18 NMR study of electronic states in semiconductor quantum structures - Spontaneous breaking of spin symmetry probed by nuclear spins -

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Motivation

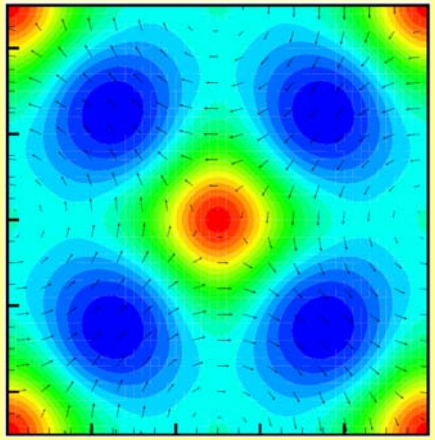
In semiconductor heterostructures, clean two-dimensional (2D) planes with atomic-scale flatness can be formed. Such a system can be an ideal laboratory to study low-dimensional physics. Our aim is to find new physics and control collective phenomena in the system.

Originality

We developed experimental techniques for nuclear magnetic resonance (NMR) in semiconductor low-dimensional systems to investigate static and dynamic properties of electron spins. The measurement detects spontaneous breaking of spin symmetry accompanied by Nambu-Goldstone modes.

Impact

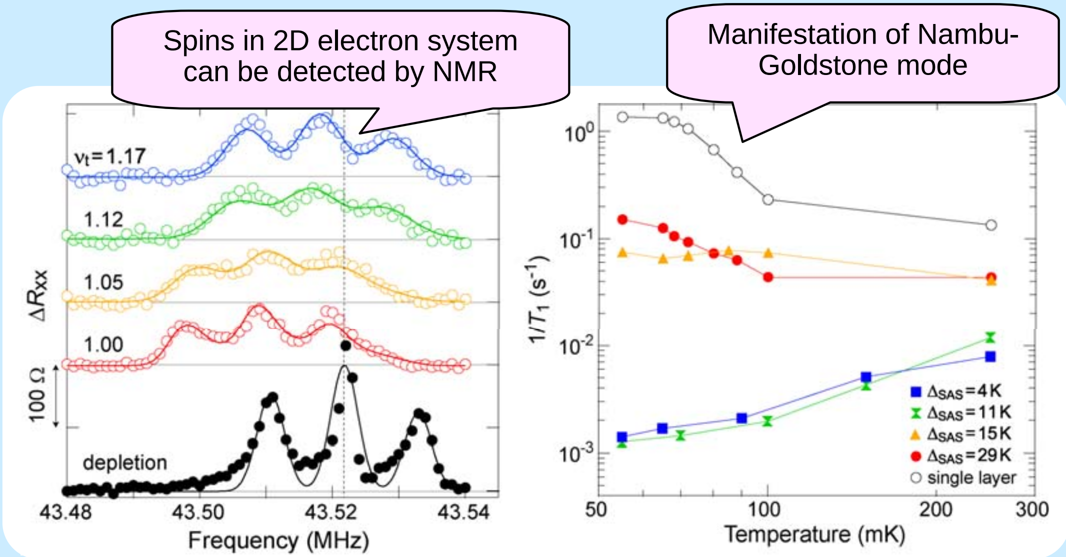
NMR detection of electron spin properties in semiconductor heterostructures has uncovered new physics in low dimensions. Furthermore, addition of the nuclear spin degree of freedom to electronics opens up possibilities for developing new device concepts.



Spontaneous symmetry breaking of spin symmetry proposed in 2D electron system. (Calculated result by R. Cote)

Essentially, spins are free to point in any direction and have a rotational symmetry. However, once the direction of a spin is fixed, the direction of other all spins are fixed by interactions. This phenomenon is called spontaneous symmetry breaking.

Observation of Nambu-Goldstone modes associated with spin symmetry breaking



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