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QUILL

Magneto-structural properties of rare-earth magnets synthesised through ionic liquid pathways

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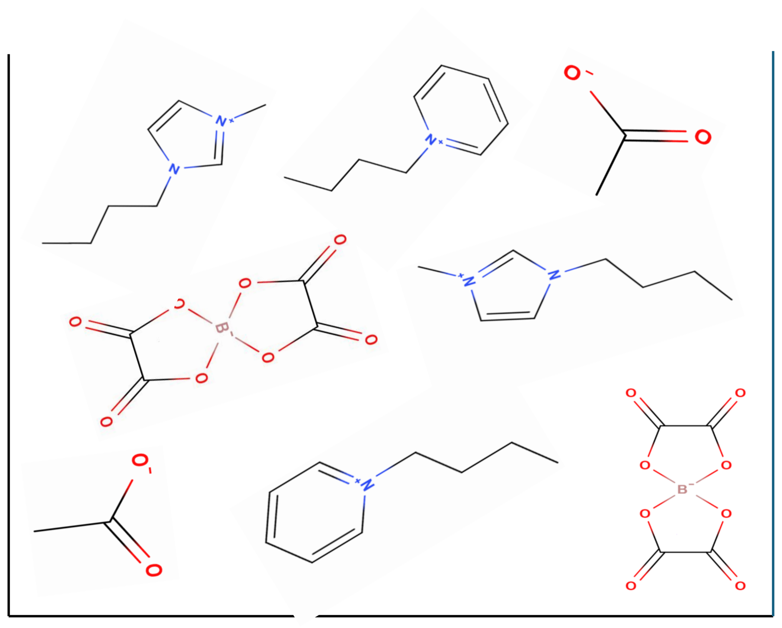
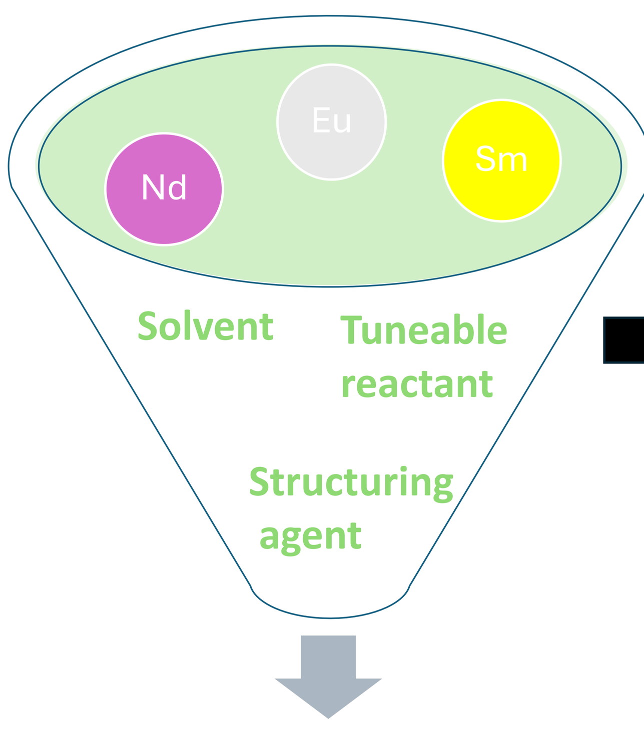
Introductions

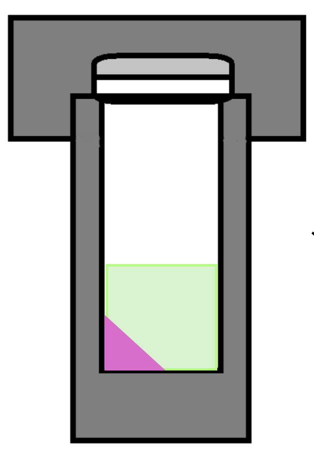
Abstract : This study investigates the magneto-structural properties of novel rare-earth magnets synthesised using ionic liquid. These nanoclusters are defined molecular structures capable of exhibiting cooperative magnetic phenomena. This research aims to exert synthetic control over magnetic materials at the molecular cluster level.



