Signature of field-induced spin ice state and evolution of structural and magnetic phase on La substitution in disordered pyrochlore $Dy_2Zr_2O_7$

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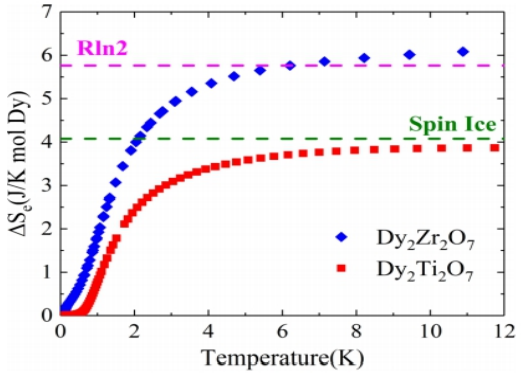
Motivation

"Spin Ice" $Dy_2Ti_2O_7$ and $Ho_2Ti_2O_7$
Zero-point entropy and monopole excitations at low temperature.

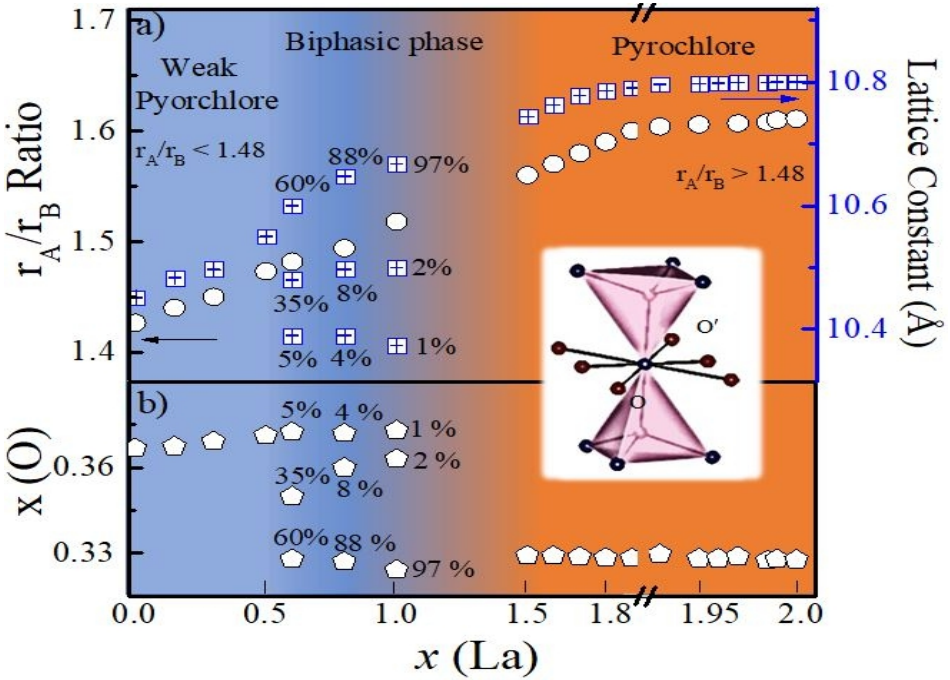
Spin freezing ~16 K observed in $Dy_2Ti_2O_7$ but not in $Ho_2Ti_2O_7$??

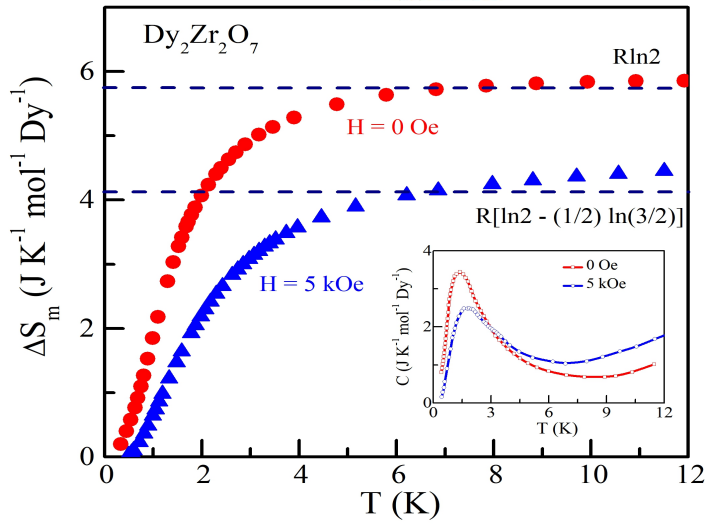
$Dy_2Zr_2O_7$: A disordered pyrochlore oxide shows the absence of spin freezing & spin ice state, due to large chemical disorder ($\Delta S_m \approx Rln2$)
[Ramon *et al.*, PRB 2019]

