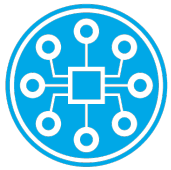
Berezinskii-Kosterlitz-Thouless (BKT) transitions in a ferromagnetic superfluid

Andrew Underwood, Andrew Groszek, Xiaoquan Yu, Blair Blakie, Lewis Williamson



EQUS
Australian Research Council
Centre of Excellence for
Engineered Quantum Systems

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ARC CENTRE OF EXCELLENCE IN
FUTURE LOW-ENERGY
ELECTRONICS TECHNOLOGIES

DODD-WALLS CENTRE
for Photonic and Quantum Technologies

UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

The BKT transition

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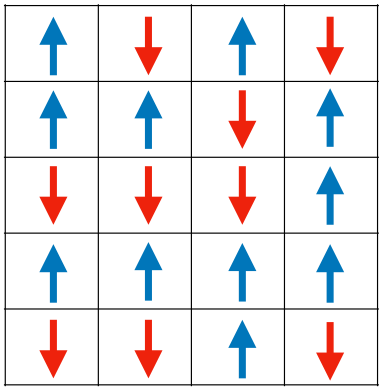

$T > T_c$

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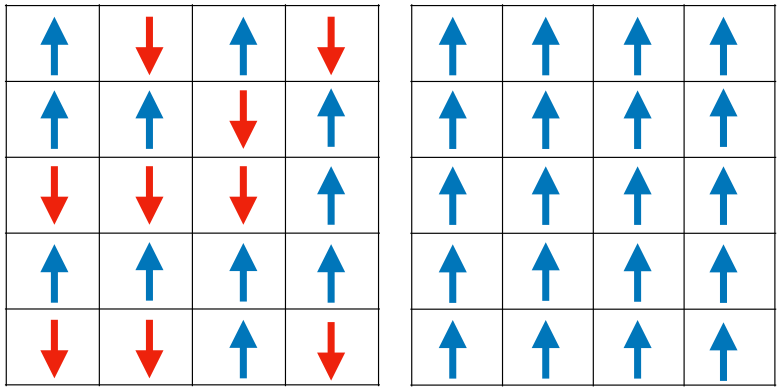

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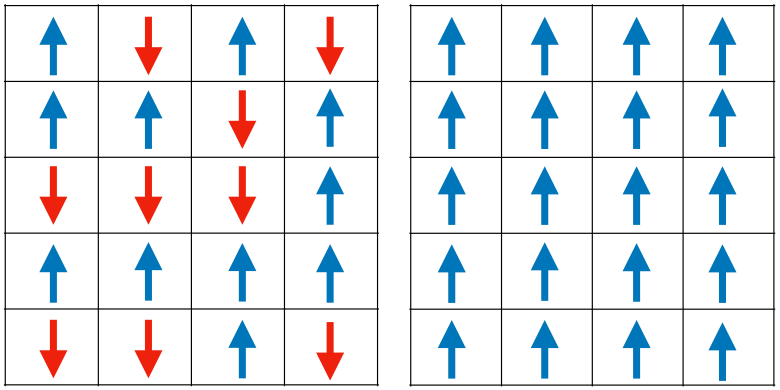

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Phase transitions involve changes of symmetry (order)

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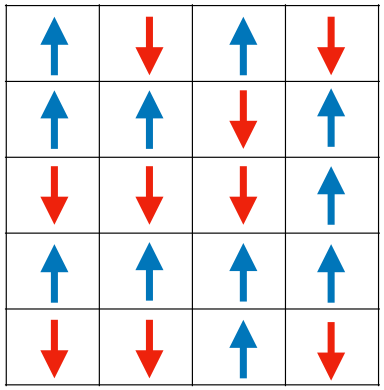

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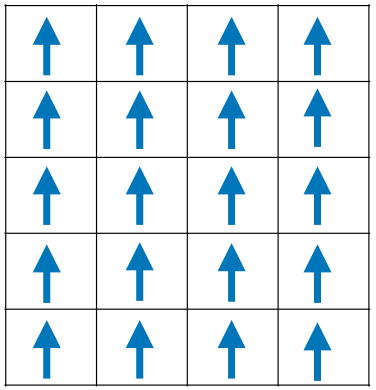

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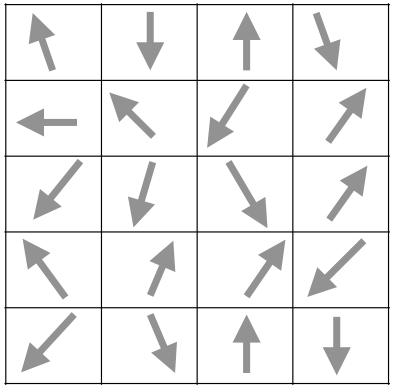

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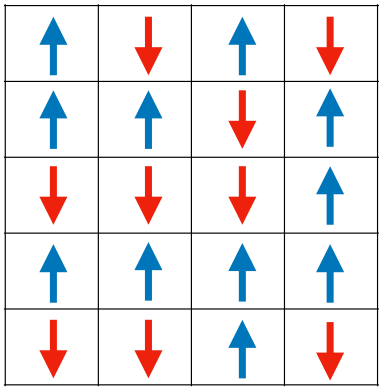

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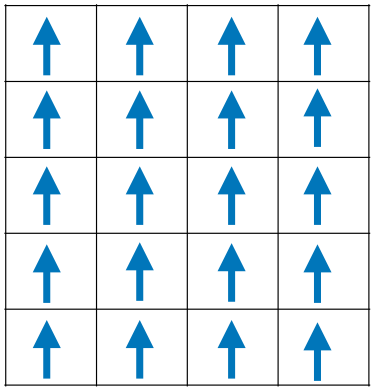

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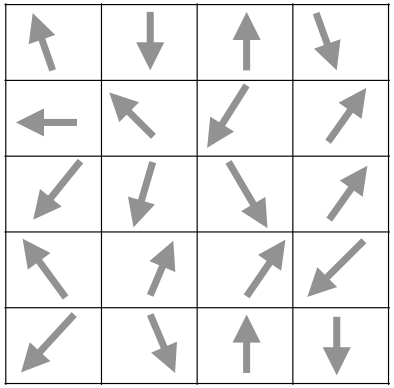

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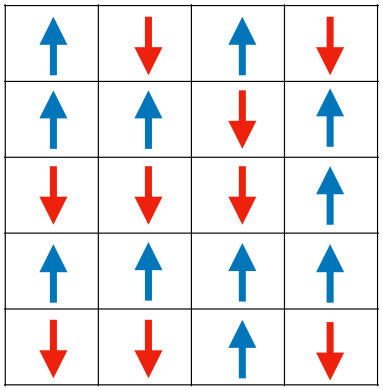

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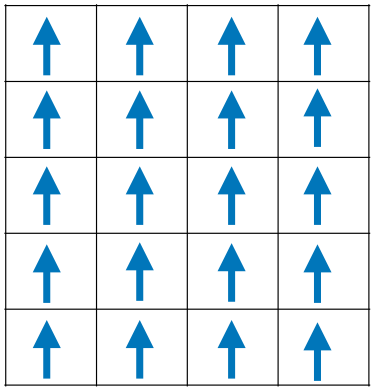

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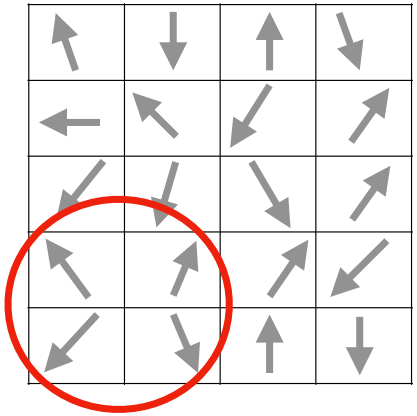

