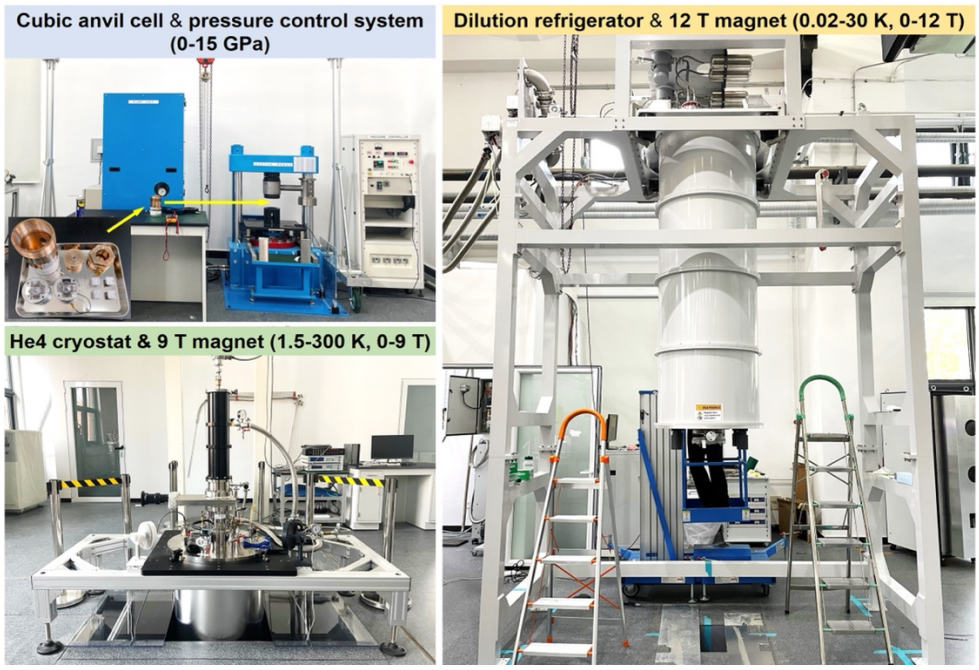
Ultra-low temperature high pressure physical property measurements - cubic anvil cell station

Ultra-low temperature high pressure physical property measurements - cubic anvil cell (CAC) station aims to regulate the quantum states of matters via accurate physical-property measurements under high hydrostatic pressures. This station adopts a unique miniature CAC that can generate hydrostatic pressures up to 15 GPa and integrates it with specially designed cryostat and superconducting magnet; it provides users the option to measure physical properties such as electrical transport, magnetic susceptibility, and AC specific heat under multiple extreme conditions including high hydrostatic pressure, extremely low temperature and strong magnetic field. New measurement techniques can also be jointly developed according to research needs.



Photos of the station

This station provides two sets of cryostat and superconducting magnet systems for use with CAC: (1) a He4 cryostat and 9 T magnet unit, (2) a dilution refrigerator and 12 T magnet unit, which can be used for high-pressure physical-property measurements under conditions of 1.5-300 K, 0-9 T and ~0.02-30 K, 0-12 T, respectively. The CAC adopts three-axis compression geometry and the sample is immersed in the liquid pressure transmitting medium. These factors ensure an excellent hydrostatic pressure

conditions in CAC and thus are conducive to obtaining the intrinsic pressure effects and the evolutions of the quantum state of matters.

Specification of the CAC station for high-pressure measurements

Parameters	Values
Pressure	0-15 GPa (hydrostatic pressure)
Temperature	1.5-300 K (He4 cryostat unit) 0.02-30 K (Dilution refrigerator unit)
Magnetic field	0-9 T (He4 cryostat unit) 0-12 T (Dilution refrigerator unit)
Typical sample size	length: 0.4-1.0 mm, width: 0.2-0.3 mm, thickness: 0.1-0.3 mm
Physical properties measured	Resistivity, magnetoresistance, ac magnetic susceptibility and specific heat

A detailed introduction to the CAC station:

1. This station adopts a unique miniature CAC to produce a high hydrostatic pressure condition. The operation principle is following: the pressure is generated by compressing the central cubic gasket via driving six anvils synchronously from three orthogonal directions; the sample to be measured is placed in a Teflon capsule filled with liquid pressure transfer medium in the center of cubic gasket. Such a three-axis compression geometry and the adoption of liquid pressure transmitting medium can ensure an isotropic and uniform pressure to the greatest extent, which is conducive to obtaining the intrinsic pressure effect and evolutions of quantum states of matters. The CAC employs two kinds of anvils with length of 4 mm and 2.5 mm, which can produce hydrostatic pressures up to 8 GPa and 15 GPa, respectively. For these two anvils, the sample space in Teflon capsule is ϕ1.5*1.8 mm^3 and ϕ1.0*1.8 mm^3, respectively. Depending on the research requirements, the users can select the CAC with 4 mm or 2.5 mm anvils.

2. In order to meet the high-pressure research needs under different temperature and magnetic field conditions, this station integrates the CAC with two sets of cryostat and superconducting magnet unit: (1) a He4 cryostat and 9 T magnet unit, (2) a dilution refrigerator and 12 T magnet unit, which can be used for high-pressure physical property measurements under 1.5-300 K, 0-9 T and ~0.02-30 K, 0-12 T conditions, respectively. The former consists of an L-He cryostat and room-temperature-bore 9 T superconducting magnet and can be used for regular rapid low-temperature experiments with a time duration of about 24 hours for a single temperature cycling experiment. The latter consists of a bottom-loading helium-free dilution refrigerator with high cooling power and a built-in 12 T superconducting magnet and can achieve extremely low temperatures measurements with a time duration of about 96 hours for a single cooling experiment.
3. In addition to providing a wide range of hydrostatic pressures, another advantage of CAC is the large sample space (>1 mm^3), which can facilitate in-situ high-pressure physical property measurements. This station can provide the following high-pressure measurements: resistance, magnetoresistance, Hall effect, AC magnetic susceptibility and specific heat as well as dielectric constant. Due to the large sample space of CAC, we can also jointly develop new measurement techniques such as high-pressure NMR measurements according to research needs.

Contact Information:

Dr. Yang，E-mail: ptyang@iphy.ac.cn .