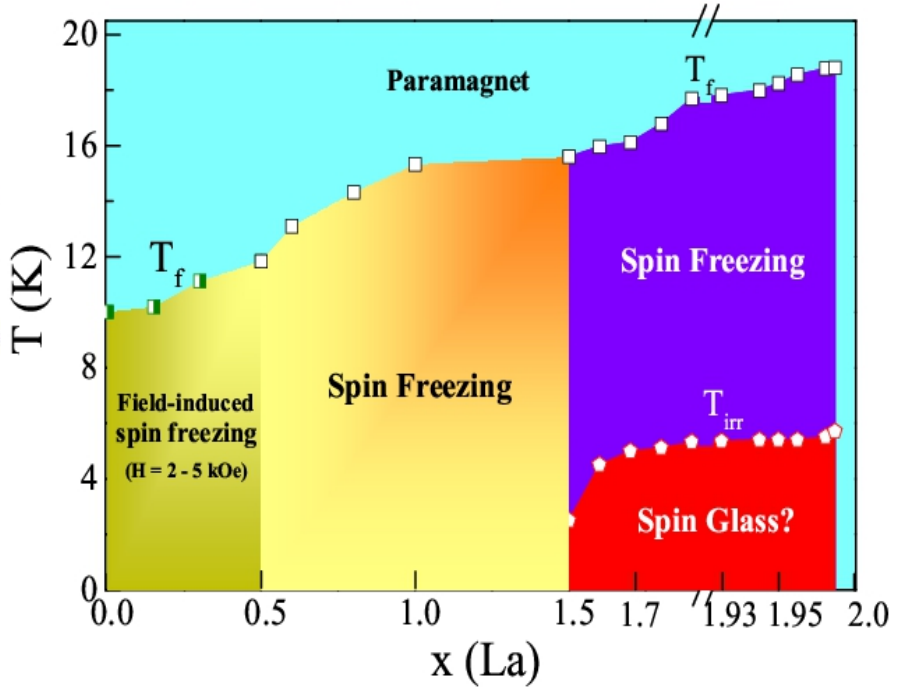


We tune the spin dynamics of $Dy_2Zr_2O_7$ by applying dc magnetic field and dilute the magnetic site to stabilized the $Dy_2Ti_2O_7$ type structure and magnetic state.

