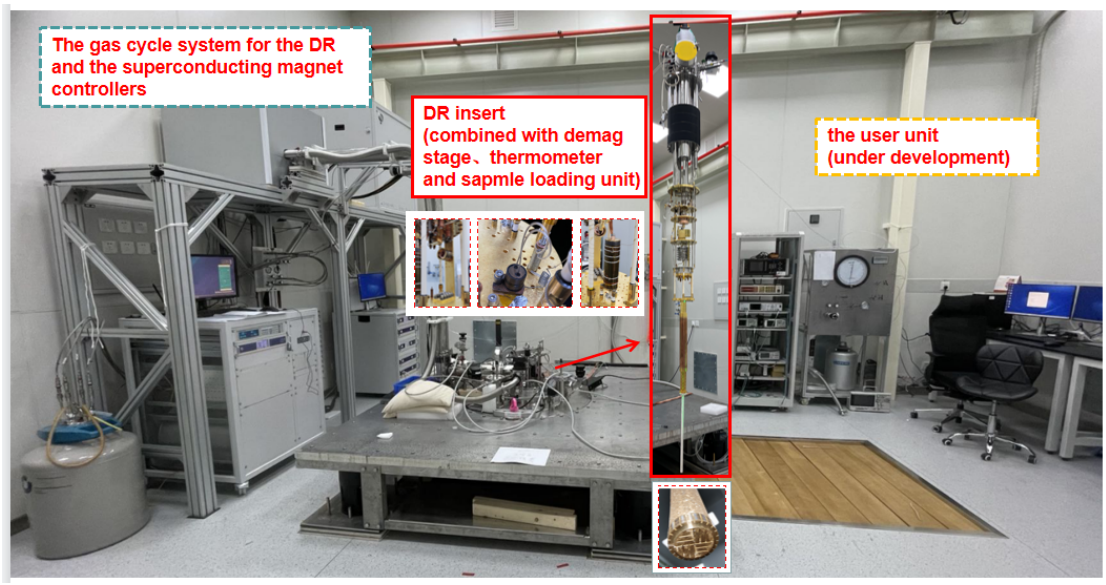
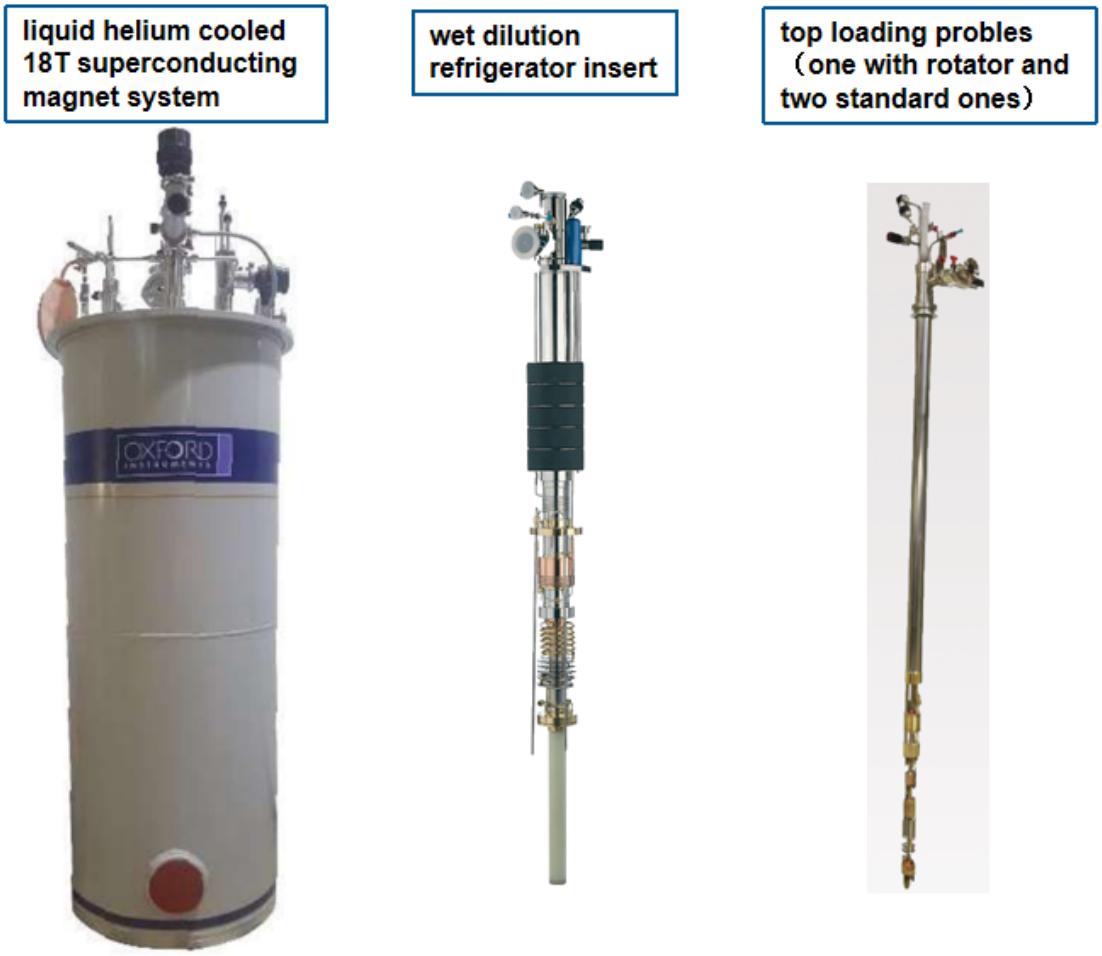
Sub-millikelvin experimental station

