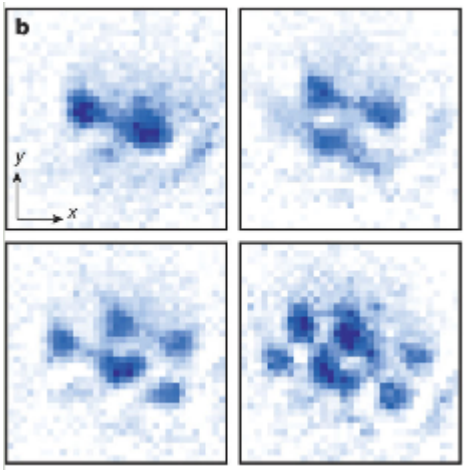
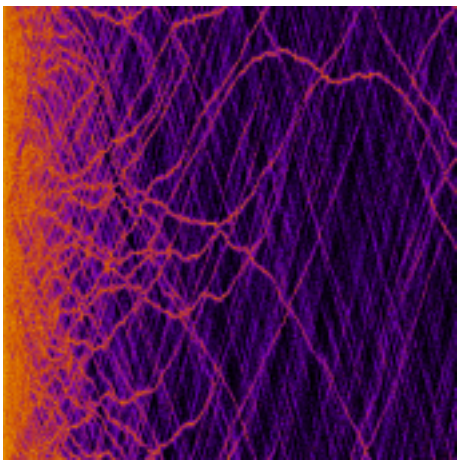
Simulation of quantum droplets

Quantum droplets are a new discovery (2015) in the ultracold gas field. Their most unusual feature is that they are stabilized and held in equilibrium by bosonic quantum fluctuations. This mechanism has never been encountered before in macroscopic objects. Despite being dilute, the droplets have many similarities to a liquid rather than a gas, which is a source of great experimental activity at the present time.

However, the theoretical description of quantum droplets to date has been somewhat primitive, and has not keep pace with experiments. Standard approaches simply postulate an empirical averaging over the quantum fluctuations, and their agreement with experiment has been mainly qualitative. A proper understanding of how quantum fluctuations act in single realizations of a droplet is lacking.



An image of quantum droplets obtained in the Stuttgart experiment.



A simulation of defects in a quantum gas using the newly developed *WSGPE* method.

In our group at IFPAN, we have last year developed a novel approach to describe quantum fluctuations, the Wigner stochastic GPE *(WSGPE)*. It allows one to simulate single realizations of quantum droplets and their dynamics without the averaging. This opens the way to better understand the droplets' behaviour, obtain agreement with experiments, and to study droplet properties that were previously inaccessible. These are the aims of the project.

We will collaborate with the Barcelona experimental group and theoreticians from IFPAN and New Zealand.

The project requires a willingness to learn numerical skills – which we will gladly help you with!

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