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Current Frequency Dependence of the Resistance Enhancement in the ν = 2/3 Quantum Hall State

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The spin degree of freedom plays an important role in the fractional quantum Hall States (QHSs). It is responsible for a variety of phenomena such as phase transitions between different ground states and interactions of the electronic system with the nuclei. At the spin phase transition point in the ν = 2/3 QHS, an anomalous longitudinal resistance R_{xx} peak is observed. So far, the enhancement of the R_{xx} is explained by a domain structure of the two different spin phases of the ν = 2/3 QHS[1]. It is believed that when current passes across a domain boundary, electron spins flip-flop scatters nuclear spins causing dynamic nuclear spin polarization (DNP), then the spin polarization affects back the domain formation and increases the length of the domain boundaries. However, details of the domain structure and the mechanism of the R_{xx} enhancement are still unclear. One reason may be a difficulty of the ultra-low frequency measurements although there are several reports [2].

We investigate the DNP pumped by the large and ultra-low frequency electric current around the spin transition point in the ν = 2/3 fractional QHS in a GaAs/AlGaAs quantum well structure. We observe the time dependence of the magnetoresistance R_{xx} during the DNP in the wide range of frequencies of the pumping currents. In Figure 1, the time evolutions of the R_{xx} for the various pumping current frequencies are illustrated. The pumping current amplitude is 60 nA. We used the rectangular shape current to make the input power the same for all frequencies. We often change to 5nA and 37.7Hz sinusoidal current to measure the R_{xx} for a short moment. In Fig. 1, when frequencies are high (≥ 1.0 Hz), the R_{xx} monotonously increase for about several hundred seconds and saturate. At ultra-low frequencies (< 0.1 Hz), the R_{xx} decrease after the enhancement. The lower frequency we use, the smaller value the R_{xx} become. The R_{xx} also shows pulsation motion at ultra-low frequencies. These results suggest that the fluctuation of domain formation by AC current cause splits of the domains and the resistance enhancement at the ν = 2/3 QHS. In the conference, we discuss the dynamics of the nuclear spin and domain morphology.

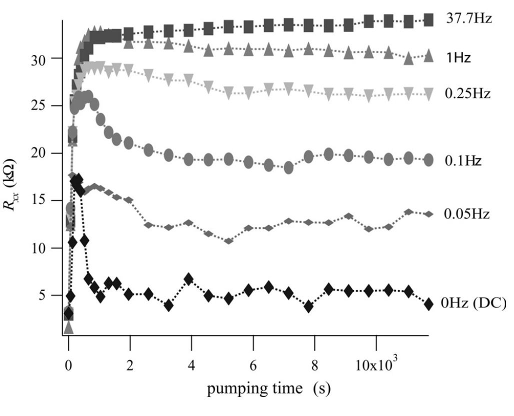

Figure 1 Time dependence of the R_{xx} during the DNP for various pumping frequencies. Pumping current has an amplitude of 60 nA with rectanguler shape. Detection is carried out with a sinusoidal current with 5 nA and 37.7 Hz.

[1] S. Kraus *et al.*, Phys. Rev. Lett. **89** (2002) 266801.
[2] J. H. Smet, *et al.*, Phys. Rev. Lett. **80**, (1998) 4538.