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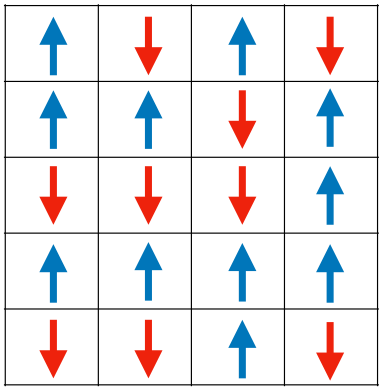

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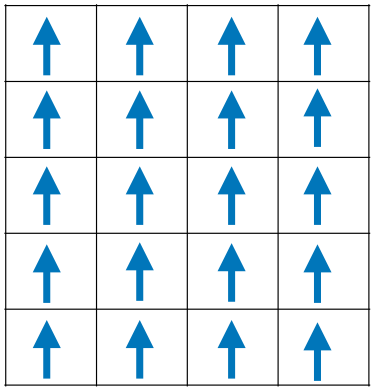

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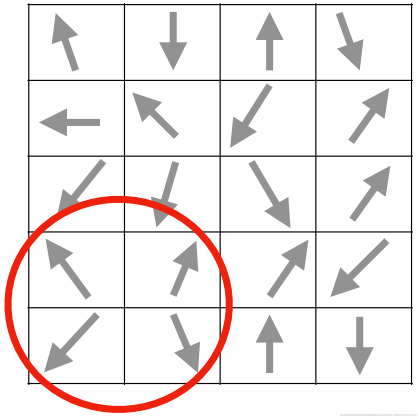

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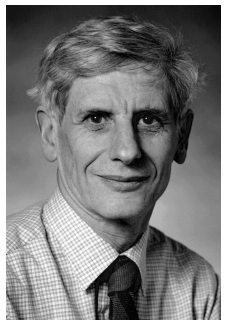

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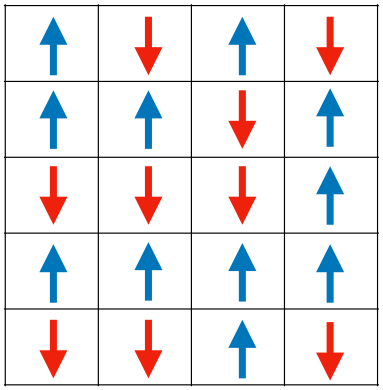

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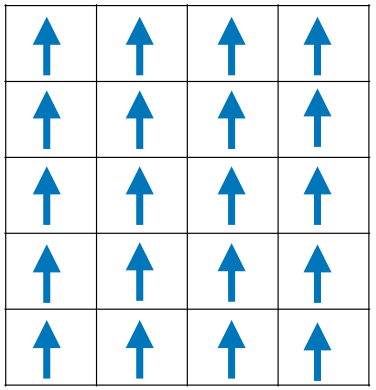

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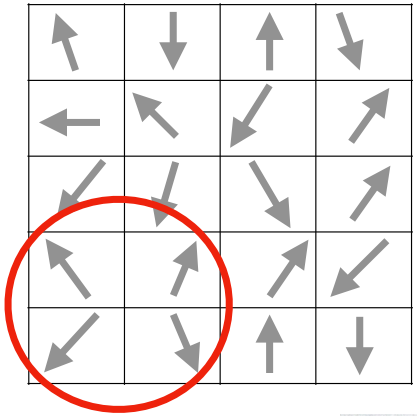

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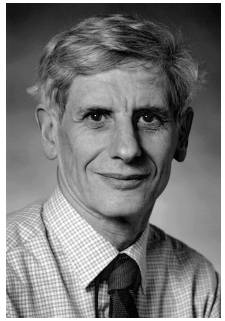
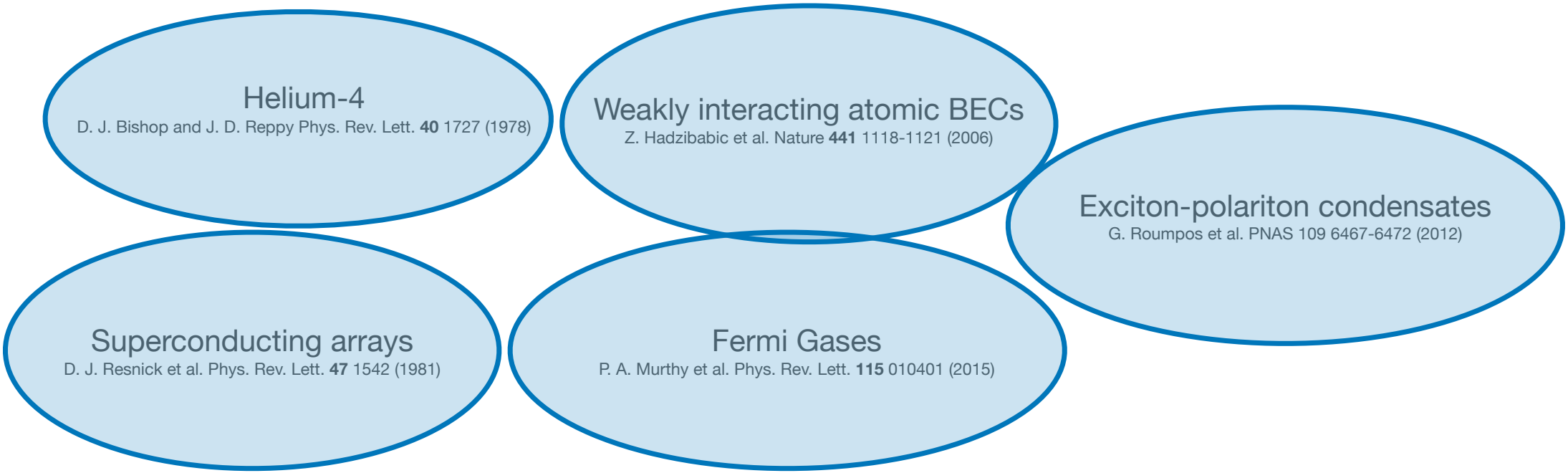


David Thouless

Interacting systems with U(1) symmetries exhibit BKT transitions in 2D.
Below the BKT temperature the system is superfluid.

Examples


Helium-4
D. J. Bishop and J. D. Reppy Phys. Rev. Lett. **40** 1727 (1978)
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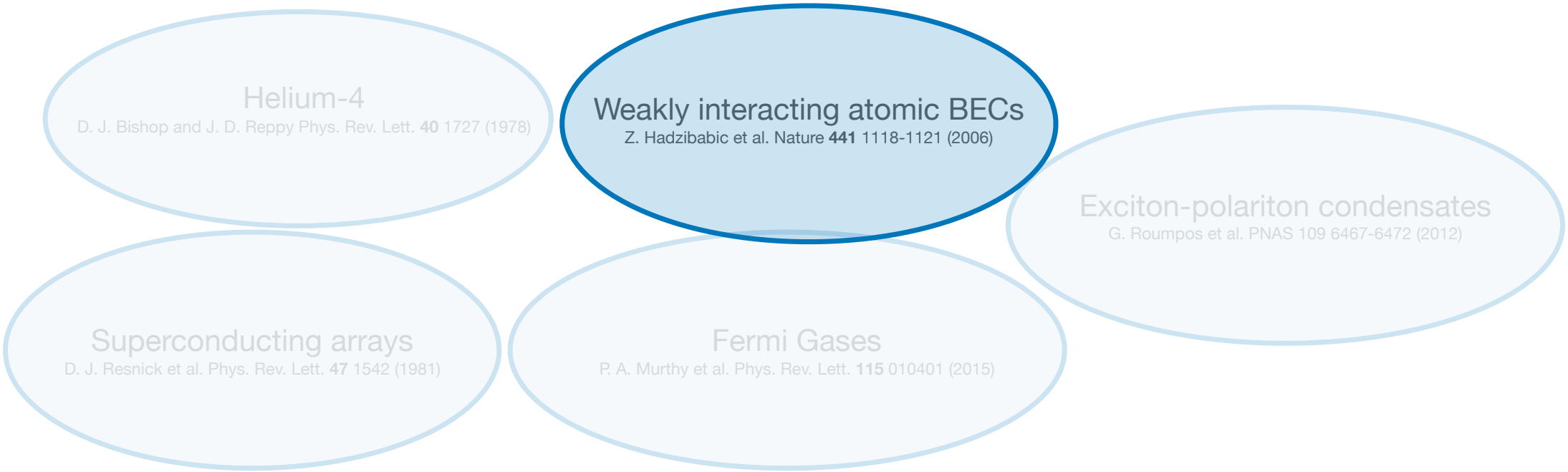
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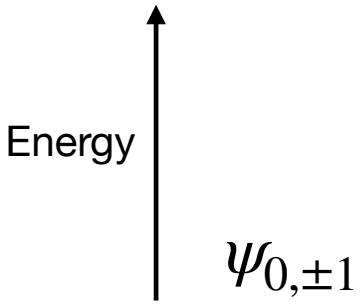

