Quantum storage: RRI theory shows network links shape magnetic order

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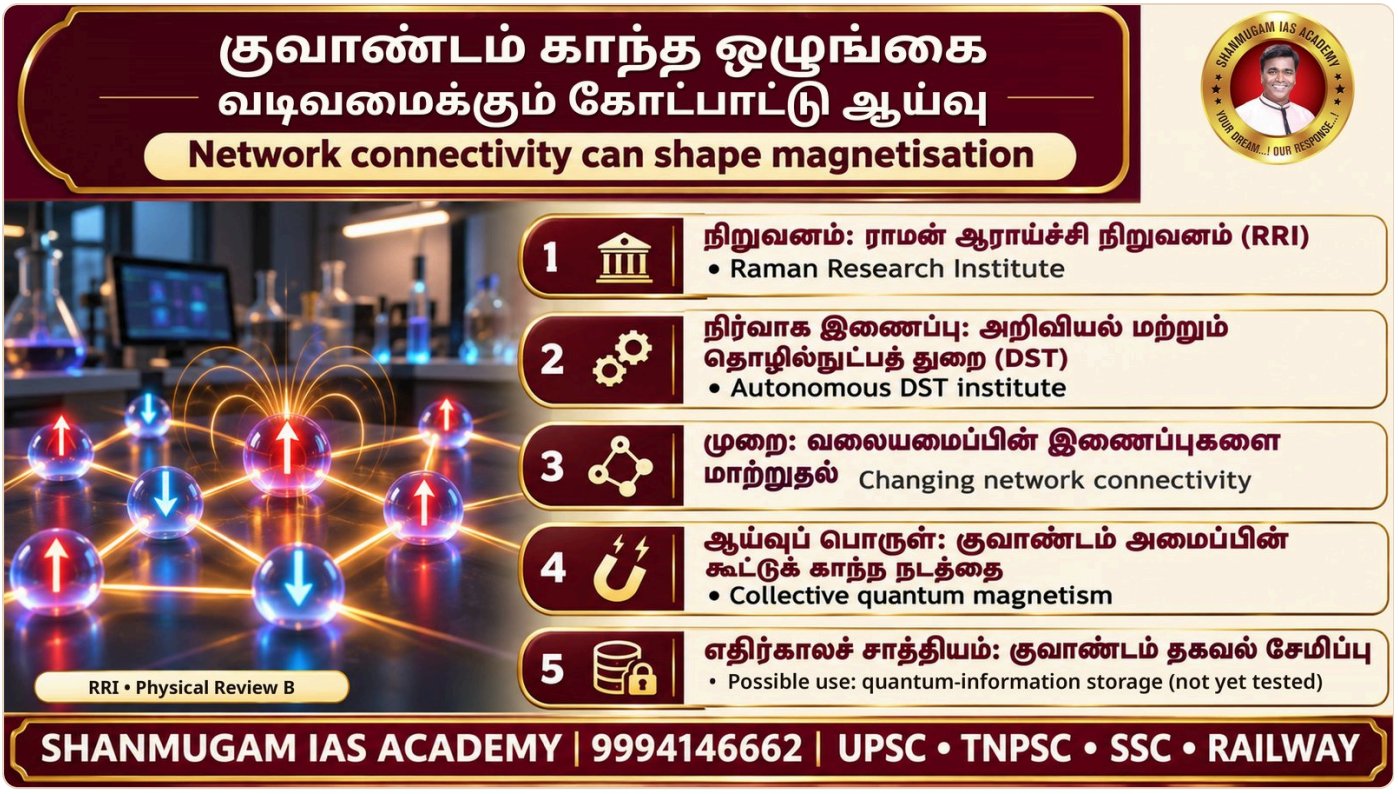

News

Revathy B. S., a postdoctoral fellow, and Shovan Dutta, an assistant professor in the Theoretical Physics group of the Raman Research Institute (RRI), Bengaluru, have shown theoretically that the magnetic order of a quantum system can be shaped by changing the links between particles in a network. The study, 'Shaping magnetic order by local frustration for itinerant fermions on a graph', was published in Physical Review B; news reports on it appeared on 20–21 November 2026. They studied a square lattice filled with electrons except for one vacant site (a 'hole'); as the hole moves, quantum interference of its paths orders the electron spins – an effect called 'kinetic magnetism'. Adding a diagonal bond between two sites makes the two electrons there form a 'singlet' – an entangled pair with opposite spins – while the other sites keep their ferromagnetic order. The authors report that the effect extends from square grids to random graphs, that the net magnetisation can be tuned this way, and they outline a protocol to test it in cold-atom set-ups. The work is purely theoretical: it has not yet been demonstrated experimentally and no quantum memory device has been built. Because singlets are entangled, it is said that this could in future offer a route to storing quantum information.

