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Jacob P. Evans, 1 Glen Stewart, 2 Sean Cadogan, 2 Wayne Hutchison, 2 Emma Mitchell 3 and James E. Downes, 1

1. MQ Photonics Research Centre, Department of Physics and Astronomy –Macquarie University, NSW 2109, Australia
2. School of Physical, Environmental and Mathematical Sciences, UNSW Canberra –at the Australian Defence Force Academy, Canberra BC, ACT 2600, Australia
3. Materials Science and Engineering, CSIRO, NSW 2070, Australia

The rare-earth nitride (REN) series has attracted considerable research interest because of the co-existence of semiconducting and ferromagnetic properties, a feature ideal for spintronic devices. Dysprosium nitride (DyN) is a promising candidate whose electronic structure is relatively well understood. However, its magnetic structure has received little attention until recently. In particular, its low temperature bulk magnetic moment of about 4 μ_B /ion is significantly lower than the predicted magnetic moment, which is much closer to the free-ion value of 10 μ_B /ion [1]. Because of this, we are attempting to understand the detailed magnetic structure of DyN using conventional magnetometry combined with ^{161}Dy Mössbauer spectroscopy.

Using ion-assisted deposition, we have grown thick 3-4 μm DyN films on both sapphire and Kapton substrates. Because the characteristic measurement time for ^{161}Dy Mössbauer spectroscopy is of the order of nanoseconds, the spectrum recorded at 5 K was sensitive to rapid thermal fluctuation between the low-lying levels of the Dy^{3+} crystal field scheme. The spectrum was successfully analysed in terms of flipping between a pair of levels with moments of the same magnitude, 10 μ_B , but opposite sign. Based on the fitted energy separation, the longer-time, thermal-averaged moment can be estimated at about 85% of the full free ion value. However, such a simple 2-level crystal field ground state model would require a breaking of the cubic symmetry appropriate for the Dy^{3+} site in bulk DyN.

References:

- [1] D. L. Cortie et. al., Phys. Rev. B 89, 064424 (2014)

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Primary author: Mr EVANS, Jacob (Macquarie University)

Co-authors: Dr MITCHELL, Emma (CSIRO); Dr STEWART, Glen (UNSW Canberra); Dr DOWNES, James (Macquarie University); Prof. CADOGAN, Sean (UNSW Canberra); Dr HUTCHISON, Wayne (UNSW Canberra)

Presenter: Mr EVANS, Jacob (Macquarie University)