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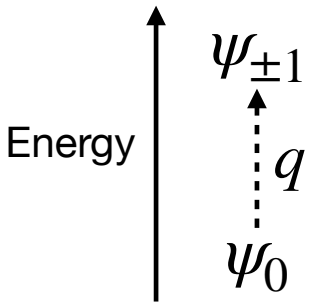

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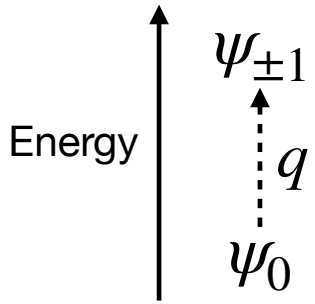

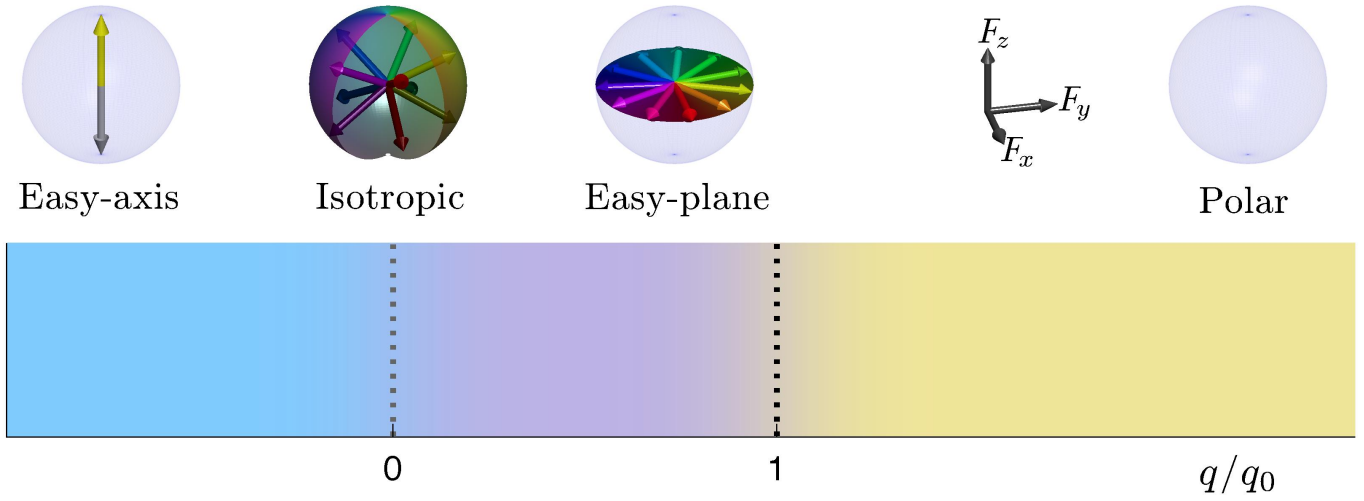

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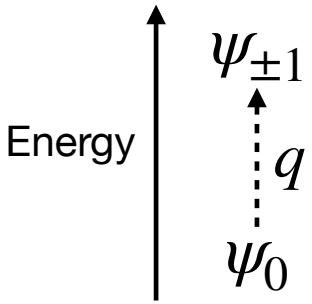

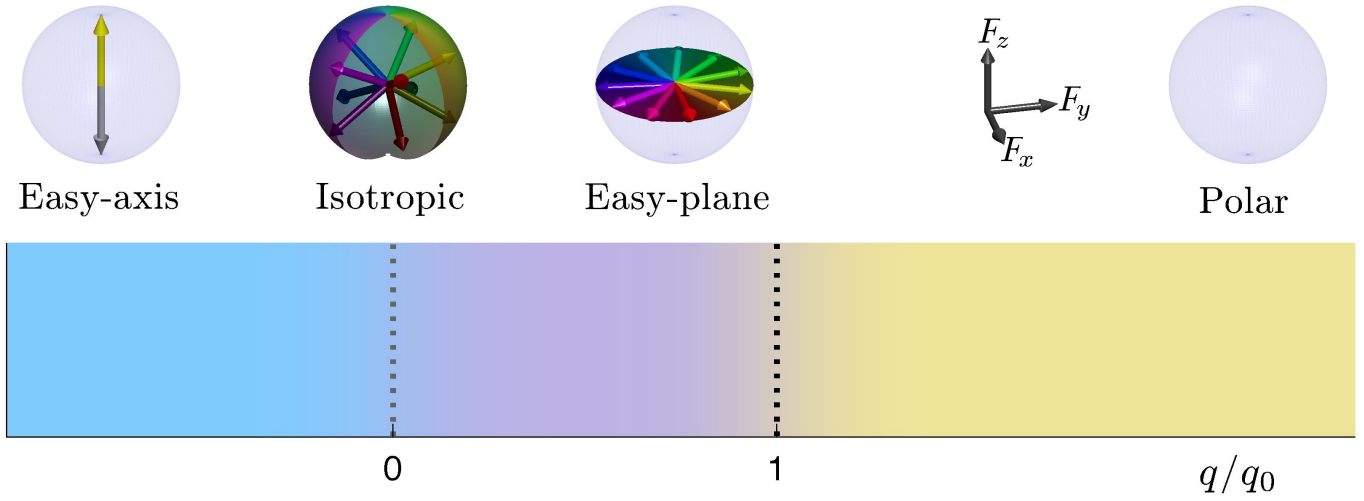

Y. Kawaguchi and M. Ueda Phys. Rep. **520** 253-381 (2012)

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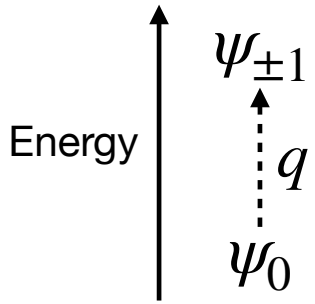

