



Département  
de Physique  
—  
École normale  
supérieure

# LPENS Laboratoire de Physique de l'ENS

Séminaire d'axe Matériaux et Dispositifs Quantiques (MDQ)  
**Mercredi 10 Avril, 14h00-15h00, Conf IV**

## Visualizing quantum Hall liquids and their boundary modes

**Ali Yazdani**

*Princeton, USA*

In a series of experiment on 2D electron gas at the surface of Bi, we have been able to probe a number of novel features of quantum Hall liquids for the first time. First, we have been able to use the scanning tunneling microscope (STM) to directly visualize Landau orbits in real space. This new technique has been used to show that the electronic states associated with the valley state on the surface of Bi form nematic quantum Hall liquids. [1] By tuning the magnetic field, we have been able to stabilize different type nematic fluids, and have been able uncover a ferroelectric quantum Hall liquid that forms when only one of the valley gets occupied. [2] We are able to demonstrate that the formation of these valley polarized states quantum Hall phases are driven by electron-electron interaction. Finally, in the most recent experiment, we have been able to uncover domain walls between different nematic quantum Hall states and to direct image the 1D Luttinger liquids that form at such interfaces. This new type of Luttinger liquids can become metallic or insulating depending on the number of valley-textured edge modes, which can be understood by considering how valley flavor constrain Coulomb interaction [3]. In addition to these experiments, I will describe proposed efforts based on these experiments in trying to use the STM to probe anyons in fractional quantum phases.

[1] B. Feldman et al. Science **354** 6310 (2016).

[2] Randeria et al. Nature Physics, **14** 1709 (2018).

[3] Randeria et al. Nature **566**, 363 (2019).