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A Strategy to Make and Manipulate Magnetic Monopoles by Exploiting Interfaces

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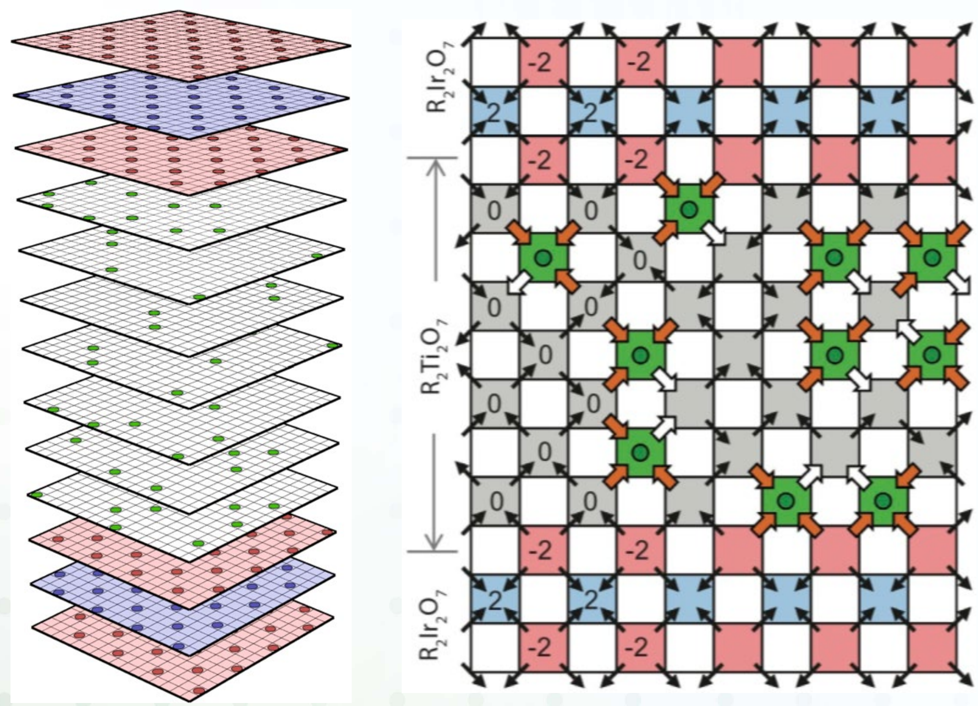
Long considered unachievable, magnetic monopoles have been realized in bulk crystals in recent years as ensembles containing equal numbers of monopoles and antimonopoles. In this form, exciting fundamental questions about the existence, properties, and dynamics of individual magnetic monopoles remain unanswered or inaccessible.

To address these issues, PARADIM's in-house research team has identified a strategy to form a two-dimensional magnetic monopole gas in a material called spin ice ($R_2Ti_2O_7$, R=Ho, Dy) that is sandwiched by the structurally matching pyrochlore compound $R_2Ir_2O_7$. In this structure, Monte Carlo simulations suggest that the net magnetic charge and the density of monopoles can be controlled by an external field.

This proposed two-dimensional monopole gas could enable entirely new classes of experiments and devices based on magnetic monopoles, akin to two-dimensional electron gases in semiconductor heterostructures.



(left) 3D snapshot of the monopole distribution generated by Monte Carlo simulation of a pyrochlore/spin ice/pyrochlore sandwich.

(right) Schematic representation of the monopole gas stabilized at the interfaces between spin ice and antiferromagnetic pyrochlore compounds. Magnetic monopoles are shown in green (orange=3 spins in, white=1 spin out).

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