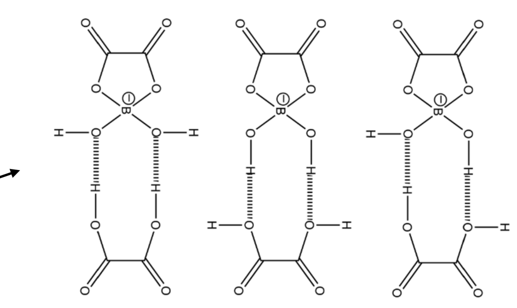
Different cation and anion molecules using ionic liquid synthesis in this project.



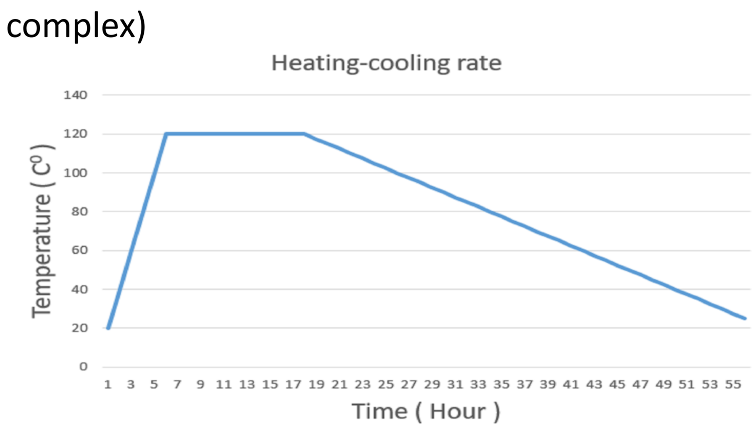
Molecular magnets



Hydrothermal crystal synthesis



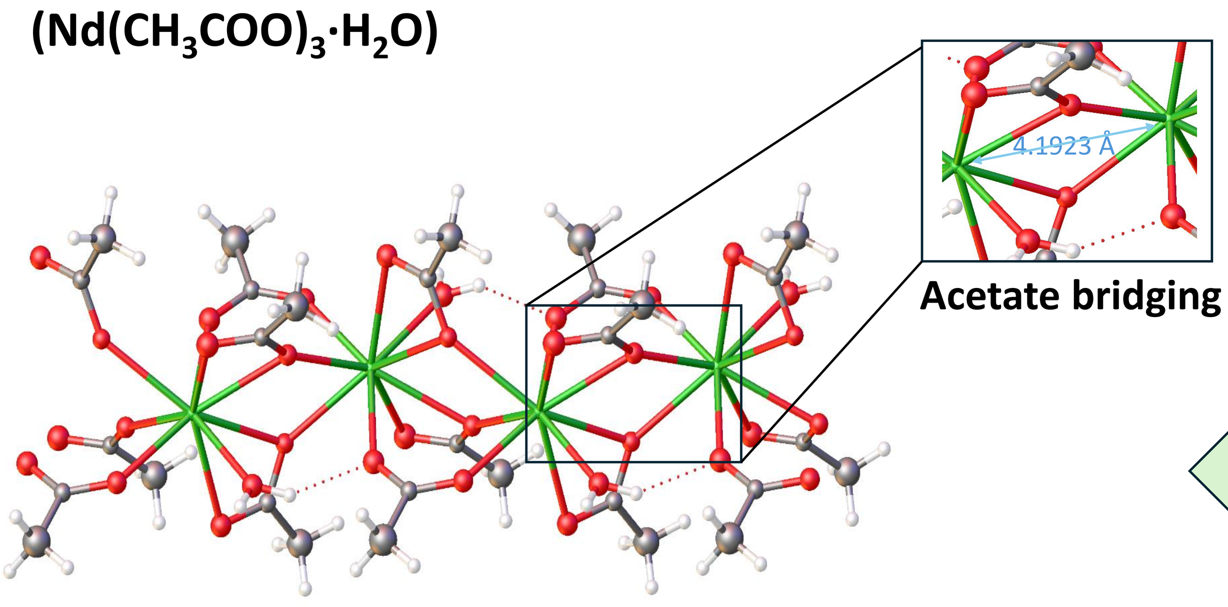
Possible structures of TAC (transition anionic complex)



