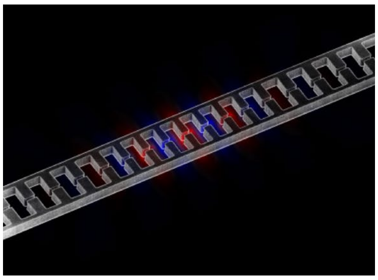
Photonic Forces group

PI: Ewold Verhagen (verhagen@amolf.nl, www.optomechanics.nl)

Research theme The *Photonic Forces* group studies light-matter interactions in nanophotonic systems, trying to push the boundaries of our abilities to measure and control both light and motion at the nanoscale. We are particularly interested in the interaction between photons and phonons in nano-optomechanical systems, where radiation pressure allows unusual quantum and classical behavior.

Project 1. Quantum control of mechanical motion through nanophotonic measurement

Supervisors: Giada la Gala, Jesse Slim, and Ewold Verhagen

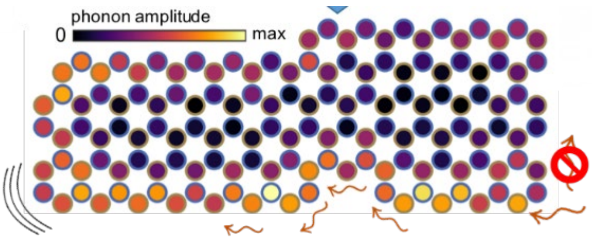


In this project, you will confine light in tiny optical cavities to both measure and control mechanical vibrations in the quantum regime. To this end, you will make special nano-optomechanical resonators that allow light to be used to sense mechanical displacements smaller than the diameter of a proton. Combining such measurement with radiation pressure forces, we will attempt to cool and control the mechanical resonator in the regime where quantum fluctuations dominate its motion. This project combines nano-engineering, advanced optical interferometry, and cryogenic measurements.

Project 2. Topological phonons in optomechanical chains

Supervisors: Javier del Pino and Ewold Verhagen

The concept of topology has revolutionized condensed matter physics, leading to exciting phenomena such as one-way electron transport and states that are protected from imperfections. In this theoretical project, you will explore topological physics for *phonons* in optomechanical arrays. We have recently shown that light fields can mediate the transfer of a mechanical vibration from one resonator to another through radiation pressure, and impose the same effect as a magnetic field has on electron transport. You will learn how this can be used to create topological states of sound in one- and two-dimensional resonator lattices. Then, you will look for the emergence of new topological states that do not have electronic counterparts, through the inclusion of naturally occurring nonlinearity in optomechanical systems.



Project 3. Nanoscale particle detection with optical antennas

Supervisors: Robin Buijs and Ewold Verhagen

The ability to detect and image objects with subwavelength dimensions is an important challenge for a wide variety of applications. Optical nano-antennas (metallic nanoparticles) scatter light very strongly, but can be coupled together to form chains that are dark almost everywhere, through so-called topological modes. In this project, you will investigate how such topological chains can be used to effectively detect a nanoscale object in their optical near field. To this end, you will position an ultrasharp needle with few-nanometer precision near the antennas, and study how this affects their optical scattering properties. This project combines nanofabrication, theoretical modeling, and optical nano-imaging.