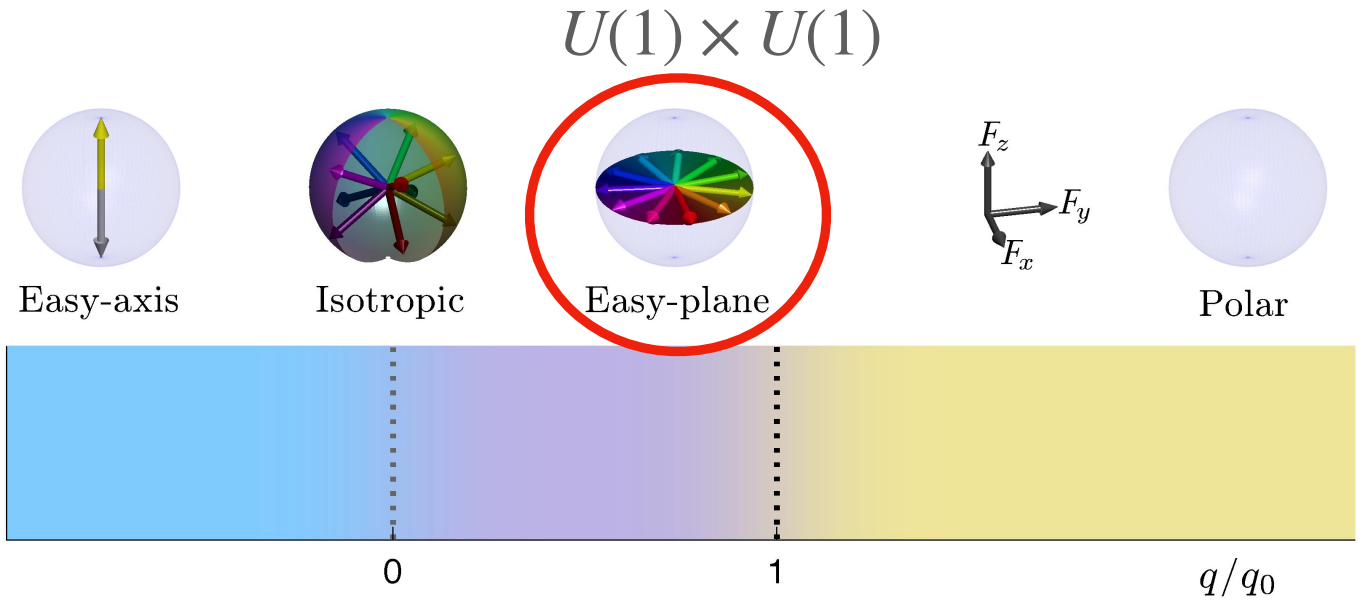

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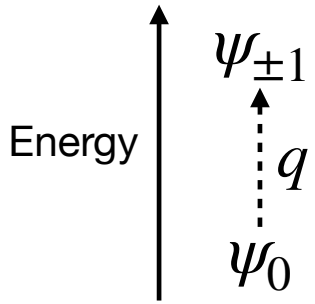

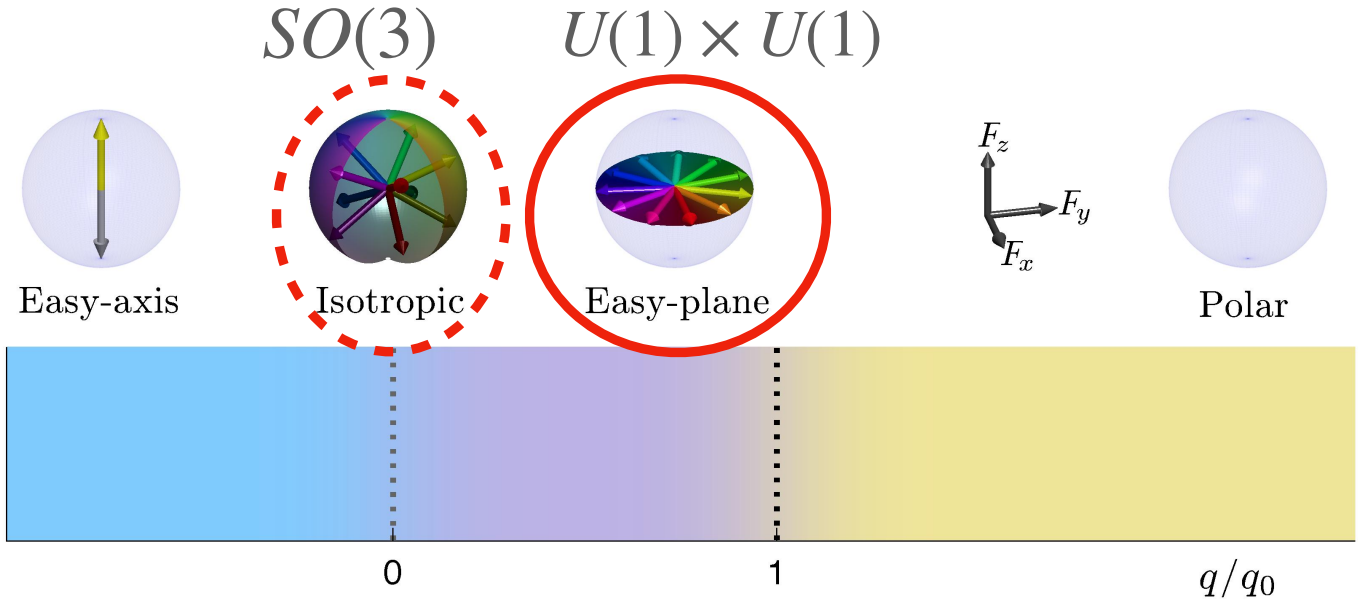

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Results

A. P. C. Underwood et al. arXiv:2207.14497

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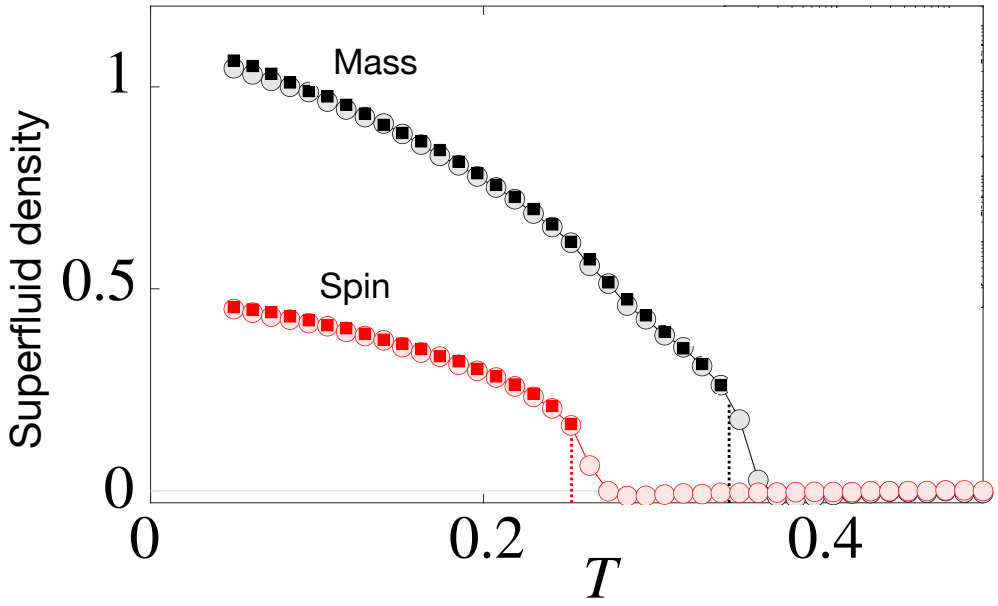

