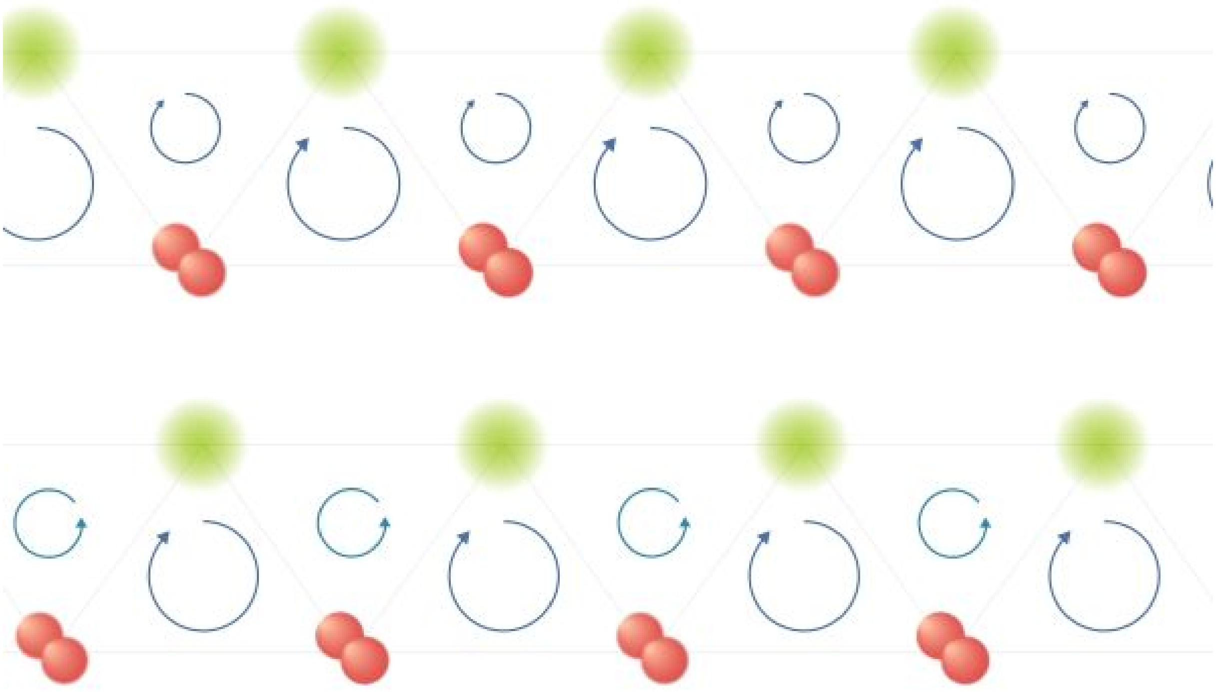

Supersolidity meets magnetism in an optical lattice

For the first time, a numerical simulation shows a phase of matter that combines lattice supersolidity and magnetism. The study, published in Physical Review Letters, proposes a concrete experimental setup to create and detect such states, something that, in the long run, could facilitate the development of exotic materials for quantum technologies.

July 23, 2026

Supersolidity -an exotic phase of matter in which atoms flow without friction like a superfluid, while maintaining the periodic spatial order characteristic of a crystal- and magnetism are both at the forefront of physics research, despite having typically remained independent research topics. In a recent Physical Review Letters publication, however, an international team of researchers, including **Prof. at ICFO Maciej Lewenstein**, have theoretically studied and **simulated phases of matter that, for the first time, combine supersolidity and magnetism**. The researchers have also proposed a concrete experimental set-up based on magnetic atoms (in particular, dysprosium) for the creation and detection of such states.

