Plenary Talk PV I Mon 8:30 Audimax

Imaging the quantum world in real space — •Tilman Pfau — 5. Physikalisches Institut and Center for Integrated Quantum Science and Technology, Universität Stuttgart, Pfaffenwaldring 57, 70550 Stuttgart, Germany

To observe matter waves optical microscopy is a standard tool. As long as the temperature is lower than the kinetic energy change caused by a single scattered photon the matter wavelength can be resolved in real space. In this ultracold regime in situ images allow for the observation of previously elusive new states of matter like the supersolid. Analyzing the fluctuations in hundreds of such images the structure factor can be mapped out, that reveals elementary excitations like sound or so called roton modes.

Optical techniques can also resolve single atoms via their fluorescence. This technique is used as readout for quantum computers or simulators. In optical quantum gas microscopes stunning pictures of e.g. antiferromagnetic order or the Pauli hole have been reported. An alternative microscope for ultracold single atoms is based on fast photoionization of atoms. An ion microscope combined with an ultracold atom setup recently allowed for the spatially resolved observation of a molecular ion bound by a previously unknown mechanism. Based on these images the bond length and the alignment of the molecule could be determined.

With the help of such ever improving imaging techniques we will continue to gain new insights into the two, few- and many-body quantum physics of synthetic materials.