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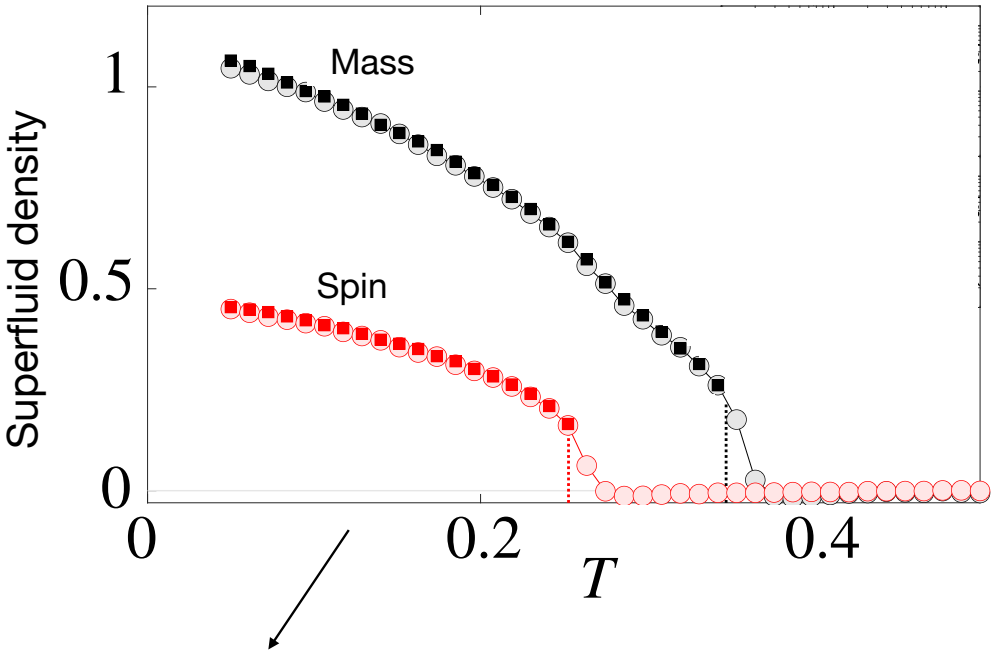

Also in: M. Kobayashi J. Phys. Soc. Jpn. **88** 094001 (2019)

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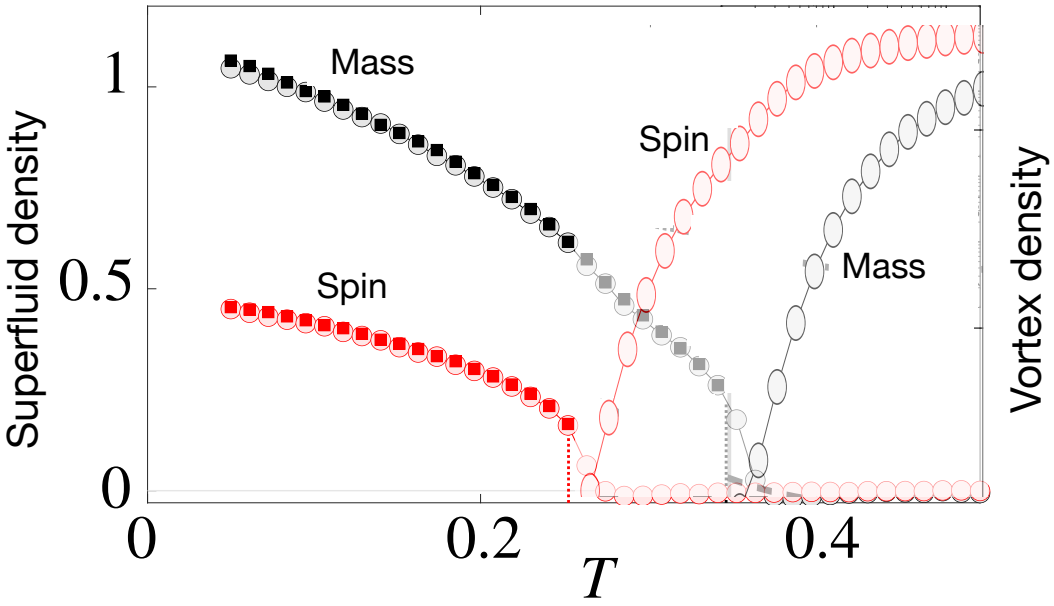

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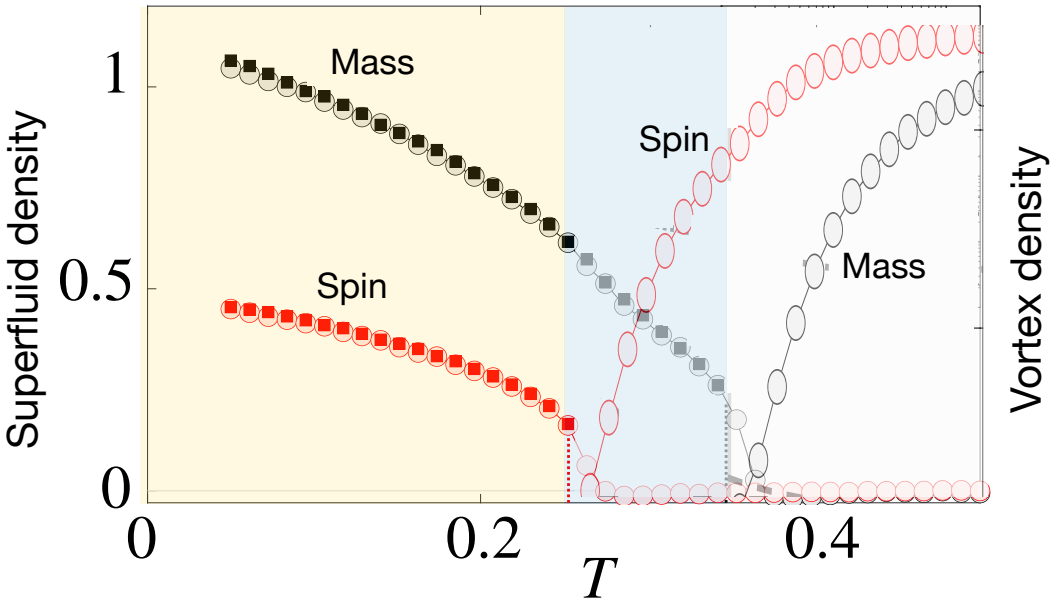

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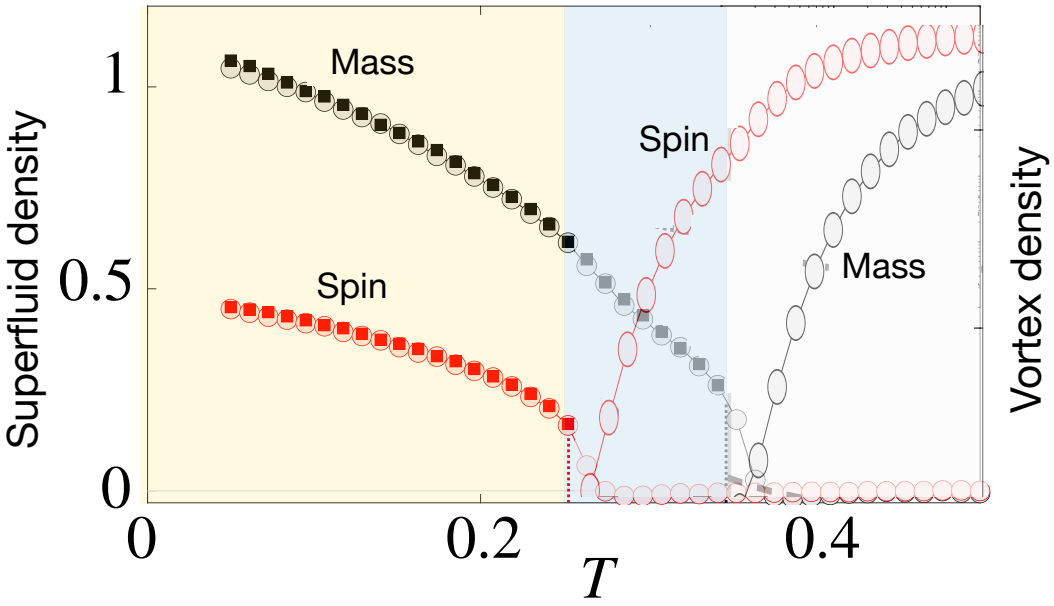

