Highly-sensitive resistively-detected NMR of InSb two-dimensional systems
InSb 二次元系における高感度抵抗検出 NMR

Hyperfine interaction between electron and nuclear spins enables us to realize highly-sensitive resistively-detected (RD) NMR (Nuclear Magnetic Resonance) in semiconductors. Although highly-sensitive RD-NMR was limited in GaAs quantum systems over the past 20 years, Liu et al. have succeeded to demonstrate RD-NMR for typical narrow-gap system, a single InSb quantum well. Differently from GaAs systems, a degeneration of the different spin states is realized by tilting the sample in a magnetic field. Extremely large g-factor of InSb results in a crossing of down spin of ground Landau-level (LL) and up spin of the first LL at $\nu = 2$ as evidenced by a resistance spike shown by green lines in Fig. 1. We can expect a formation of the simplest pseudospin (involving spin and Landau-level) quantum Hall ferromagnet with a domain structure at this crossing. By flowing a large current at this crossing, dynamic nuclear polarization and RD-NMR have been demonstrated for both In and Sb nuclei. ^{115}In has $I = 9/2$ and transitions between neighboring states form nine peaks with equal interval in the NMR spectrum under quadrupolar splitting. Such separation is clearly observed in the experiments as shown in Fig. 2. The RD-NMR signal of ^{115}In can be detected up to 4 K.

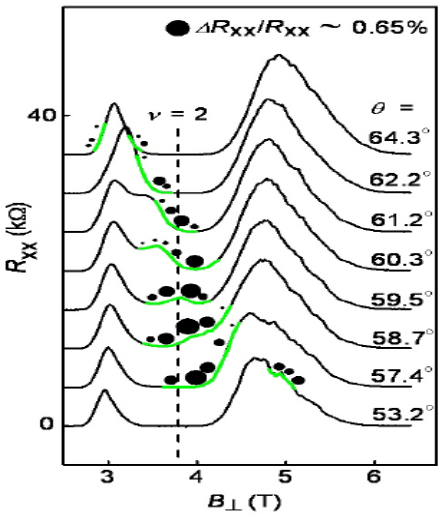

Fig. 1 Resistance spike observed at $\nu = 2$ for tilted magnetic field experiment. Solid-state circles indicate positions where RD-NMR can be detected.

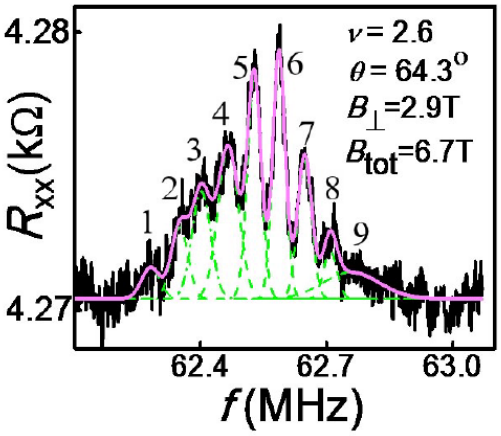

Fig. 2 RD-NMR signal of ^{115}In measured at T = 100 mK. The data was obtained from the spike inside the LL peak at $\theta = 64.3°$ in Fig. 1. The solid line is a fit with nine Gaussian curves (dashed line).

Representative publications:

1. H. W. Liu, K. F. Yang, T. D. Mishima, M. B. Santos, and Y. Hirayama, Phys. Rev. B **82**, 241304(RC) (2010). [editor's suggestion]
2. K. F. Yang, H. W. Liu, K. Nagase, T. D. Mishima, M. B. Santos, and Y. Hirayama, Appl. Phys. Lett. 98, 142109 (2011).
3. K. F. Yang, H. W. Liu, K. Nagase, T. D. Mishima, M. B. Santos, K. Nagase, and Y. Hirayama, New Journal of Physics 13, 083010 (2011).