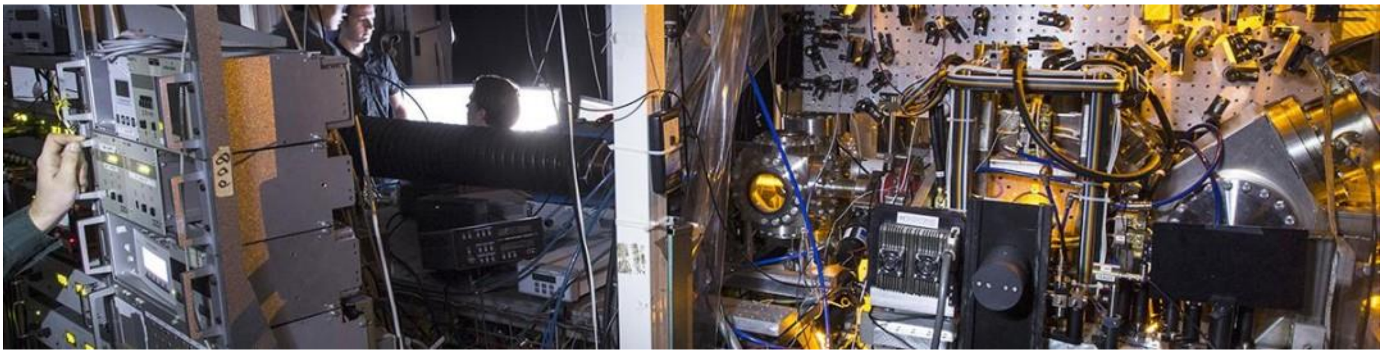
NANOPHOTONICS

The Nanophotonics group, which is part of the Debye Institute of Nanomaterials Research, studies the interaction of light and matter on the scale of a wavelength and below. We use light to probe and manipulate ultracold atoms, to image objects through scattering materials, to track and trap nanoparticles in complex flows, and to characterize and modify material surfaces. We aim to deepen our knowledge of these complex interactions to enable applications in the areas of sustainability and life sciences.



ULTRACOLD ATOMS AND PHOTONS

The interaction of laser light with atoms can be used to cool and trap atomic gases to nanokelvin temperatures, and then to excite and non-invasively study the trapped gas. In our laser cooling and trapping experiments we are able to study quantum phenomena such as Bose-Einstein condensation and reveal subtle oscillations of the condensed atoms.
Bose- Einstein condensation can also occur in the photon gas itself, and we Study light-matter and light-light interactions in such condensates.

NEW NONLINEAR PHOTONIC SYSTEMS

The non-linear response of atoms and semiconductor materials could be an important ingredient in energy-efficient optical communication and information processing systems. We study this highly complex nonlinear response in a variety of systems including photonic crystals and atomic vapors. While most nonlinear phenomena require high powered pulsed lasers, in finely tuned photonic crystal resonators we observe strongly nonlinear behaviour at microwatt laser powers.

CONTROLLING SCATTERED LIGHT

Random scattering of light by small particles is what gives paper its opaque white color, and what makes it difficult to see objects inside a glass of milk or inside biological tissue. In most cases such a scattering material makes imaging of objects impossible. We have pioneered methods to focus and image through scattering materials by adapting the phase of the incident laser light, allowing us to obtain a sharp image of hidden objects. Key to this work are correlations in the scattered light, which carry information even if it seems that scattering fully randomized the light field.

INTENSE LIGHT-MATTER INTERACTION

High energy laser pulses drastic changes in matter, temporarily turning insulators into conductors or vice versa. We use such pulses to temporarily or permanently change the properties of surfaces and of photonic crystals. In laser ablation the change is even permanent as part of the material evaporates in an industrially relevant process that has fascinating multiple time-scale dynamics, which we study using several modes of time-resolved imaging.

NANOPARTICLE TRACKING AND TRAPPING

Many chemical and biochemical reactions happen at the surface of nanoparticles or nanosized protein complexes. By tracking these objects using scattering and fluorescence we aim to learn more about their behaviour even as they are participating in reactions. This tracking and trapping technology may also find applications in medical diagnostics.

U-FAB

The Ornstein laboratory hosts a rapid-prototyping facility (3D- printer, laser cutter, blade plotter, CNC) where students and staff can build their own models and experiments. The mission of the "Fab Lab" is to build an open-collaboration platform. We hope to build a local community of all those creative and enthusiastic people who like to learn modern physics through experiments.

CONTACTS

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