Drive amplitude modulation atomic force microscopy: from vacuum to liquids.

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Amplitude modulation atomic force microscopy (AM-FM), also known as tapping [1], is the most extended technique since it is used as the standard mode for AFM imaging in air ambient conditions. AM-AFM has a well known limitation, the long settling times imposed by the high quality factors Q result in slow scanning rates making it impractical for vacuum operation. Frequency modulation (FM-AFM) [2] is the classical alternative to AM allowing atomic resolution in vacuum with high scanning rates. FM-AFM has recently extended to operate in other media with lower *Q* with remarkable success. However, FM-AFM has a well-known drawback: the transition between non-contact and contact causes an instability in the feedback control, which is particularly important for inhomogeneous surfaces where, for instance, the adhesion changes abruptly.

In this talk **we introduce drive amplitude modulation** atomic force microscopy (**DAM-AFM**) [3] as a dynamic mode with outstanding performance in all environments from vacuum to liquids. As with frequency modulation, the new mode follows a feedback scheme with two nested loops: the first keeps the cantilever oscillation amplitude constant by regulating the driving force, and the second uses the driving force as the feedback variable for topography. Additionally, a phase-locked loop can be used as a parallel feedback allowing separation of the conservative and non conservative interactions. FM and DAM can be seen as complementary modes. In FM the topography image is a map of conservative interactions in addition a dissipation map is obtained as a spectroscopic image. In DAM the topography image is a map of non-conservative interactions and the spectroscopic image is a map of conservative ineractions.

The feedback architecture implemented for DM-AFM ensures stable transition between the non-contact and contact regime. Moreover, **DM has a similar settling time to FM and consequently the scanning time in vacuum is also very similar**. We will describe the basis of this mode and present some examples of its performance in the three different environments.

References

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[3] Miriam Jaafar, David Martínez-Martín, Mariano Cuenca, John Melcher, Arvind Raman and Julio Gómez-Herrero. Submitted to BJ- nano