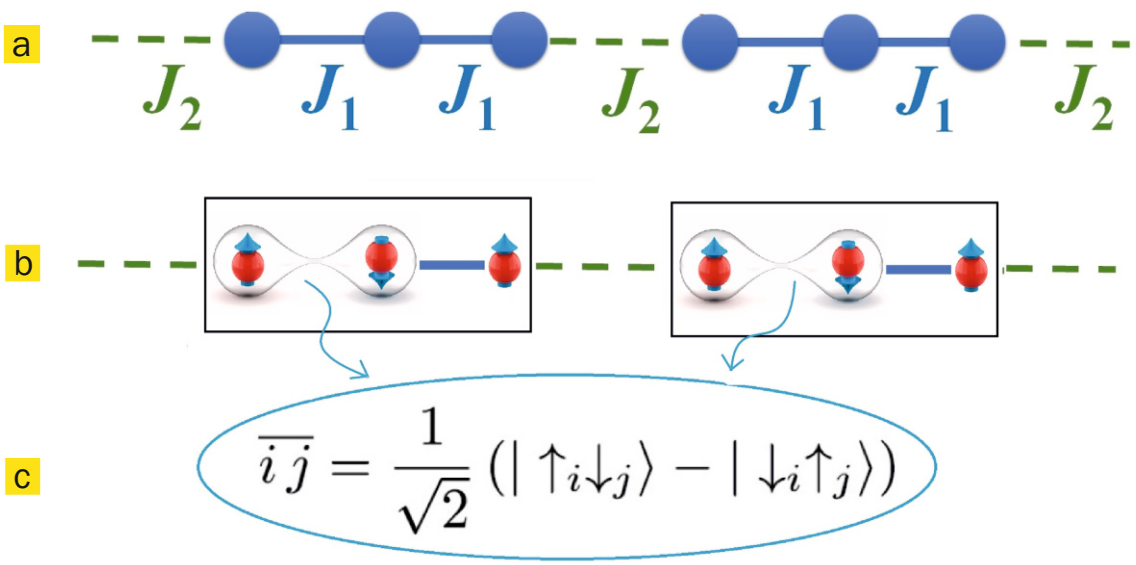
Quantum technology applications

Spin Quantum Entanglement Near Room Temperature



A schematic snapshot of the quantum entangled spin state (b) of a trimer spin-chain having periodic quantum mechanical magnetic exchange interactions J1-J1-J2 along the spin chain (a) involving the wave function (c).

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Entangled spin states are found to be very stable against temperature and persist up to near room temperature (~250 K), which has a special importance for practical device applications in the upcoming quantum technology.

Quantum entanglement has drawn a tremendous attention of researchers for its importance in quantum technology. Quantum entanglement phenomenon occurs when a group of quasi-particles interact and share spatial proximity in a way such that the quantum states of each particle of the group cannot be described independently of the states of the other particles.

Recent study [A. K. Bera, S. M. Yusuf* et al., Nature Communications 13, 6888 (2022)] has demonstrated for the first time the novel quasi-particle excitations of strong spin entangled ground state [Fig. (b)] of a quantum spin-1/2 trimer-chain antiferromagnet [Fig. (a)]. Such a model spin-1/2 trimer-chain antiferromagnet has been achieved in the compound $Na_2Cu_3Ge_4O_{12}$ where the group of three spin-1/2 of Cu^{2+} are strongly coupled to form a spin-trimer, and such trimers are magnetically weakly coupled to make a spin-chain [Fig. (a)]. The ground state of such a spin-trimer system involves a quantum entangled [Fig. (b)] wave function of two spins (out of the three spins) as shown in [Fig. (c)]. Most importantly, such entangled spin states are found to be very stable against temperature and persist up to near room temperature (~250 K), which has a special importance for practical device applications in the upcoming quantum technology.

Dr. S.M. Yusuf, Director, Physics Group, BARC has been elected as a Fellow of New Delhi headquartered prestigious Indian National Science Academy (INSA). Dr. Yusuf is recognized internationally for his outstanding contributions in the area of advanced magnetic materials and neutron scattering. He has published nearly 300 research papers in internationally reputed peer reviewed journals. He has one US patent and one European patent to his credit. Dr. Yusuf is also a Fellow of the Indian Academy of Sciences, and the National Academy of Sciences. He was a post-doctoral fellow at Argonne National Laboratory, USA, and a visiting scientist at the Institute of Materials Science, Spain. Dr. Yusuf is a recipient of U.S. Department of Energy Fellowship as well as the Spanish Ministry of Science & Education Fellowship.