From Icky to Pretty

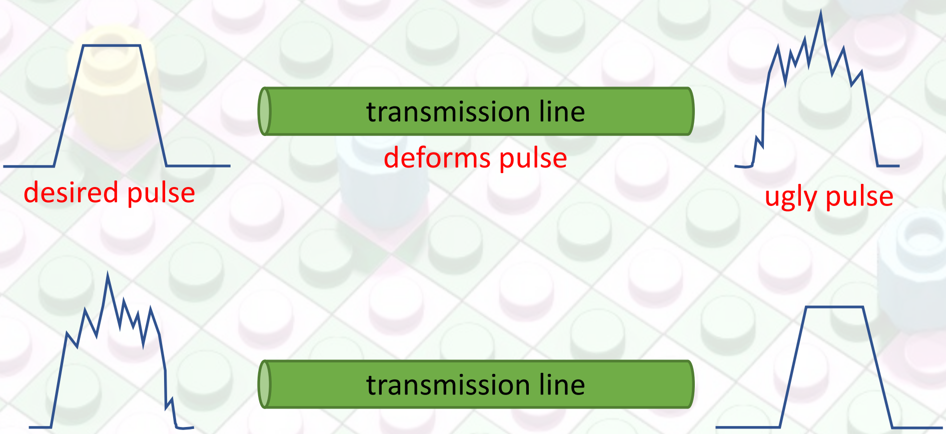
(pulse shaping for ultrafast scanning tunneling microscopy)

Master Project

The dynamics of spins on surfaces happens on very short timescales (picoseconds to nanoseconds), which can be measured by pump-probe spectroscopy using ultra-fast voltage pulses. One pulse excites, the other probes the system.

However, when sending pulses through cables, they get deformed, which limits our time-resolution.

The goal of this project is to measure the pulse-deformation and to use this information to pre-shape the ultrafast voltage pulses such that they arrive with sharp edges at the experiment, taking the deformation of the transmission into consideration.



Want to learn more? Contact fabian.natterer@uzh.ch

Lucky Spectroscopy

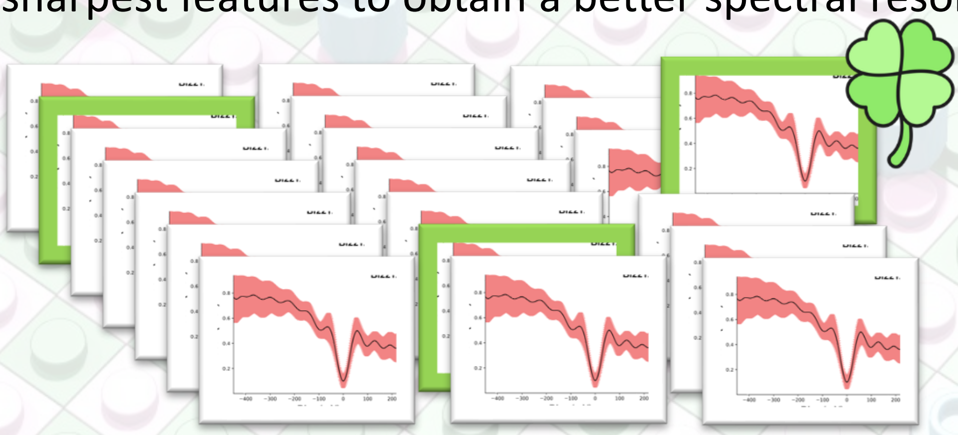
(taking chances for better spectral resolution)

Bachelor/Master Project

When gazing at the night sky through a telescope and admiring the many stars, one notices their twinkling due to atmospheric distortions. Averaging for longer time blurs these fluctuations but also reduces the resolution of the image.

However, in some rare moments, the atmosphere is just right, and a sharp image may be measured. By taking many images and selecting the few lucky shots, one can produce extremely sharp images that rival the resolution of space telescopes.

Here we intend to apply this concept to tunneling spectroscopy in a scanning tunneling microscope whose resolution is limited by temperature and instabilities of the tunneling junction. We would record a massive number of spectra and combine the few with the sharpest features to obtain a better spectral resolution.