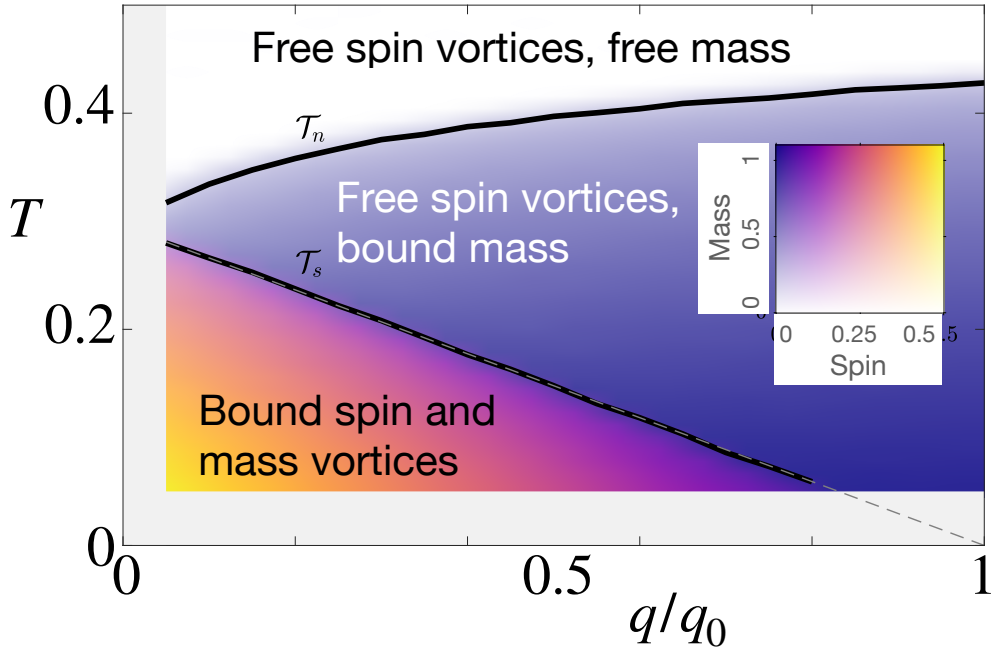

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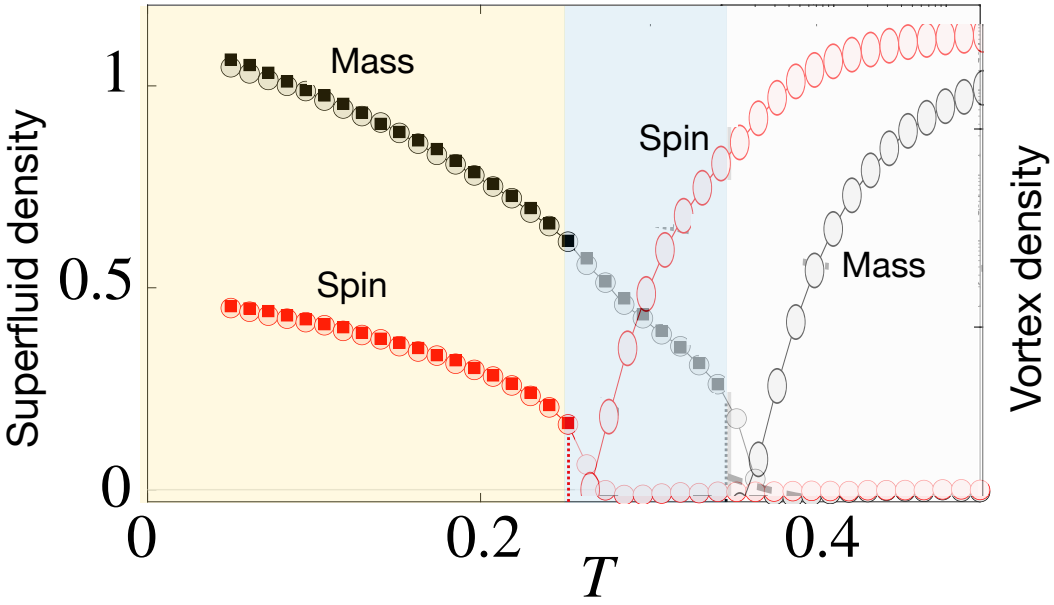

