

# A route towards stable homochiral topological textures in $\alpha\text{-Fe}_2\text{O}_3$

J. Harrison,\* H. Jani,<sup>†</sup> and P. G. Radaelli\*

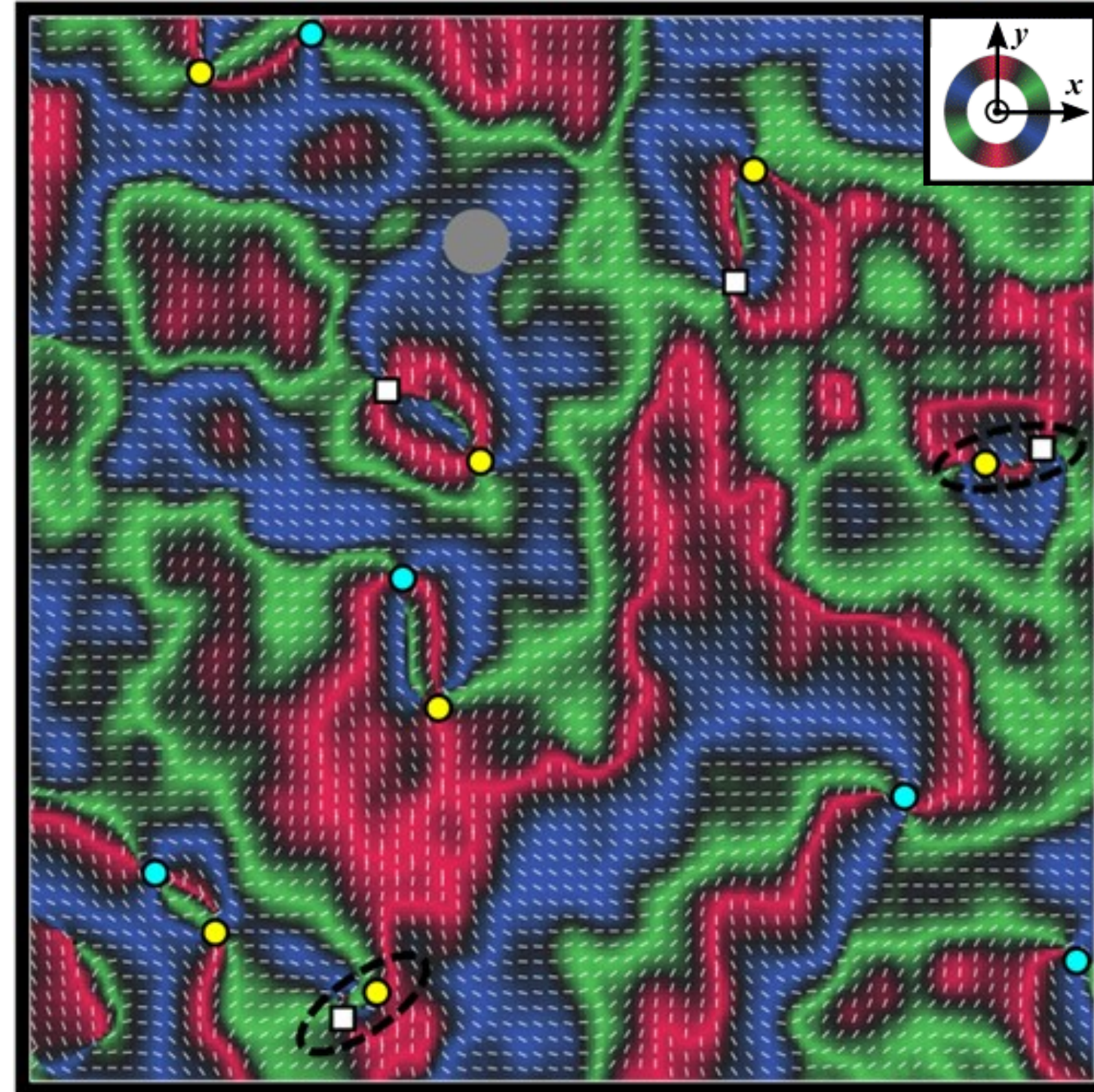