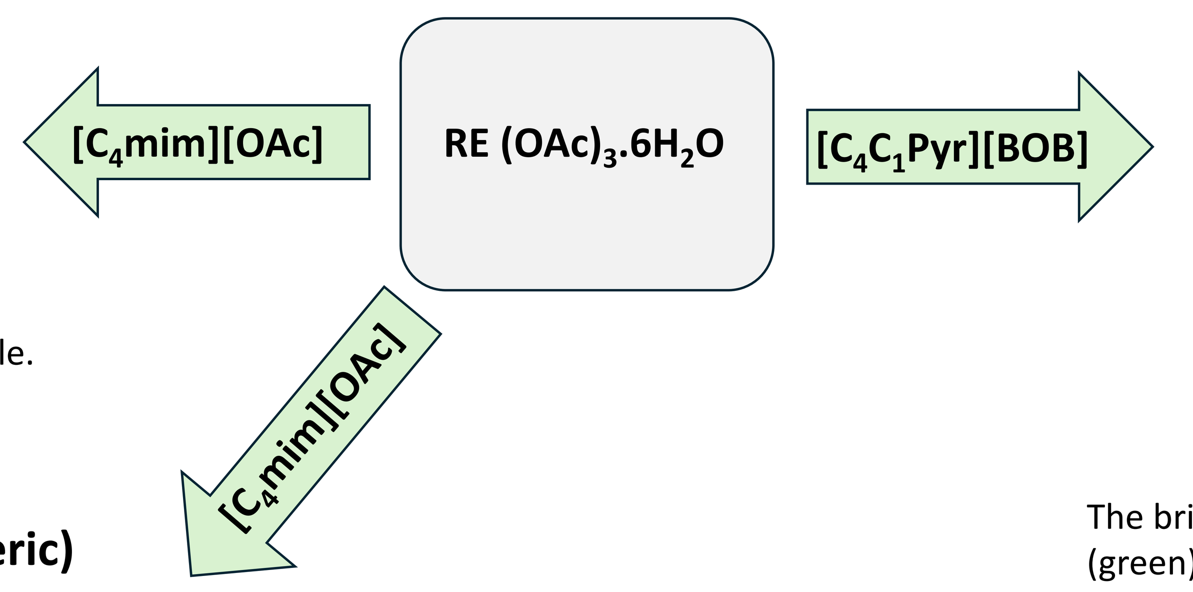
The heating and cooling rate applied in the ionic liquid synthesis method.