To do so, first, atoms must be placed within an optical lattice, distributed in space like eggs in an egg carton. Dysprosium atoms are chosen precisely because they possess significant magnetic dipole moments, so that an atom placed in a specific spot of the i¿½cartoni¿½ can feel the magnetic repulsion not only from the atoms in the neighboring sites, but also
rom atoms located further away. This ends up distributing atoms non-uniformly in sp
ce, following a specific pattern as in a solid, but with the atoms flowing without lo
ing coherence, thus creating a superso
id. What the researchers have shown is that these atomic movements can generate finite cur
ent fluxes, which effectively act as carriers of magnetic moments and, as such, can give rise
o a non-zero magnetic field. Depending on the ordering of the fluxes, the result
s a ferrimagnetic (if the fluxes spin in opposite directions but with unequal strengths
 or ferromagnetic phase (if they all rotate in the same direction), much like how anti-aligne
 or aligned electron spins produce magnetism in a mag
et. i¿½The coexistence between lattice supersolidity and magnetic ordering of fluxes had never been studied before,i¿½ says Michele Miotto, researcher at the Technische Universita
 Berlin and first author of the article. i¿½And yet, we have now shown how to achieve a rea
 magnetic mate**the role of ?magnets' is played not by the magnetic particles themselves, but by current loops in a supersolid**.i¿
? So far, their study has considered a one-dimensional system (that is, atoms arranged along a line), but the researchers hypothesize that extending this work to two dimensio
s could reveal some insights about possible connections between supersolidity and topolo
y, the field that studies how entanglement patterns in quantum materials with speci
ic geometries produce different quantum phas

Reference:

Miotto M., et. al., Flux magnetism in a strongly interacting dipolar lattice supersolid under tunable gauge fields, Phys Rev Lett, **137**, 043401 (2026).
DOI: https://doi.org/10.1103/tbp3-7rh3

Acknowledgements:
We thank N. Baldelli, C. Cabrera, S. Dhar, A. Eckardt, F. Ferlaino, M. Landini, M. Mark, G. Modugno, L. Santos and G. Valtolina for discussions. M. M., L. T. and L. B. acknowledge funding from the Italian MUR (PRIN DiQut Grant No. 2022523NA7). M. M. acknowledges funding from the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) via the Research Unit FOR 5688 (Project No. 521530974). P. L., G. F. and L. T. acknowledge funding from the European Union (European Research Council, SUPERSOLIDS, Grant No. 101055319). M. L. acknowledges support from: European Research Council AdG NOQIA; MCIN/AEI (PGC2018-0910.13039/501100011033, CEX2019000910-S/10.13039/501100011033, Plan National FIDEUA PID2019-106901GB-I00,

Plan National STAMEENA PID2022-139099NB, I00, project funded by
MCIN/AEI/10.13039/501100011033 and by the ï¿½European Uni
n NextGenerationEU/PRTRï¿½; (PRTRC17.I1), FPI); QUANTERA DYNAMITE PCI2022132
19, QuantERA II Programme co-funded by European Union's Horizon 2020 program under G
ant Agreement No 101017733; Ministry for Digital Transformation and of Civil Service of
the Spanish Government through the QUANTUM ENIA project call - Quantum Spain project,
and by the European Union through the Recovery, Transformation and Resili
nce PlanNextGenerationEU within the framework of the Digital Spain 2026 Agenda; Fund
cio Cellex; Fundacio Mir-Puig; Generalitat de Catalunya (European Social Fund FEDER and C
RCA program; Barcelona Supercomputing Center MareNostrum (FI-2023-3-0024); Funded by
the European Union. (HORIZON-CL4-2022-QUANTUM-02-SGA PASQuanS2.1, 101113690
EU Horizon 2020 FETOPEN OPTOlogic, Grant No 899794, QU-ATTO, 101168628), EU Hor
zon Europe Program (This project has received funding from the European Union's Hor
zon Europe research and innovation program under grant agreement No 101080086 NeQSTG
ant Agreement 101080086 - NeQST); ICFO Internalï¿½QuantumGaudiï¿½ project.