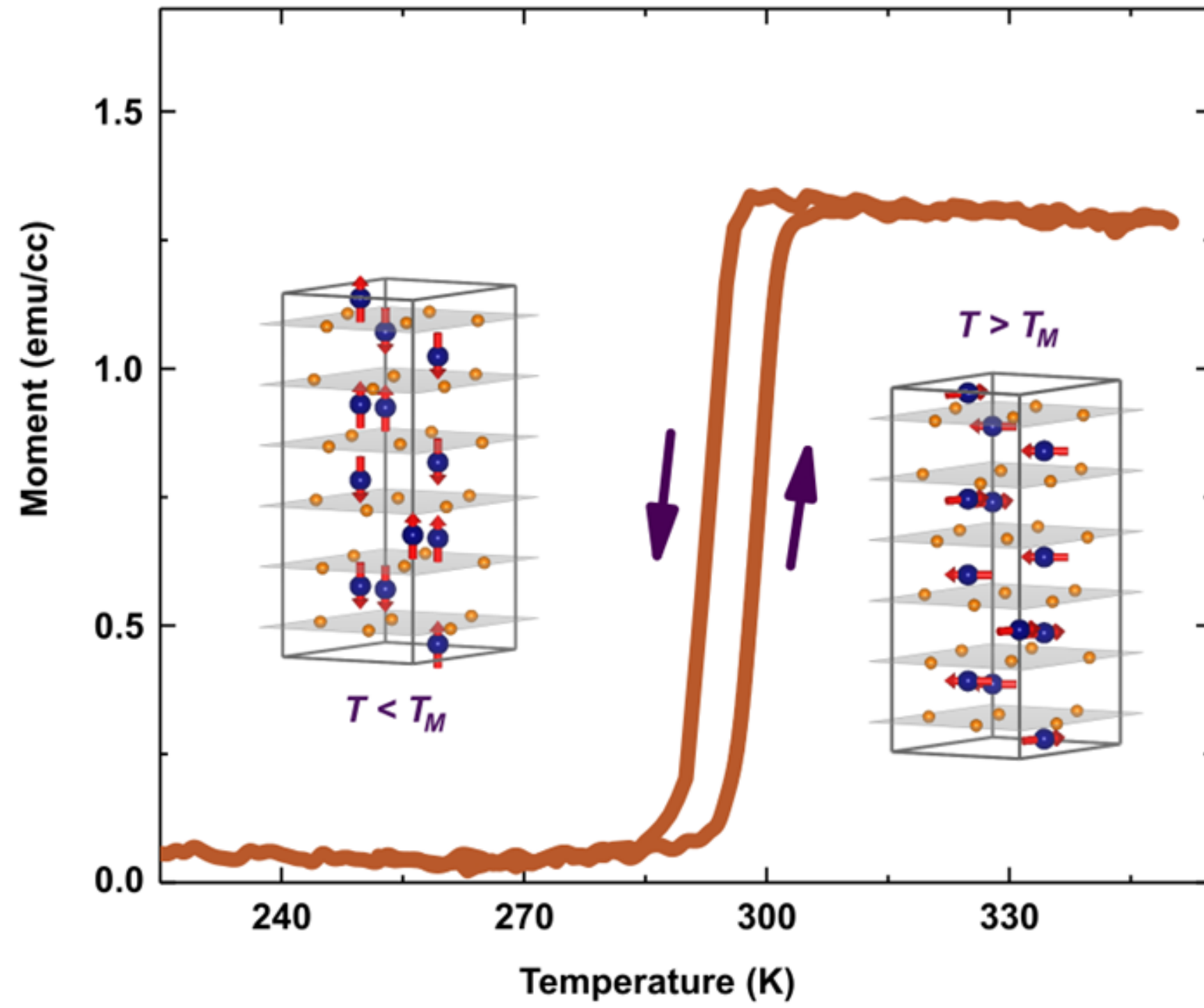
\*Clarendon Laboratory, Department of Physics, University of Oxford, Oxford, OX1 3PU, UK

<sup>†</sup>Department of Physics, National University of Singapore, 117411, Singapore