Key facts for the exam

Point	Details
Institute	Raman Research Institute (RRI), Bengaluru

Point	Details
Researchers	Revathy B. S. (postdoc), Shovan Dutta (Asst Professor)
Journal	Physical Review B
Type	Theoretical (numerical + analytical)
Concept	Kinetic magnetism – a moving 'hole' orders the spins
Key result	Diagonal bond → singlet (entangled pair); rest stays ferromagnetic
Possible use	Storing quantum information in entangled states – not yet tested
RRI	Founded by Sir C.V. Raman, 1948; DST-aided autonomous institute (since 1972)

Background

- Raman Research Institute: founded in Bengaluru in 1948 by Nobel laureate Sir C.V. Raman; today an autonomous research institute funded by the Union Department of Science and Technology (DST). Its areas include astronomy and astrophysics, light–matter interactions (including quantum technologies), soft condensed matter and theoretical physics.
- Quantum information: a classical computer's basic unit is the 'bit' (0 or 1); a quantum computer's is the 'qubit', which can be in a superposition of 0 and 1. 'Entanglement' is when the states of two or more particles stay linked regardless of distance. The 2022 Nobel Prize in Physics went to Alain Aspect, John Clauser and Anton Zeilinger for experiments with entangled photons.
- Magnetism: in ferromagnetic materials such as iron, nickel and cobalt, atomic spins align in one direction, giving strong magnetisation. Above a certain temperature this order breaks down and the material becomes paramagnetic – the 'Curie temperature' (after Pierre Curie). The equivalent for antiferromagnets is the 'Néel temperature'. Technology that uses spins to carry information is 'spintronics'.
- National Quantum Mission (NQM): approved by the Union Cabinet in April 2023 and implemented by DST for 2023-24 to 2030-31. Thematic hubs (T-Hubs) have been set up for four areas – quantum computing, quantum communication, quantum sensing and metrology, and quantum materials and devices.

Tamil Nadu link: Under the National Quantum Mission, IIT Madras leads the 'quantum communication' thematic hub together with C-DOT, New Delhi. Sir C.V. Raman, who founded RRI, was born at Thiruvanaikoil near Tiruchirappalli; 28 February, the day of the 'Raman Effect' discovery, is celebrated as National Science Day.

Frequently asked questions

What is this news about?

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What are the key facts to remember for the exam?

Institute: Raman Research Institute (RRI), Bengaluru; Researchers: Revathy B. S. (postdoc), Shovan Dutta (Asst Professor); Journal: Physical Review B; Type: Theoretical (numerical + analytical).

What is the background to this news?

Raman Research Institute: founded in Bengaluru in 1948 by Nobel laureate Sir C.V. Raman; today an autonomous research institute funded by the Union Department of Science and Technology (DST).

Practice questions (with answers)

1. The Raman Research Institute, Bengaluru, is an autonomous institute funded by which Union department?

A) Science & Technology

B) Atomic Energy

C) Scientific & Industrial Research

D) Biotechnology

Answer: A – Explanation: DST – Department of Science & Technology. Raman founded it in 1948. CSIR labs come under DSIR; TIFR under Atomic Energy.

2. In a quantum computer, what is the basic unit of information that can exist in a superposition of 0 and 1?

A) Bit

B) Byte

C) Photon

D) Qubit

Answer: D – Explanation: Qubit (quantum bit). A classical bit is only 0 or 1; 8 bits make a byte. A photon is just one medium that can carry a qubit.

3. In which year did Aspect, Clauser and Zeilinger win the Physics Nobel for experiments with entangled photons?

A) 2020

B) 2022

C) 2024

D) 2025

Answer: B – Explanation: 2022. They showed experimentally that Bell inequalities are violated, laying foundations for quantum information science.

4. Above which temperature does a ferromagnetic material lose its permanent magnetism and become paramagnetic?

A) Néel temperature

B) Debye temperature

C) Curie temperature

D) Kelvin temperature

Answer: C – Explanation: The Curie temperature – after Pierre Curie (about 770°C for iron). The Néel temperature applies to antiferromagnets.

5. Under the National Quantum Mission, IIT Madras with C-DOT leads the thematic hub for which area?

A) Quantum communication

B) Quantum computing

C) Sensing & metrology

D) Materials & devices

Answer: A – Explanation: Quantum communication. Computing – IISc Bengaluru; sensing & metrology – IIT Bombay; materials & devices – IIT Delhi.

Sources: Physical Review B; arXiv:2507.07886 (authors' affiliation: RRI); RRI – rri.res.in/about/overview; PIB – static.pib.gov.in/WriteReadData/specificdocs/documents/2026/feb/doc202624779701.pdf (NQM T-Hubs); Lok Sabha reply AU2939 – eparlib.sansad.in/bitstream/123456789/2994685/1/AU2939_NuhKD4.pdf; DST – dst.gov.in/cabinet-approves-national-quantum-mission-scale-scientific-industrial-rd-quantum-technologies; nobelprize.org – Physics 2022; NCERT Class XII Physics Part 1, Ch. 5 (Magnetism and Matter – Curie temperature). © Shanmugam IAS Academy.