Sub-millikelvin experimental station is constructed on a commercial powerful dilution refrigerator with a home-made adiabatic nuclear demagnetization system, which can provide extreme conditions of ultra-low temperature (below 1 mK) and strong magnetic field (up to 16 T). Equipped with high-precision electrical measurement instruments including lock-in amplifiers, pre-amplifiers and low-noise source measure units, the station has a noise level as low as 10 nV by strictly multi-stage filtering and optimized grounding. This makes it an ideal measurement platform for the study of nanoscale electronics, topological quantum computing, physical property measurements and manipulations of strong correlated electron systems. At present, this station consists of adiabatic nuclear demagnetization measurement unit and dilution refrigerator measurement unit. The dilution refrigerator measurement unit is composed of a commercial top-loading dilution refrigerator, which is designed for quick sample screening for the Adiabatic nuclear demagnetization measurement.

Specifications of Adiabatic nuclear demagnetization measurement unit

Parameters	Values
Minimum temperature	Less than 1 mK, and the exact minimum temperature and duration time is under testing.
Maximum sample field	16 T
Sample field homogeneity	0.1% variation over the a 1 cm diameter spherical volume located in the magnet center
Maximum demagnetization field	9 T
Demagnetization field homogeneity	1% variation over 10 cm length on axis
Base temperature for dilution refrigerator	4.6 mK
Cooling power for dilution refrigerator	0.9 mW@100 mK
Size for sample space	Φ39.4 mm





Photos of the experimental station

A detailed introduction to the adiabatic nuclear demagnetization measurement unit:

1. The adiabatic nuclear demagnetization system is developed by ourselves, where the

nuclear stage is made of a high purity copper rod and the sample stage is made of annealed high purity silver.

2. The sample temperature in the range of sub-mK to mK can be monitored with the ^{3}He melting curve thermometer (MCT) and Pt-nuclear magnetic resonance (NMR) thermometer.
3. The measurement wire is made of 12 pair shielded twisted pair cable. To measure weak signals accurately at ultra-low temperatures, the electrical leads each are well thermally anchored and filtered at different temperatures.
4. The user unit is equipped with precise electrical measurement instruments working at low frequency and DC, including digital source meters, lock-in amplifiers and voltage per-amplifiers, nanovoltmeter and so on.

Specifications of top-loading dilution refrigerator

Parameters	Values
Base temperature	15 mK
Cooling power	0.4 mW@100 mK
Maximum field	18 T
Size for magnetic bore	52 mm
Field homogeneity	0.1 % variation over the a 1 cm diameter spherical volume located in the magnet center
Field decay rate	1 part in 10^{-4}

A detailed introduction to the top-loading dilution refrigerator:

1. We provide three sample probes for users: one probe equips with a rotator, and the other two are standard ones, which can be modified according to the measurement requirements.
2. The magnet is made with superconducting wires specially prepared for high field, and no flux jumping will occur.
3. Model 372 resistance bridge is applied to precisely and fast measure and control the temperature of each cold stage of dilution refrigerator.
4. The user unit is equipped with precise electrical measurement instruments working

at low frequency and high frequency, including microwave signal generator, arbitrary wave generator, microwave vector network analyzer, semiconductor parameter analyzer, digital source meters, lock-in amplifiers and voltage per-amplifiers, nanovoltmeter and so on.

Contact Information:

Dr. Tong, E-mail: tongbb@iphy.ac.cn .