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## 1 Experimental observations- Topological textures in $\alpha\text{-Fe}_2\text{O}_3$



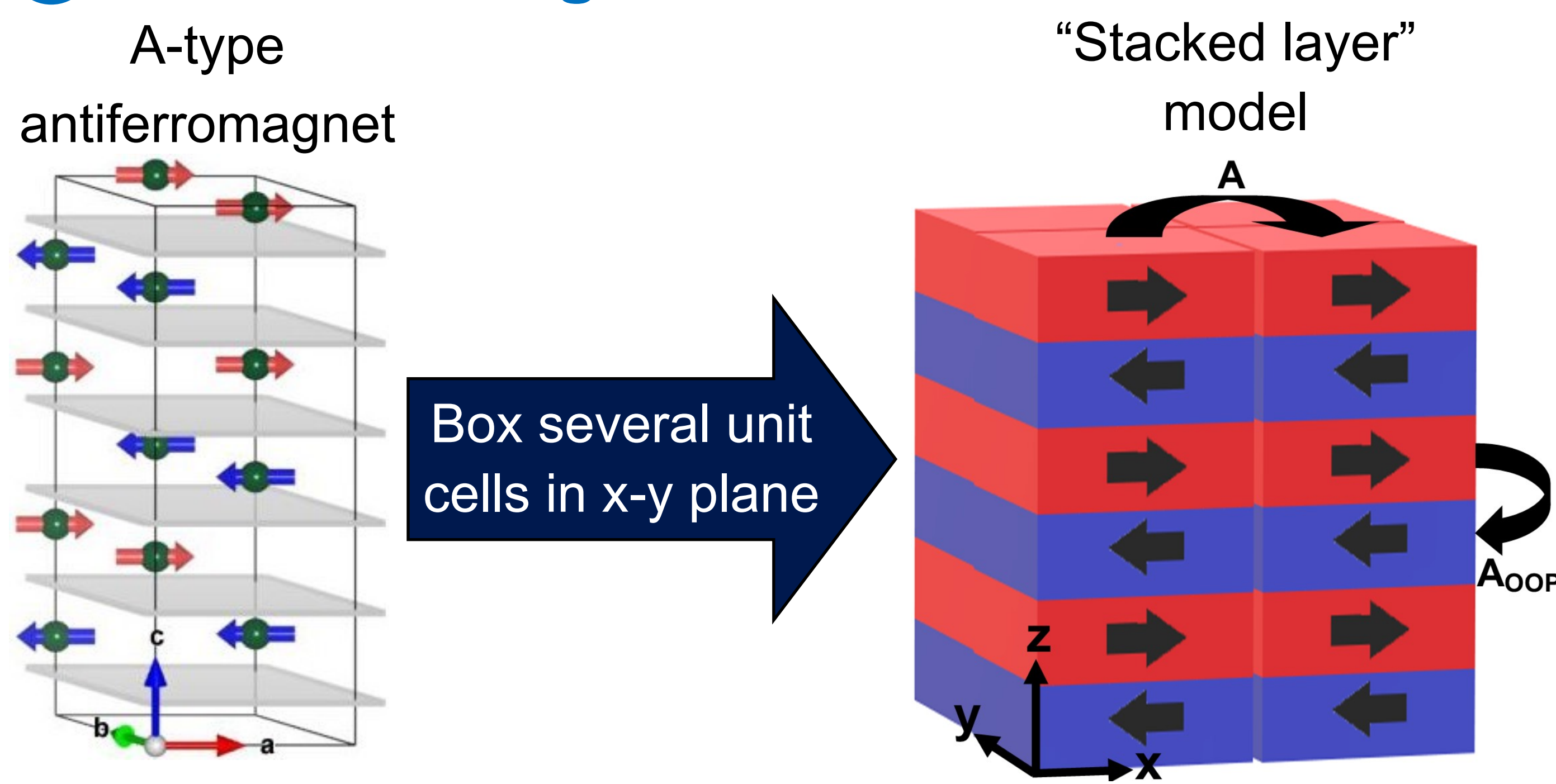
◆ Spin reorientation (Morin) transition allows for nucleation of topological textures near room temperature (left).