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Correcting Creepy Moves

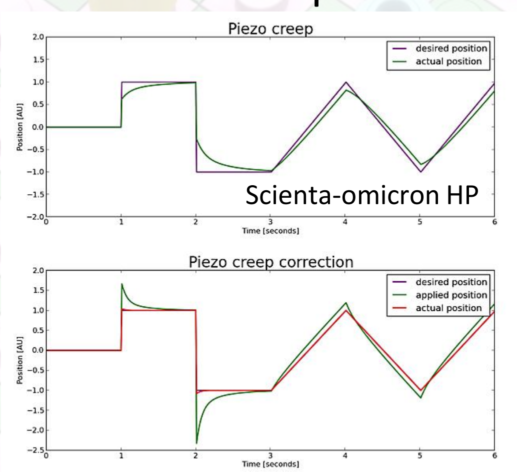
(characterizing and compensating for nonlinearities in a piezo scanner)

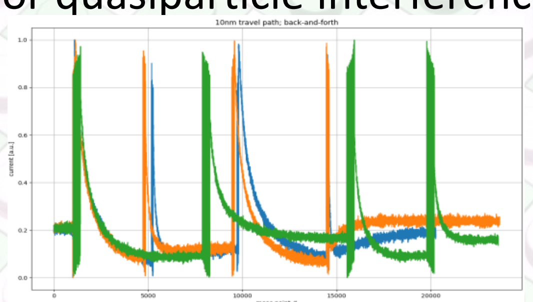
Bachelor Project

A piezo-tube is a ceramic component that allows arbitrarily fine adjustment of its length by the application of a voltage. This is very useful for positioning devices, which is why it is at the heart of a scanning tunneling microscope, enabling atomic resolution and manipulation capabilities at microscopic length scales.

Unfortunately, piezo scanners exhibit nonlinearities when the voltage is changed, which makes it difficult to accurately position or know the location of the tip.

This project aims at characterizing the creep and hysteretic behavior of a low-temperature scanning tunneling microscope to either remove the nonlinear effect during measurement or to correct the coordinates a posteriori for quasiparticle interference imaging.





Courtesy Kevin Hauser

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“What’s your time, wavelength?”

(building a time-of-flight spectrometer)

Master Project

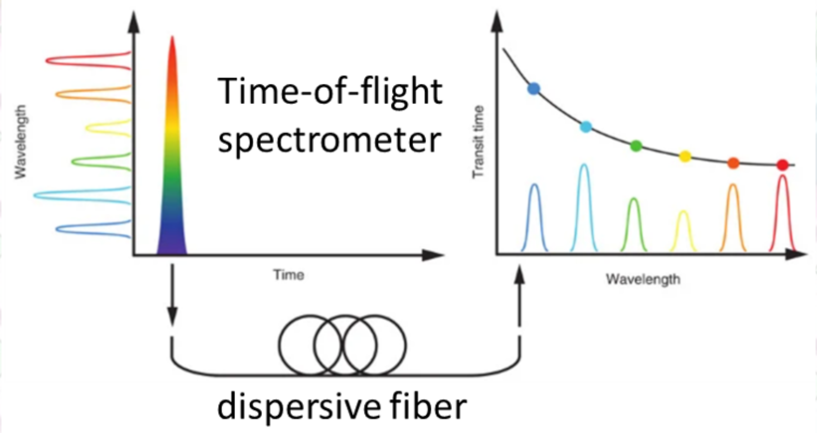
The wavelength and intensity at which photons are received carries a wealth of information about the physical processes that lead to their emission.

In condensed matter systems, photons excited via electro luminescence in a scanning tunneling microscope reveal unique insight into a molecule or 2D material’s properties.

The separation of the photon’s wavelength is conventionally achieved with the dispersion from a grating and a cooled CCD sensor array.

Albeit providing high resolution, grating spectrometers are very expensive and not that flexible in dynamical systems that require fast excitation.

This project aims at building a spectrometer using the wavelength dependent refractive index of an optical fiber that transforms arrival time into wavelength information.



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