Condensed Matter NMR User Facility at NHMFL

Low Temperature Wideline NMR - probes electronic interactions in Condensed Matter Systems via electron-nuclear hyperfine coupling.

Magnets
• 25T 52mm bore, 1 ppm/mm resistive (Cell 6) 31T 32mm bore, 3 ppm/mm resistive (Cell 2), Optics (Cell 3)
• 45T hybrid, 32 mm bore, 25ppm/mm (Cell 15)
• 12T 39mm, 40ppm/cm field-sweepable superconducting
• 15T 40mm, 4ppm/cm field-sweepable superconducting
• 17T 40mm, 10ppm/cm, sweepable superconducting
• 18T 25mm, 100ppm, SC dil-fridge equipped (SCM1)

Spectrometers and probes
• Five MagRes2000 homemade portable homodyne quadrature-detected console 2MHz-2GHz system, 100 MS/s, Labview interface, 25ns pulse widths, up to 600W
• Four High Field Probes – >500 MHz, 1.6-350K vacuum sealed, ~micron to 10mm sample dia, single and dual axis goniometry, optical access, high pressure, stepper motor bottom tuning, simultaneous transport and NMR
• Q=1 probe, top tuning for ultrawide frequency sweeps

Cryogenics
• 4 Adjustable flow VT cryostats- 1.4 to 325K, fast cooldown, for 31mm bucket dewars
• $^3$He sorption 350mK Janis cryostat
• 20-300mK Oxford Dilution Fridge (SCM1)
World’s Highest NMR Frequency 1.90GHz (44.7T protons) - microcoils

Critical Fluctuations in Quasi-1D SDW (TMTSF)$_2$PF$_6$

Clark et al., Int. J. of Mod. Physics B16,3252 (2002).
NMR in HTSC: Field Map and Vortex Image

The real space internal magnetic field profile and the corresponding field distribution function, \( P(H_{\text{int}}) \), for a square vortex lattice in a superconductor as seen by NMR.

Reyes et al., PRB 55, R14737(1997)
Topological Kondo Insulator SmB\textsubscript{6}

$^{11}$B Field dependent relaxation and model density of states

Spin-Nematic Phase in Frustrated AF LiCuVO$_4$ (New state of matter)

- Spin-nematic - new exotic state of matter
- Similar to liquid crystals
- Rotational symmetry, no LR spin order
- Results of competition between AF and FM interaction
- Magnon pairs undergo BEC above $T_c \sim 40T$
- NMR shows narrowing of line where all magnons line up with field

Buettgen et al. (2013)