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Far-Infrared Spectroscopy on a Dysprosium Single-Ion Magnet

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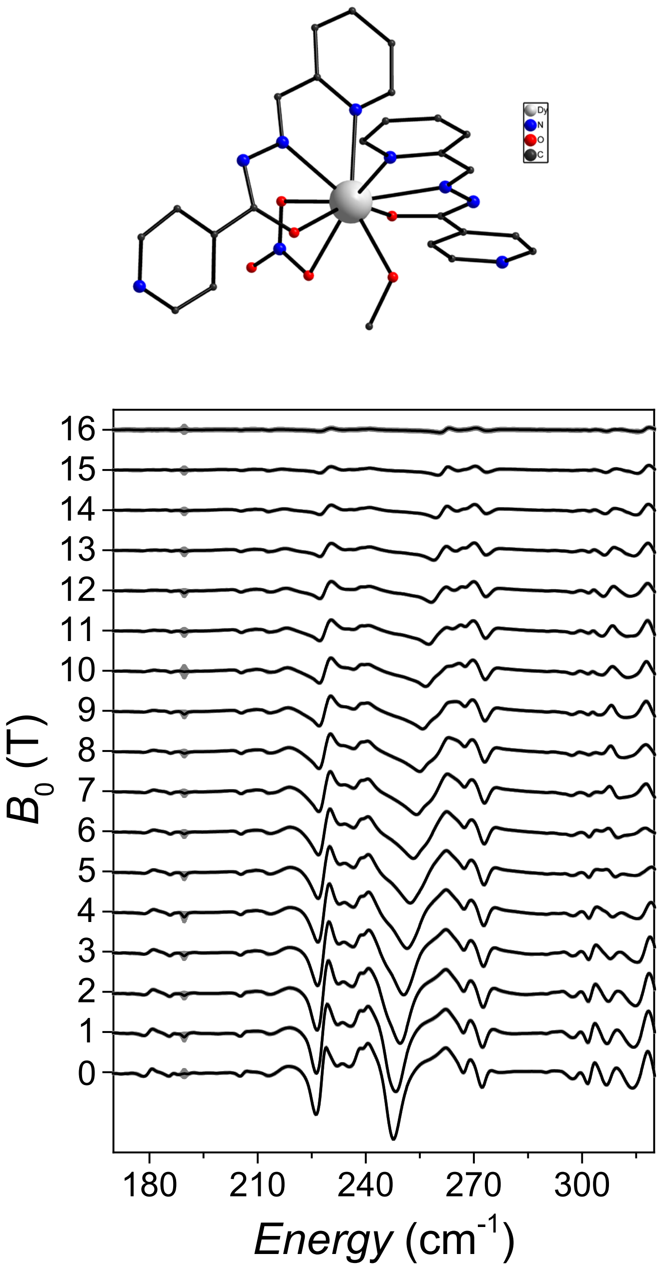

Fig.1 (top): Molecular structure of **1**. (bottom) FIR transmission spectra of **1**. Data is rescaled and offset according to B_0. The gray-shaded area indicate experimental uncertainty.

Introduction

Molecules containing a single magnetic ion and displaying slow relaxation of the magnetization are called Single-Ion Magnets (SIMs). With only one spin center, they can be considered the smallest possible realization of a magnet. However, their blocking temperature T_B, below which slow relaxation of the magnetization can be observed, is too low for potential applications such as data storage. Lanthanide molecules are currently considered the most promising candidates to raise T_B. There, oftentimes, very large splitting of spin energy levels in zero magnetic field, the Zero-Field Splitting (ZFS), can help to increase T_B. However, the large ZFS also pose an experimental challenge, and one of the very few methods to determine it is far-infrared spectroscopy in applied magnetic fields.

$[Dy^{III}L(NO_3)_2(H_2O)(MeOH)]$ (**1**), where L is N'-(pyridin-2-ylmethylene)isonicotinohydrazide, (see **Fig. 1**) was found to behave as an SIM at low temperatures. The goal of our experiments was to observe the ZFS of **1**, an important jigsaw piece in understanding its relaxation properties.

Experimental

Far-infrared (FIR) transmission spectra were measured at the temperature of 4.6 K using a commercial FT-IR spectrometer (Bruker Vertex 80v) combined with a SC 17 T magnet (SCM3 at the DC Facility). A broadband multilayer beam splitter was used to obtain a data in the spectral range between 25 and 900 cm^{-1} with 0.6 cm^{-1} resolution.

Results and Discussion

FIR transmission spectra of **1** are shown in **Fig. 1**. As reference the measurement at the highest applied magnetic field (17 T) was used. Several features with a magnetic field dependent intensity were observed. However, as no shift in energy was observed they were not identified as magnetic. A single line at 248 cm^{-1} did shift in energy and broadens significantly with magnetic field. To clearly distinguish it from those features, which only change in intensity with magnetic field, application of high magnetic fields was essential.

Conclusions

The ZFS of **1** was directly observed to be 248 cm^{-1}. Application of high magnetic fields was necessary to distinguish the feature due to ZFS from features with field-dependent intensity.

Acknowledgements

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