Current-induced nuclear-spin activation in a two-dimensional electron gas

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Introduction

- Electrical detection of NMR
  - Zeeman energy (gap)
    \[ \Delta_Z = g^* \mu_B (B + B_N) \]
  - RF pulse destroys \( B_N \)
    \( \Rightarrow \) effective field \( \uparrow \)
    \( \Rightarrow \) longit. Res \( \downarrow \)
    \[ R_{xx} \propto e^{-\frac{\Delta}{2kT}} \]
  - alternative: wiggle around on the slope of \( R_{xx} \)-peak

- picture too simple
  - “…”anomalous dispersive” lineshape…of unknown origin…”
  - “…peak only response…”
Sample and Set-up

- 2DEG in 40nm quantum well
- mobility: $16.6 \times 10^6$ cm$^2$/Vs
- density: $1.6 \times 10^{11}$ cm$^{-2}$
- Lock-in parameters 10Hz, 10nA
- $T$ is $T_e$ calibrated against CMN + supercond. fixed point, corrected for non-resonant RF
- NMR: $^{75}$As (same for Ga [8,14])
Re-entrance

- $T_e=34\text{mK}$
- $I_{dc}=0$ (?)
- Scanning time 10h
- 10min between lines
Heating vs. Current (1)
Heating vs Current (2)
Summary

- dc-current induced re-entrance of anomalous dispersive signal
- two mechanisms/reasons for the signals:
  - thermal activation at low T / small I_{dc}
  - current intensity
- current-induced nuclear spin enhancement
- some things to be edited
  - e.g. caption Figure 1 (I_{dc}=0?)
  - What’s the dashed line in Figure 3(a)?
  - What are the solid lines in Figure 2(c+d)?
  - What are the frequencies of the normalised minima and peaks in Figures 1(c) and 3(c+f)?