Results and Discussion



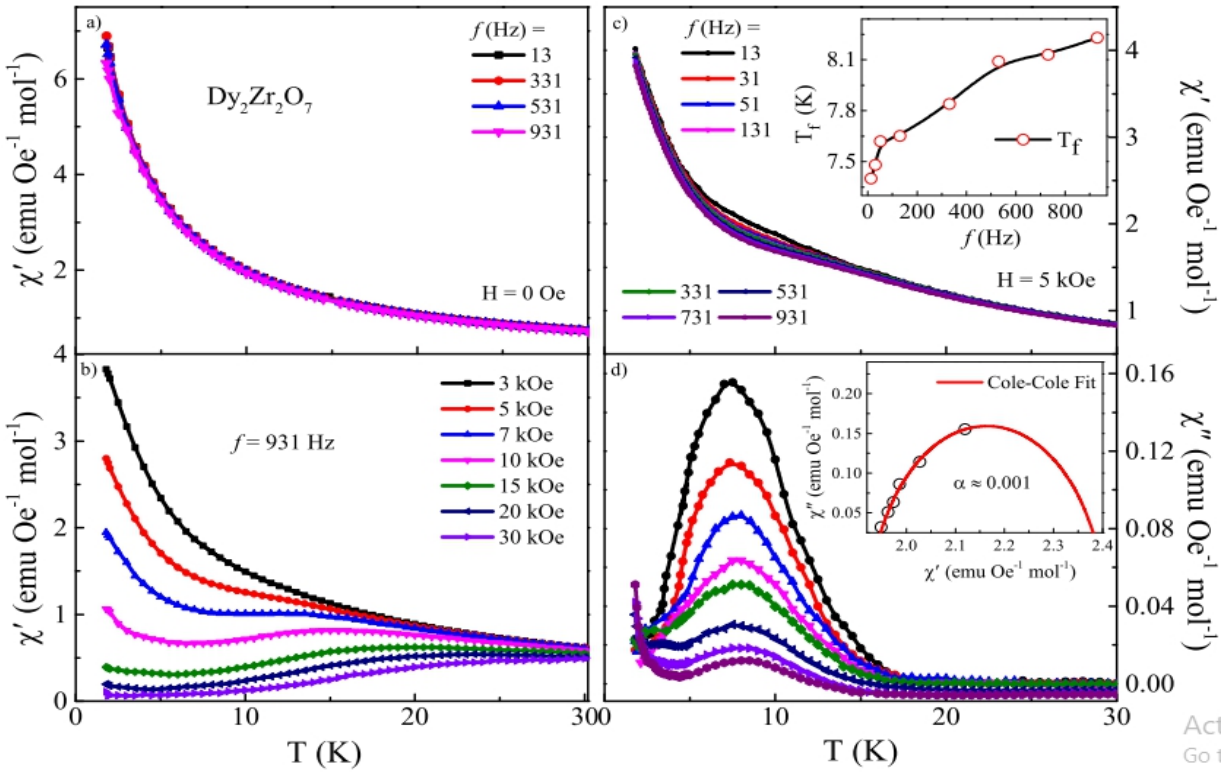


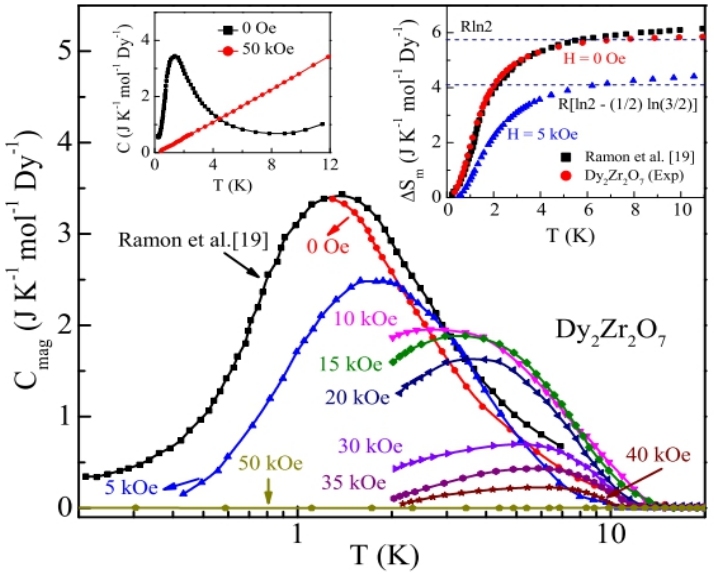


Conclusion

- $Dy_2Zr_2O_7$ evolve from spin liquid to spin ice ground state with the presence of Pauling's residual entropy at H = 5 kOe.
- It exhibits $Dy_2Ti_2O_7$ type structural and magnetic behavior with La substitution up to 99.5%.
- The low temperature magnetic state culminates to spin-glass-like behavior.

Signature of Spin Ice





A very dynamic ground state in the absence of magnetic field; $\Delta S_m = R\ln 2$

System evolves from spin liquid to spin ice ground state; $\Delta S_m = R[\ln 2 - (1/2)\ln(3/2)]$ at H = 5 kOe. (similar behavior to well-known spin ice compound $Dy_2Ti_2O_7$)

Spin liquid → Field induced spin Ice → Non-magnetic ground state

Spin freezing in $Dy_{2-x}La_xZr_2O_7$ (x = 0 - 2)