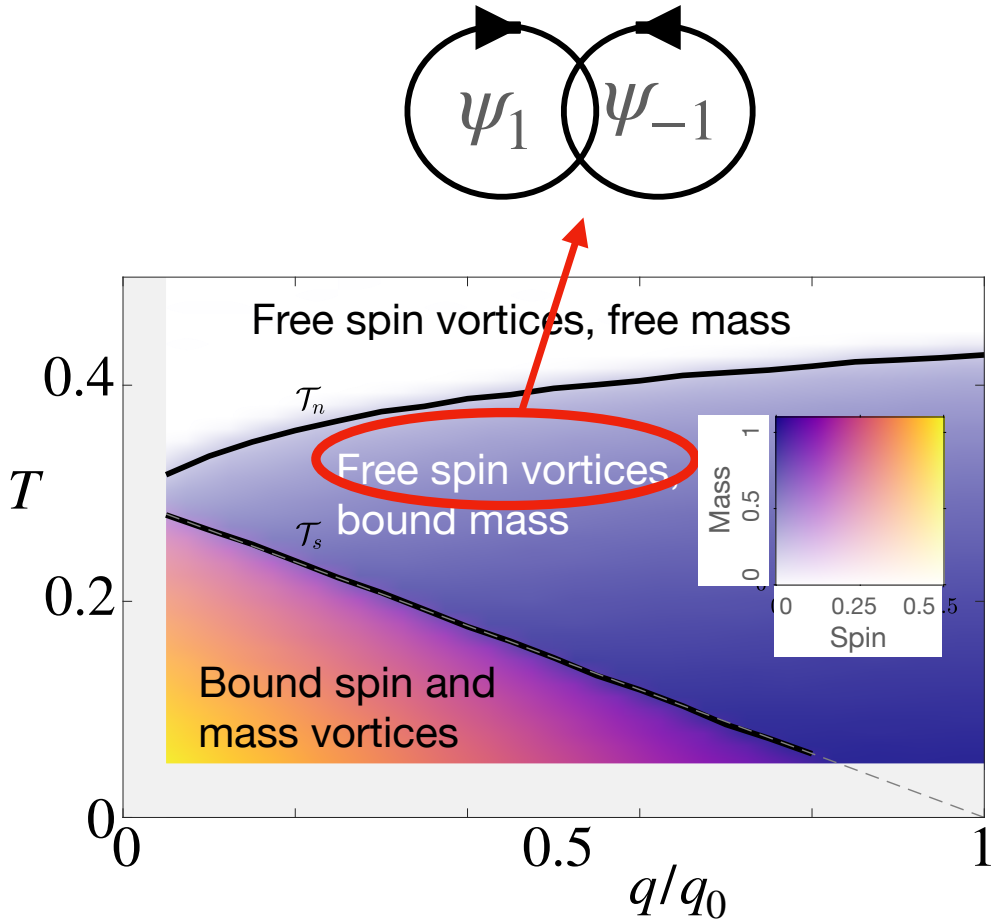

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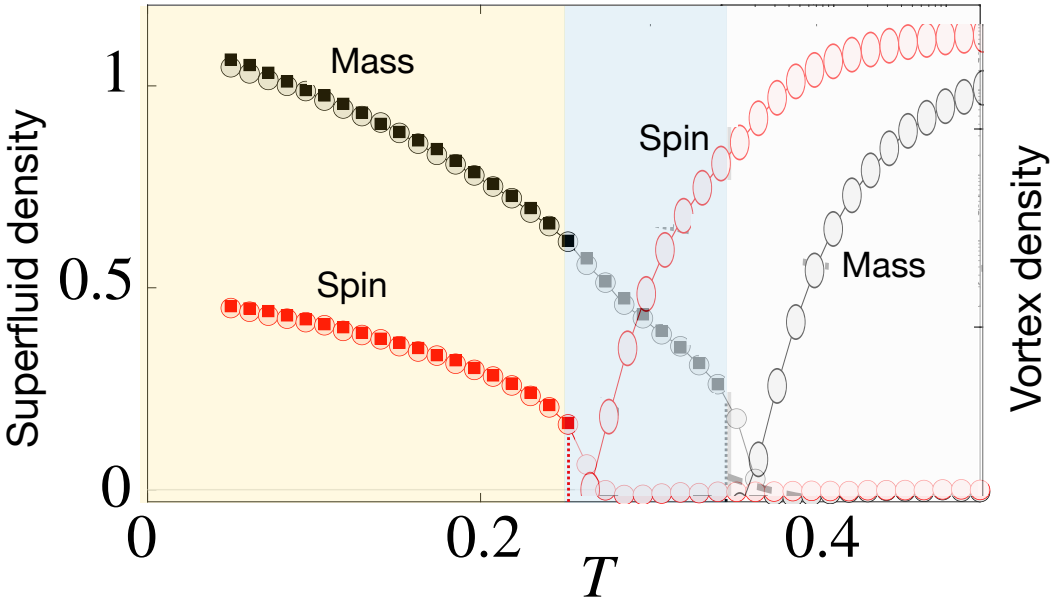

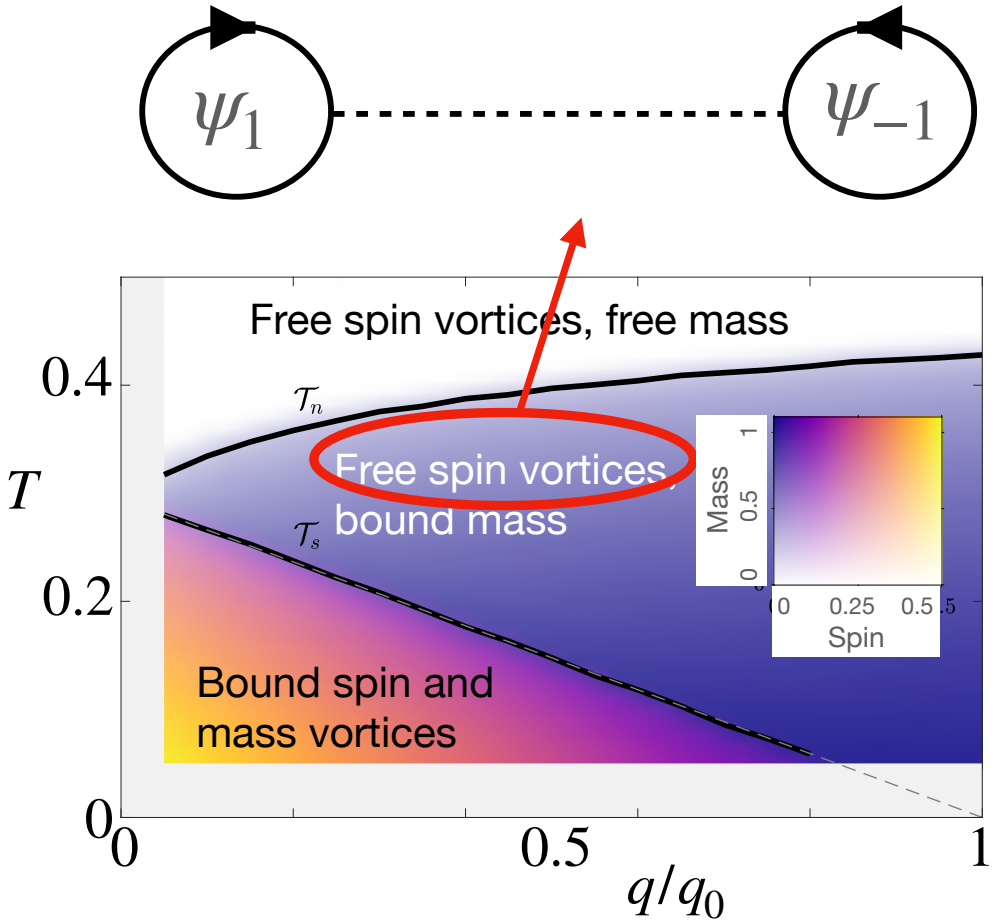

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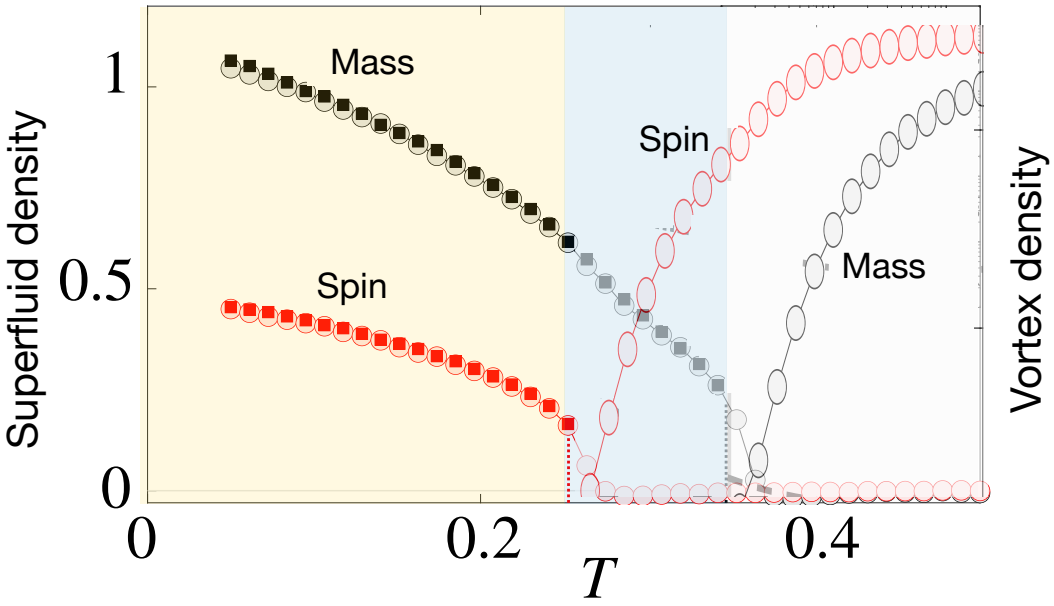

