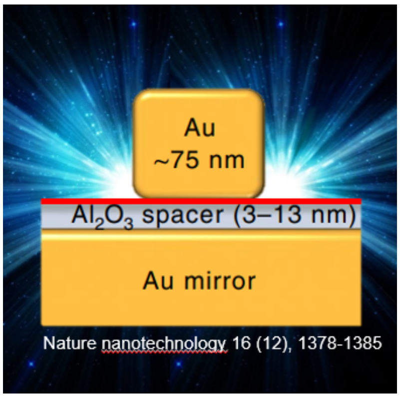
Resonant Nanophotonics group (AMOLF)

Group leader: Femius Koenderink, f.koenderink@amolf.nl. Websites at AMOLF and more about our work.

Research theme: The Resonant Nanophotonics team studies subwavelength resonators to control the emission, absorption, amplification and detection of light, on levels down to single photons and single molecules. We turn concepts from the field of plasmonic antennas and metasurfaces into nanolasers, LEDs, quantum light sources, and tools for spectroscopy and microscopy. Projects typically involve the realization of your new nanophotonic designs in the Amsterdam NanoLab cleanroom, optical microscopy, interferometry, ultrafast methods and time-resolved single-photon counting. Our group has 4

1. Extreme light interaction in an atomic-scale junction

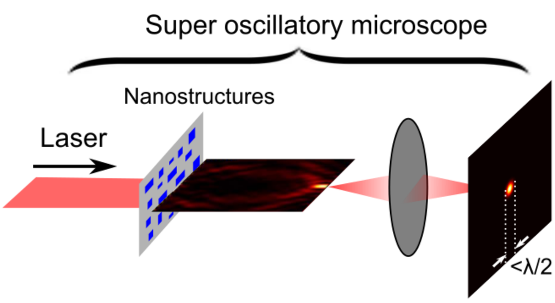
Daily supervisor: Falco Bijloo. With Jorik van de Groep at UvA.



You will create extreme nanophotonic confinement in the small gap gap between a metallic nano-antenna and a mirror, confining light to < 10^{-6} of a cubic wavelength. Here the optical field of a single photon is so strong, that you can do extreme light-interaction experiments on atomically thin layers of material (2D materials, semiconducting cousins of graphene) right in the gap. In this project, you explore nonlinear optical signal generated from flat atomically thin layers of material that convert red femtosecond pulses into blue light. Nonlinear generation is usually an extremely weak optical phenomenon. Can you measure the extreme magnitude of the field enhancement in the gap from the blue light? Can we make efficient nonlinear light sources that are ultimately small? The activities of the project are tunable to your preference, including nanofabrication, femtosecond pulsed laser technology and simulation.

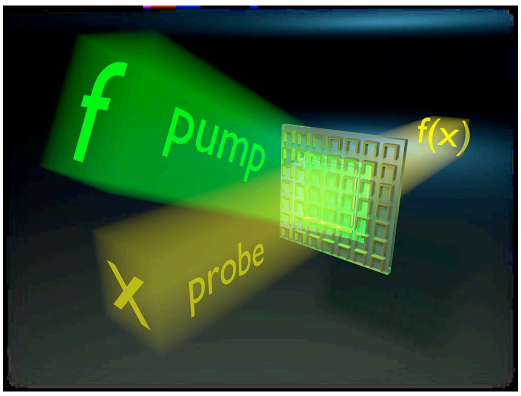
2 . A superoscillatory microscope

Daily supervisor: Nick Feldman, with Lyuba Amitonova (VU, ARCNL)



In this project you will build a microscope that beats the traditional diffraction limit, using metasurfaces to realize a clever trick from mathematics called “superoscillation”. The exotic superoscillation trick stems from Fourier series theory, and says that under *precisely engineered* circumstances, you can create a focus that locally has *sharper* features than the highest spatial frequency that your focusing optics can offer. You will design superoscillation generating metastructures, after which you will fabricate them in our cleanroom facilities and design and perform the experiment that measures these oscillations. Ultimately we want to understand the fundamental limits of this trick for microscopy and metrology: how far can you beat the diffraction limit, and how precisely can you measure ?

3. Switching the function of a metasurface within a picosecond



Daily supervisor: Nelson de Gaay Fortman, with Peter Schall (UvA)

The functionality of a passive metasurface, whether that be a lens, a polarization state converter, or an analog processor, is unchangeable after it leaves the cleanroom. Therefore, we want to go to ‘active metasurfaces’ where we will dynamically tune the metasurface response. We will work with a pump-probe setup to accomplish this. The pump excites active material within the metasurface and the probe (which arrives later in time) is amplified by optical gain mediated by the pump. We’ll start with a study of how the gain affects the band structure of the metasurface, since that gives a clear picture of its functionality. Then, we’ll continue with ways to push this tunability, for instance by using a spatially structured pump that only illuminates a sublattice of the full metasurface.