Specifications

attoAFM III

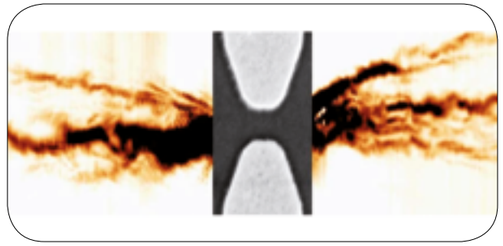
General Specifications	
type of instrument	tuning-fork based AFM with shear-force or standard detection
sensor head specifics	etched metal wires, etched or pulled optical fiber probes, STM tips, Akiyama probes (also compatible with NaugaNeedles commercial tips)
Operation Modes	
imaging modes	non-contact mode AFM, EFM, SGM
slope compensation	2 axis scan plane correction
z feedback	PI feedback loop for amplitude modulation (AM), phase modulation (PM) or frequency modulation (FM) using included PLL
optional upgrades	AFM/STM mode
Resolution*	
measured z-noise density	< 16 pm/√Hz
z bit resolution @ 4 K	7.6 pm at 2 µm scan range
Sample Positioning	
total travel range	5 x 5 x 5 mm³ (open loop)
step size	0.05..3 µm @ 300 K, 10..500 nm @ 4 K
fine scan range	50 x 50 x 4.2 µm³ @ 300 K 30 x 30 x 2 µm³ @ 4 K
sample holder	ASH/QE/0 quick exchange sample holder and integrated heater with calibrated temperature sensor
Suitable Operating Conditions	
temperature range	1.5 K..300 K (dependent on cryostat); mK compatible setup available on request
magnetic field range	0..15 T+ (dependent on magnet)
operating pressure	designed for He exchange gas (vacuum compatible version down to 1E-6 mbar on request)
Suitable Cooling Systems	
titanium housing diameter	48 mm
bore size requirement	designed for a 2" (50.8 mm) cryostat/magnet bore
compatible cryostats	attoDRY1000/1100/2100 attoLIQUID1000/2000/3000/5000
Electronics	
scan controller and software	ASC500 (for detailed specifications please see attoCONTROL section)
Options	
sample holder upgrade	ASH/QE/4CX quick-exchange sample holder with 8 electrical contacts and integrated heater with calibrated temperature sensor
closed loop upgrade for coarse positioners	resistive encoder, range 5 mm, sensor resolution approx. 200 nm, repeatability 1-2 µm
ultra-large scan range upgrade	80 x 80 @ 300 K 125 x 125 @ 4 K
in-situ inspection optics	tip/sample monitoring via *in-situ* LT-LED for illumination, mirrors, lenses and CCD camera (outside of cryostat) field of view approx. 3 mm x 2 mm, resolution approx. 20 µm (depending on cryostat: distance top-flange to field center)
closed loop scanning upgrade	interferometric encoders available

The attoAFM III microscope stick

* Resolution may vary depending on applied tip, sample, and cryostat

Selected Applications

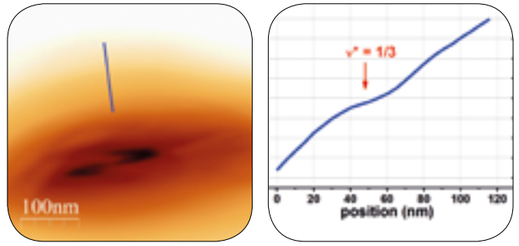
attoAFM III



Scanning Gate Microscopy at 300 mK

In this measurement, an attoAFM III was operated inside an attoLIQUID3000 cryostat at 300 mK in scanning gate microscopy mode (SGM) - investigating the trajectory and interaction of edge channels of a split-gate quantum point contact (QPC) device in the Quantum Hall (QH) regime. By scanning the SGM tip over the surface of the QPC at constant height and by simultaneously measuring and plotting the source-drain current, conductance maps were obtained. The image to the left is an example of such a conductance map depicting the characteristic branched-flow of electrons at zero magnetic field, which in turn shows electron interference fringes and the actual electron path (T = 400 mK, 2DEG density $n_{2D} = 3.37 \times 10^{11}\,cm^{-2}$).

(Data and images were generously provided by S. Heun et al., NEST, CNR-INFM and Scuola Normale Superiore, Pisa, Italy.)



Imaging Fractional Incompressible Stripes in Quantum Hall Systems

In newer measurements, the group performed SGM measurements at the temperature and magnetic field conditions required to observe the fractional quantum Hall effect. The goal is to image for the first time the presence of fractional incompressible stripes, i.e. the existence of an inner structure within the integer edge channel. The measurements were performed at bulk filling factor n = 1 (B = 8.23 T, T = 300 mK). The corresponding SGM map in the region close to the QPC center is depicted in the lower Figure (a). Analogously to the n = 4 case, one expects to find plateaus when the local electron phase is gapped, i.e. when the local filling factor n*equals a robust fraction. The scan profile depicted in the right figure reveals a clear shoulder for $G_{sd} = e^2/3h$ (corresponding to points where n* = 1/3). A more careful analysis [1] allows to determine the occurrence of incompressible phases for n* = 1/3, 2/5, 2/3, and 3/5, i.e. the two most robust fractions and their hole-particle conjugates, respectively. The SGM maps allow not only to reveal the fractional incompressible stripes, but also to measure their width and correlate it with the local electron density slope. The agreement between the data and a reconstruction model is remarkable, especially in light of the uncertainty on the fractional-gap value, which is known to be rather sensitive to the details of disorder potential.

(Data and images were generously provided by N. Paradiso, S. Heun et al., NEST, CNR-INFM and Scuola Normale Superiore, Pisa, Italy.)

[1] N. Paradiso et al., Phys. Rev. Lett. 108, 246801 (2012). See also the Supplemental Material.