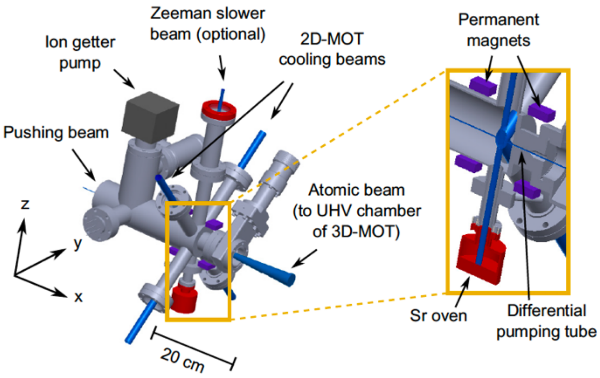
Laboratory: Physikalisches Institut, Heidelberg University.
Internship director: Chomaz, Lauriane.
e-mail: Lauriane.chomaz@gmail.com **Phone number:** +436764286462
Internship location: Heidelberg, Germany
Thesis possibility after internship: YES.
Funding : No funding for the internship. Funding for a PhD thesis available.

Title: A novel source concept for dipolar quantum gases, a dysprosium 2D MOT.

Ultracold quantum gases realize exquisite platforms to study few- and many-body phenomena in a well-controlled environment. In this respect, the range of applications of dipolar quantum gases, in which particles interact at long range and in an anisotropic manner, has been rapidly expanding. Using the most magnetic species of the periodic table, dysprosium (Dy), has led to experimental breakthroughs, in particular the demonstration of novel many-body states, including droplets, and supersolids.

The new Dy quantum gas lab at Heidelberg University will be started in February 2021 by Lauriane Chomaz in the context of her tenure-track professorship. This new-generation apparatus aims to produce dipolar quantum gases in a highly-controllable, versatile, yet simplified manner. Various projects at the Bachelor, Master, and PhD levels are available to take part in setting up this new experimental platform.

This master project consists in designing and building a new source for a slow beam of Dy atoms. The plan for this new source is to rely on a two-dimensional magneto-optical trap (2D MOT) instead of the conventional Zeeman Slower approach, used in current experiments. Developing this new scheme is key for both the compactness and the cutting-edge performances of the new apparatus as a whole. It will indeed allow a design where degenerate samples can be directly produced in a glass cell offering large optical access and nonmagnetic environment, without need of atomic transport. While such an approach have been developed for many other atomic species, including Sr and Yb, which have many similarities with Dy, a Dy 2D-MOT has not been designed yet.



Experimental setup of a 2D MOT of Sr atoms, taken from I. Nosske & al., Phys. Rev. A 96, 053415 (2017).

During this internship, the student will have to understand the working principles of cold atomic beam sources, perform numerical estimates and simulations of the cooling performance of a 2D-MOT source for Dy, potentially compare it to other kinds of sources, and make design choices accordingly. The student will also design mechanical and optical setups for the experimental implementation of this source, and may build prototypes e.g. 3D printing. First optical setups for the cooling light could also be implemented.

In the interesting case of the internship being followed by a PhD, the source will be built up, integrated within the full apparatus, and used to produce and investigate quantum gases of Dy.

Specialities more adapted to the subject:

Condensed Matter Physics: YES Soft Matter and Biological Physics: NO
Quantum Physics: YES Theoretical Physics: YES