Results

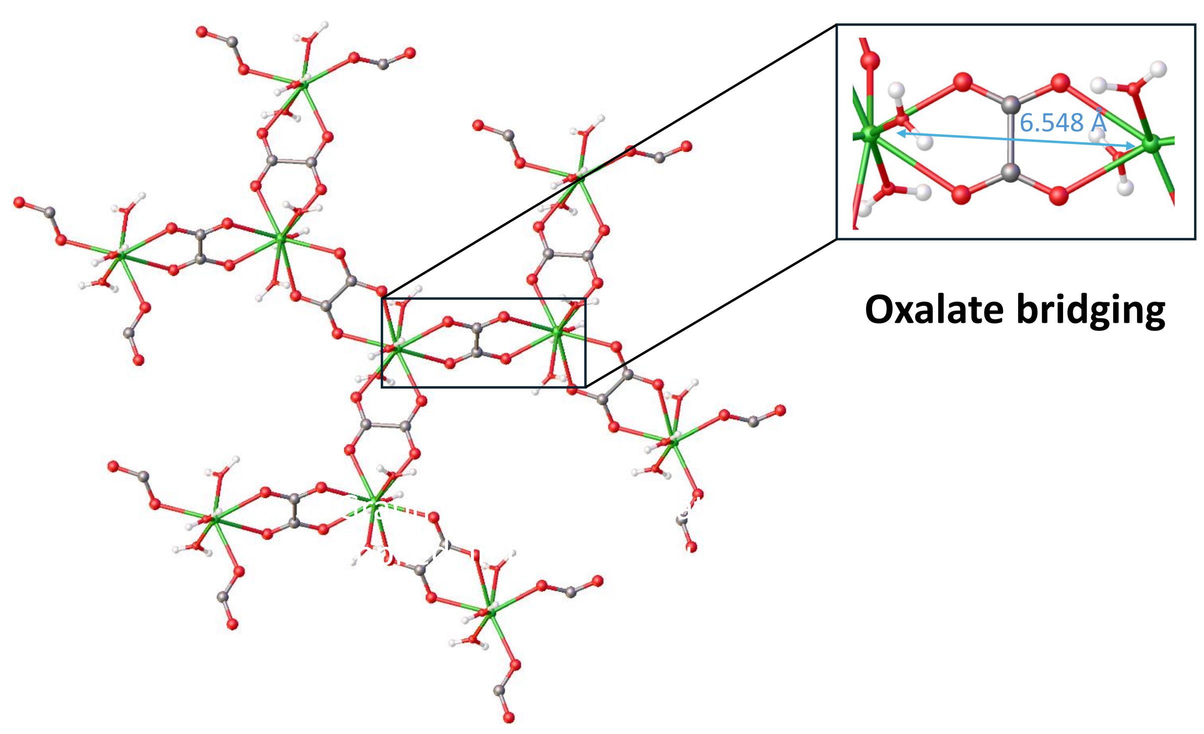
Neodymium acetate monohydrate (polymeric) ($Nd(CH_3COO)_3 \cdot H_2O$)



The bridging structure of the neodymium acetate monohydrate molecule. Neodymium (green), oxygen (red), carbon (gray), and hydrogen (white) atoms are represented as spheres. Thermal ellipsoids are drawn at the 50% probability level.

