Quasicrystal is a solid form of matter that is neither amorphous nor crystallized. It possesses long-range order but lack periodicity and exhibit rotational symmetry forbidden by crystallography rules. Because of their unique properties, there are ideal test-subjects for fundamental questions in the field of surface science. Questions such as: do quasicrystal surfaces share bulk physical properties? Not long after their discovery, AFM was invented. Although being both active fields of research since then, AFM atomic resolution images of quasicrystal surfaces are almost non-existent in the literature.

Since the 1980s, several innovations have been published to further improve AFM: non-contact AFM by frequency modulation (1991), atomic resolution (1995), chemical contrast (2007). The latter was famously implemented by Sugimoto and Al [1]. In their study, they have implemented lateral drift compensation control to allow averaging of the force curve on a designated site for as much as a hundred times to improve signal to noise ratio of the curves. This method provides true atomic resolution images but requires averaging and signal processing and is therefore not suitable for fast scanning. We present a new imaging technique that allows simultaneous acquisition of both the topography and chemical contrast with atomic resolution and on-the-flight intrinsic chemical contrast. Our scanning scheme detects local minimum frequency shift $\Delta f_{\text{bottom}}(x,y)$ at the bottom of the frequency shift curves and the corresponding tip-sample distance $z_{\text{bottom}}(x,y)$. We will show that those two orthogonal parameters could be considered as chemical fingerprints. For instance, from the simplified Lenard-Jones potential [2], we derive the normalised frequency shift:

$$\frac{\Omega_0(a+z)}{8 \pi^2 (2a+z)^5 L^4} \sqrt{\frac{1}{(a+z)^2} \left[ 8z^8 - 32z^5(L^4 - 2z^4) + 8z^3(-7L^4 + 32z^4) + a^2(128z^4 - 21L^4) + a^2 \left( 192z^6 - 60L^4z^2 \right) - 8z^4L^6 \right]}$$

(a,k) are the amplitude and the spring constant of the cantilever. ($\Omega_0$, L) are parameters defining the simplified Lenard-Jones potential [2]; z is the tip-sample distance. We will show similar formulae for other potentials such as the Buckingham potential.

The most famous benchmark sample for atomic resolution for AFM images is silicon the 7x7 reconstruction. Here we also propose to use quasicrystal structures to benchmark SPM images quality. Due to their non-periodicity multi-atomic quasicrystal structures cannot be subject to heavy FFT-based filtering. We will show images of Al-Pd-Mn to illustrate this idea.