◆ **Multichiral** topological (anti)merons and bimerons have been observed in antiferromagnetic (AFM)  $\alpha\text{-Fe}_2\text{O}_3$  thin films (right).

Outstanding challenges:

- Can we make textures **homochiral**, as required for device applications?
- Can we expand the family of stable topological textures?

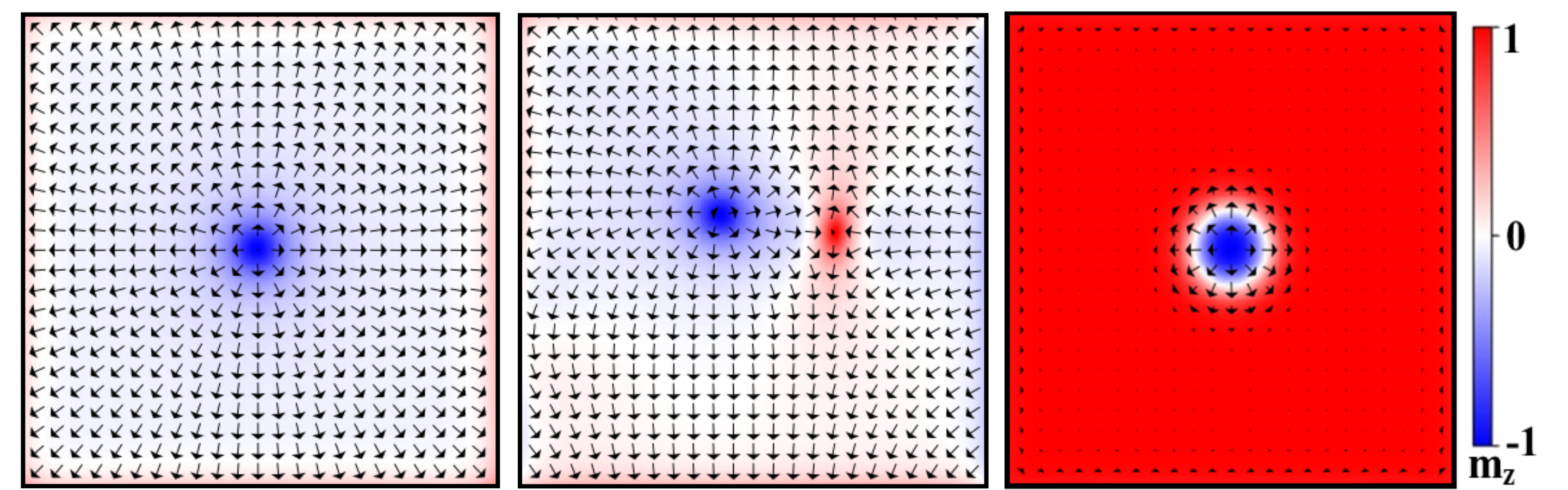
## 2 Our micromagnetic model



We model a generic A-type antiferromagnet as a **set of stacked layers**, ferromagnetically coupled within the plane and antiferromagnetically coupled between adjacent planes.

## 3 Simulated topological textures

Using Mumax3, we minimised the energy of the system starting from a topological state. The textures that survived for a given set of material parameters were determined to be stable.