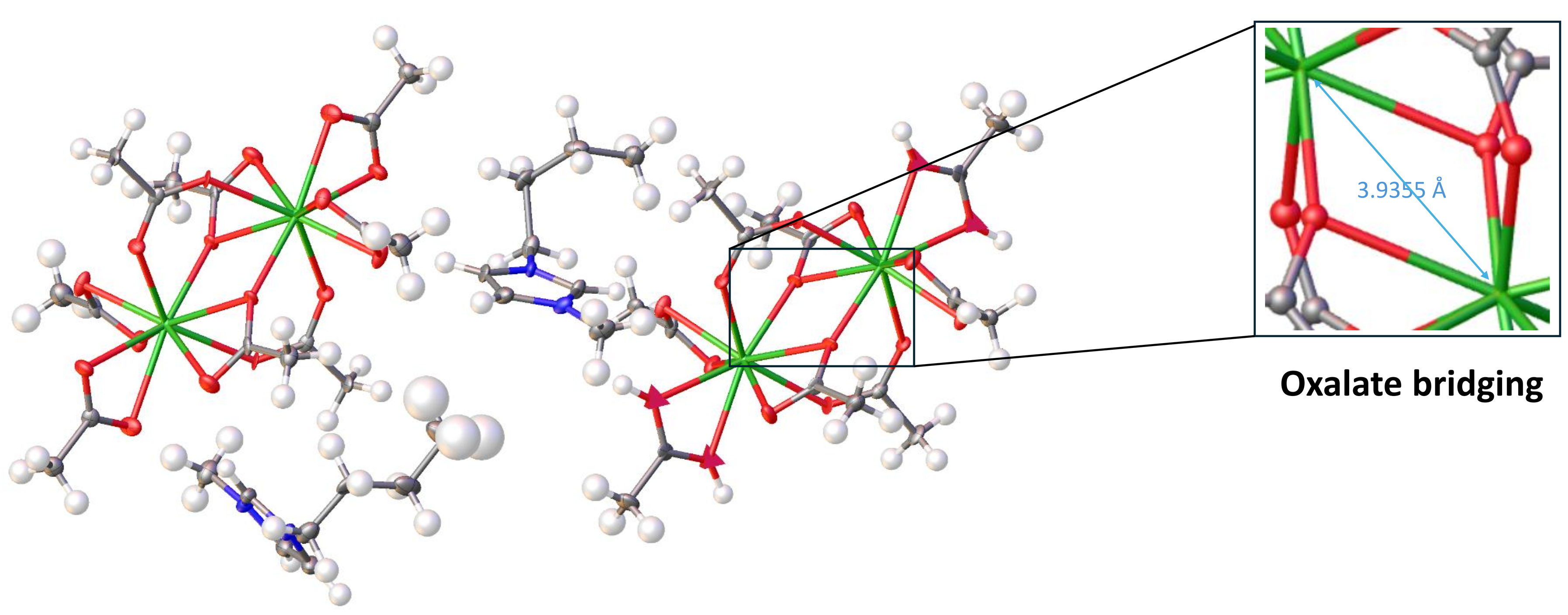


Neodymium oxalate trihydrate (3D coordination polymer), $Nd_2(C_2O_4)_3 \cdot 3H_2O$



The bridging crystal structure of the neodymium oxalate trihydrate. Neodymium (green), oxygen (red), carbon (gray), and hydrogen (white) atoms are represented as spheres. Thermal ellipsoids are drawn at the 50% probability level.

1-Butyl-3-methylimidazolium europium acetate (Dimeric) ($[C_4Mim]_2[Eu_2(CH_3COO)_8]$)



The growth molecule structure of the $[C_4Mim]_2[Eu_2(CH_3COO)_8]$. Neodymium (green), oxygen (red), carbon (gray),nitrogen(blue) and hydrogen (white) atoms are represented as spheres. Thermal ellipsoids are drawn at the 50% probability level.

Conclusions

MAGNETIC SUSCEPTIBILITY COMPARISON			
Synthesis samples (20^0)		Reference samples (20^0)	
Samples	Mass Susceptibility (X_g)	Mass Susceptibility (X_g)	Samples
Neodymium acetate polimeric structure	13.05 $\times 10^{-5}$ cgs	1.64 10^{-5} cgs	$HgCo(SCN)_4$
Neodymium acetate tetrahydrate	14.39 $\times 10^{-5}$ cgs	1.1 10^{-5} cgs	$Ni(en)_3S_2O_3$
Neodymium oxalate	14.40 $\times 10^{-5}$ cgs	3.23 10^{-5} cgs	$(NH_4)_2Fe(SO_4)_2.6H_2O$
Europium acetate tetrahydrate	11.80 $\times 10^{-5}$ cgs	0.6 10^{-5} cgs	$CuSO_4.5H_2O$
$[C_4mim]$ Europium acetate	5.77 $\times 10^{-5}$ cgs	5.65 10^{-5} cgs	$MnSO_4.4H_2O$

The magnetic susceptibility (Mass susceptibility) comparison between synthesis compounds and reference samples.

Applying an ionothermal synthesis method using rare earth salts results in diverse polymeric structures with potential spin-spin magnetic interactions.

Bridging ligands expected to facilitate spin-spin interaction between the metal centers of the lanthanide structures.

Research Plan

Exploring the magnetic properties of the synthesised compounds and establishing structure-property relationships and Superconducting quantum interference device (SQUID) will be used for advanced magnetic characterisation of the neodymium acetate monohydrate and neodymium oxalate trihydrate.

The developed methodology using the BOB ligand as a source of the oxalate anion will be further explored using other REs and anions.

References

Shimpi, M. R.; Rohlmann, P.; Shah, F. U.; Glavatskih, S.; Antzutkin, O. N. Transition Anionic Complex in Trihexyl(Tetradecyl)Phosphonium-Bis(Oxalato)Borate Ionic Liquid – Revisited. *Phys. Chem. Chem. Phys.* **2021**, *23* (10), 6190–6203. https://doi.org/10.1039/D0CP05845A.

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