



Séminaire commun

des équipes IRCP

**Matériaux pour la Photonique et l'OptoElectronique (MPOE),
Physico-Chimie des Matériaux Témoins de l'Histoire (PCMTH)**

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Salle 4**

Professor Michael F. Reid

School of Physical and Chemical Sciences, University of Canterbury,
Christchurch, New Zealand.

Dodd-Walls Centre for Photonic and Quantum Technologies.
mike.reid@canterbury.ac.nz

High-Resolution Spectroscopic Studies of Upconverting Lanthanide-Doped Fluoride Nanoparticles

ABSTRACT

Lanthanide-doped luminescent nanoparticles are important candidates for low-toxicity imaging agents and nano-thermometers for biomedical applications [1]. Lanthanide ions doped into bulk CaF_2 and SrF_2 crystals are known to form a variety of sites, and to form clusters at concentrations as low as 0.01 mol%, becoming the dominant centres by 0.1 mol% [2, 3]. This clustering gives enhanced energy transfer, promising significant improvements in applications requiring up-conversion or down-conversion via energy transfer.

Most work on lanthanide-doped CaF_2 and SrF_2 nanoparticles has made use of low-resolution spectroscopy at high temperatures [4,5], and was therefore unable to clearly discriminate between the different sites.

In this work we present high resolution laser spectroscopy of fluoride nano-particles doped with Eu^{3+} , Yb^{3+} , and Er^{3+} at cryogenic temperatures (10 K), including site-selective excitation, emission, lifetime, and upconversion measurements. These techniques allow us to relate the site distribution to those observed in bulk crystals and to better understand the optimal excitation for upconversion [6].

1. W. Zheng, S. Zhou, Z. Chen, P. Hu, Y. Liu, D. Tu, H. Zhu, R. Li, M. Huang, and X. Chen, *Angew. Chem. Int. Ed.* 52, 6671 (2014)
2. K.M. Cirillo-Penn and J.C. Wright, *J. Lumin.*, 48-49, 505, (1991)
3. J.-P. R. Wells, G. D. Jones and R. J. Reeves, *J. Lumin.*, 72-74, 977 (1997)
4. V. Petit, P. Camy, J.L. Doualan, X. Portier, R. Moncorgé, Spectroscopy of Yb^{3+} : CaF_2 : From Isolated Centers to Clusters. *Phys. Rev. B* 78, 085131 (2008).
5. L. Song, J. Gao, R. Song, *J. Lumin.*, 130, 1179 (2010)
6. P. Cortelletti, M. Pedroni, F. Boschi, S. Pin, P. Ghigna, P. Canton, F. Vetrone and A. Speghini, *Cryst. Growth and Des.* 18, 686 (2018).
7. S. Balabhadra, M.F. Reid, V. Golovko, and J.-P.R. Wells. The Importance of Fluorescence-Detected Absorption as a Diagnostic Tool for Upconverting Nanoparticles Doped with Lanthanide Ions. Submitted to *J. Phys. Chem. C*
<https://arxiv.org/abs/1909.02645>