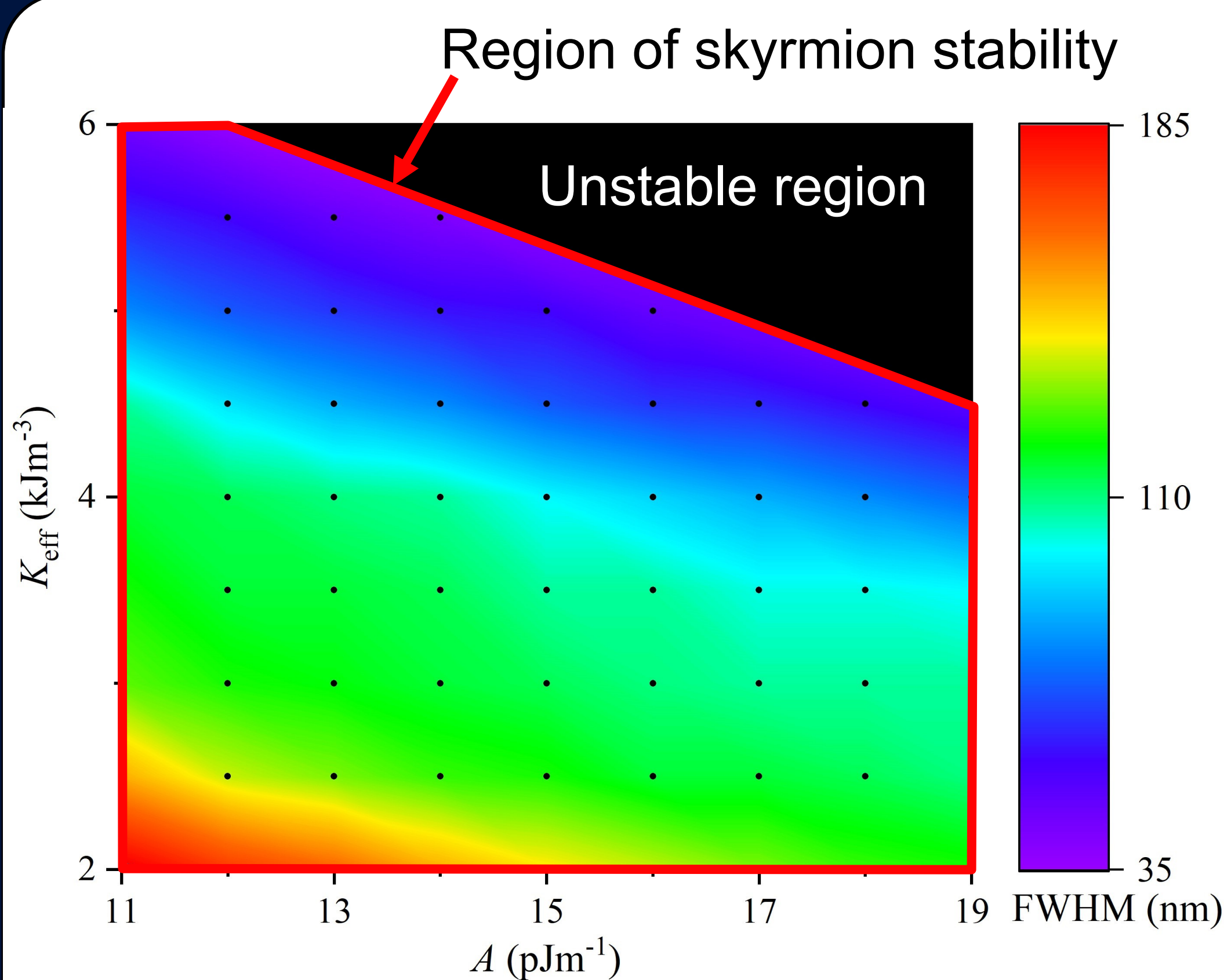
Homochiral meron

Bimeron

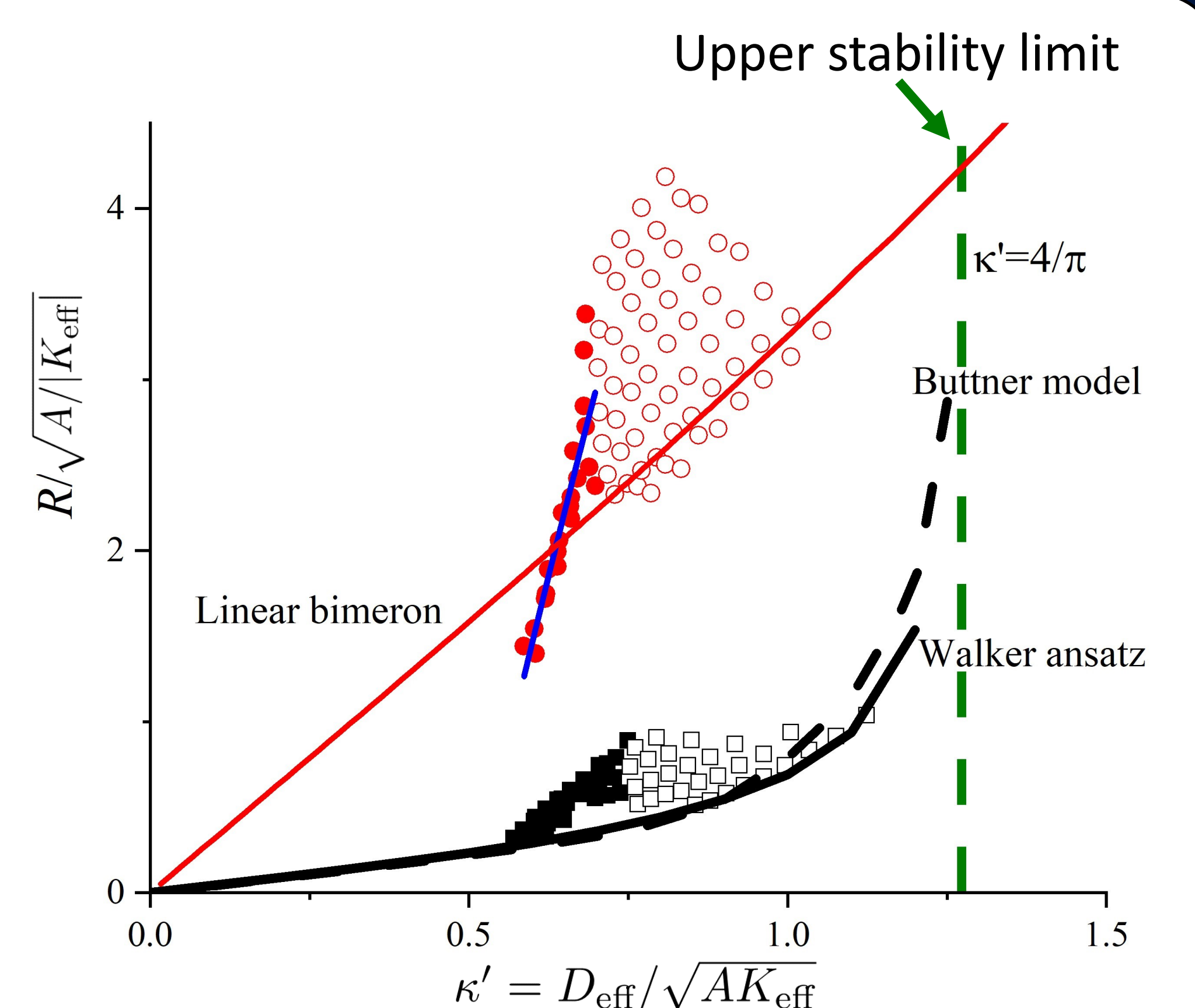
Antiferromagnetic skyrmion

## 4 Key results

- ◆ Previously observed topological textures become **homochiral** in the presence of a modest iDMI ( $\geq 0.4 \text{ mJm}^{-2}$ ).
- ◆ Antimerons **distort** due to the iDMI.
- ◆ iDMI is crucial for stabilising  $Q=1$  topological textures in this system.
- ◆ AFM skyrmions should be **stable and experimentally observable** for realistic material parameters in  $\alpha\text{-Fe}_2\text{O}_3$ .



AFM skyrmion size and stability over  $\alpha\text{-Fe}_2\text{O}_3$  parameter space for reasonable  $D=1 \text{ mJm}^{-2}$



Scaling of  $Q=1$  textures with dimensionless control parameter is linear for smaller objects.

## 5 References

- [1] J. Harrison, et al., arXiv:2111.15520 [cond-mat.mtrl-sci] (2021)
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- [3] H. Jani, et al., Nature Communications 12, 1668 (2021)
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If you have any questions or would like to discuss this work further, please email me at [jack.harrison@physics.ox.ac.uk](mailto:jack.harrison@physics.ox.ac.uk)

