P666 14]2[Ln2(Oct)8] – is an ionic liquid. X-ray diffraction of the crystalline solid imidazolium lanthanide acetate – [C4Mim]2[Ln2(OAc)8] confirm that the Ln(III) ions form dimers, bridged by carboxyl groups, but cannot yield information about samples phosphonium lanthanide acetate – [P666 14]2[Ln2(OAc)8] (glass) and phosphonium lanthanide octanoate – [P666 14]2[Ln2(Oct)8] (ionic liquid) since these lack long-range order. SQUID magnetometry studies show that all three samples have effective magnetic moments consistent with non-interacting Ln(III) ions at room temperature but deviate from this behavior in the same way below 50 K. Through modeling the magnetic response, we are able to show that we have formed magnetic dimers, in all compounds, that are weakly antiferromagnetically interacting

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