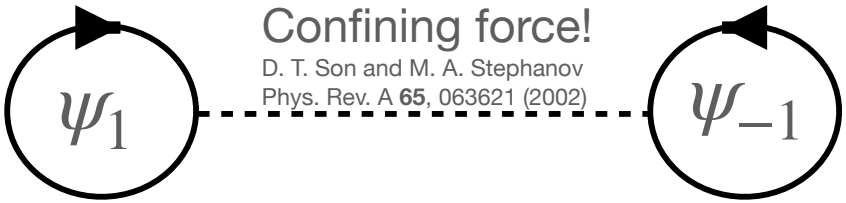

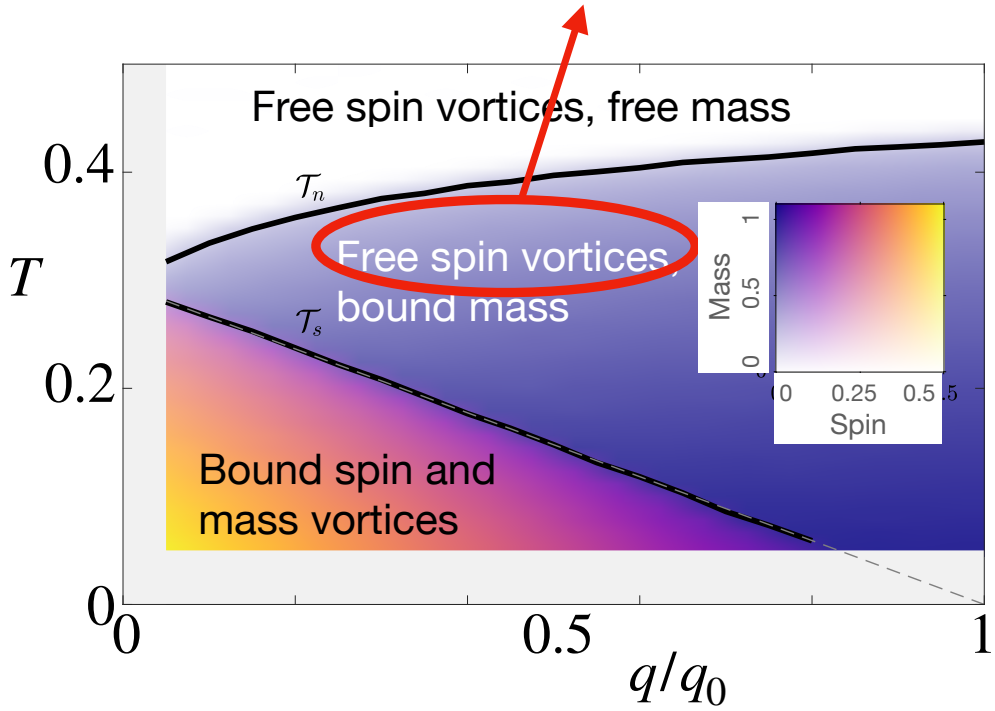

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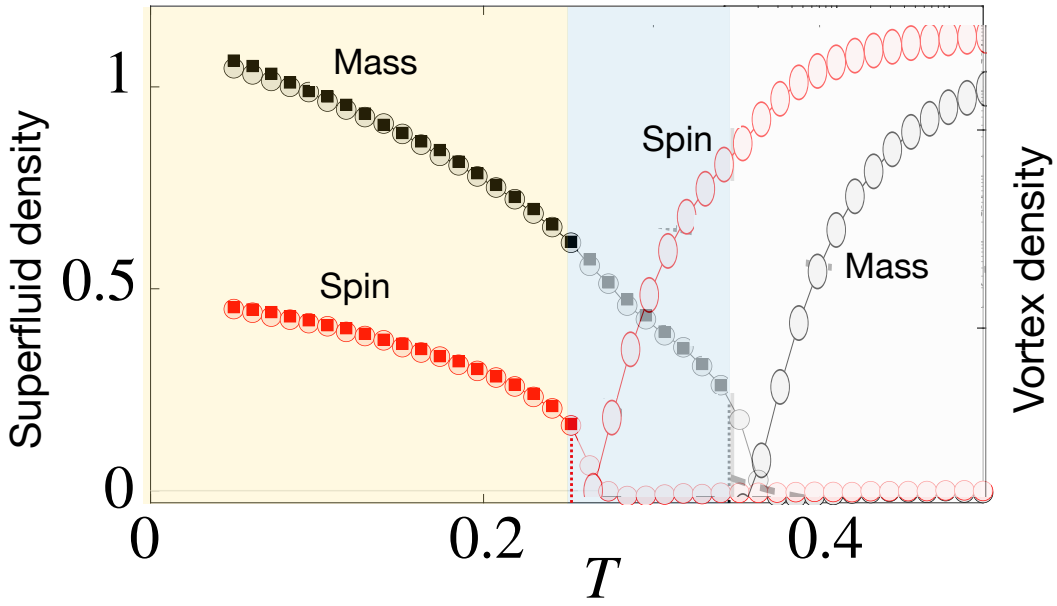
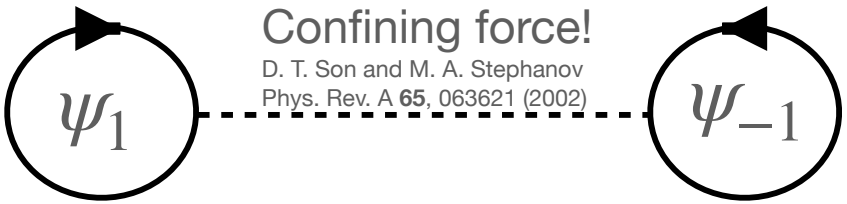
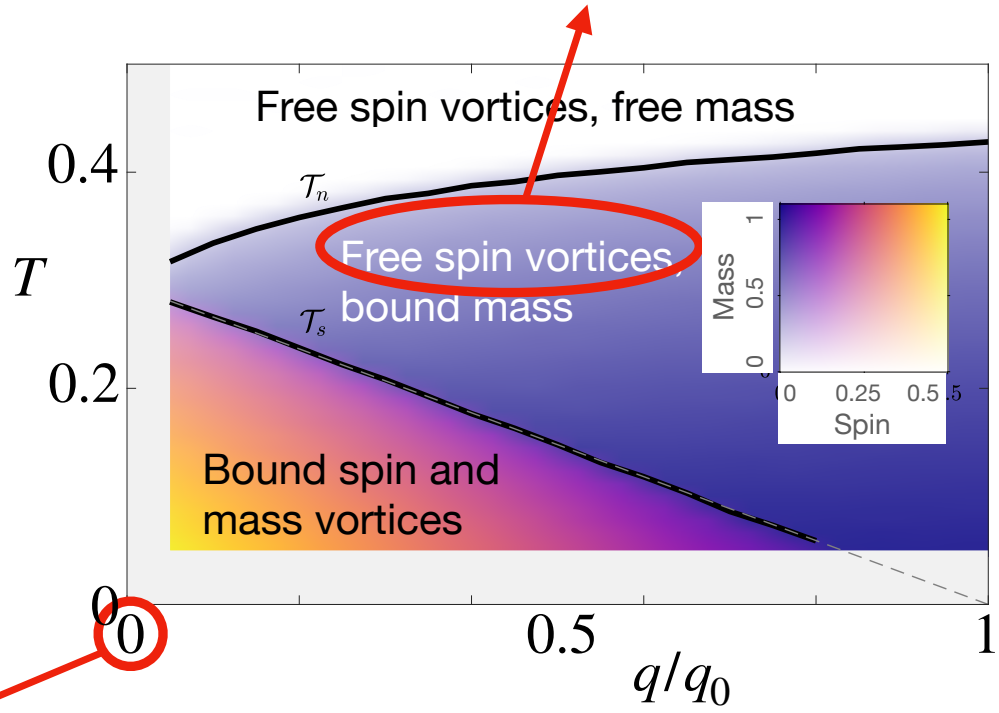
Results







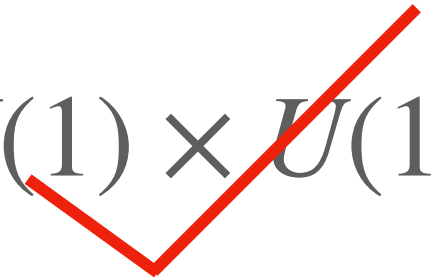
Fluctuations sensitive to system size:
no BKT transition in thermodynamic limit.
But in any finite system…

A. P. C. Underwood et al. arXiv:2207.14497

Where to next?

Where to next?

$U(1) \times U(1)$ $SO(3)$



Where to next?

$U(1) \times U(1)$

$SO(3)$

Where to next?

$U(1) \times U(1)$

$SO(3)$

Quenches

Where to next?

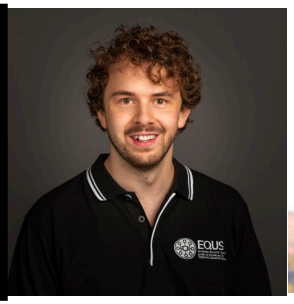
$U(1) \times U(1)$ ✓

$SO(3)$

Quenches

Acknowledgements:

Andrew Underwood



Andrew Groszek

Xiaoquan Yu

Blair Blake

EQUS
Australian Research Council
Centre of Excellence for
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Thanks for listening!