Unravelling Heterodyne Force Microscopy

Verbiest, G.J.

Propositions

belonging to the thesis

Unravelling Heterodyne Force Microscopy

1. The contrast mechanism in Heterodyne Force Microscope experiments on buried metal nanoparticles embedded in a soft polymer matrix is different from that in metal samples with voids inside *(Chapter 6)*.
2. Whenever a heterodyne technique is applied to extract a measurable signal, the phenomenon of beating should be included in the analysis if the nonlinearity of the element that mixes the high frequency signals is of higher order than quadratic *(Chapter 5)*.
3. Rayleigh scattering of the ultrasonic wave that propagates through the sample cannot be responsible for the phase and amplitude contrast in current Heterodyne Force Microscope experiments *(Chapters 2 and 6)*.
4. If the cantilever in an Atomic Force Microscope is ultrasonically excited at a frequency that does not coincide with a resonance frequency of the cantilever, the resulting vibration amplitude remains almost constant with increasing contact force. This counterintuitive result even holds for a hard Silicon tip indenting into a hard sample like a Silicon wafer *(Chapters 3 and 4)*.
5. Although one needs multiple modes to describe the cantilever dynamics in Heterodyne Force Microscopy, one can interpret and understand most results using a single mode *(Chapters 3 and 6)*.
6. The low-frequency signal in heterodyne measurements is generated through a nonlinear element. Nonlinear equations and problems are usually difficult (and often impossible) to solve exactly, which makes it dangerous to interpret the results of heterodyne measurements without a detailed numerical study.
7. The "best" car tires in the world contain nanotechnology for improved wet traction, rolling resistance, and abrasion resistance *(ObservatoryNANO, Transport, Briefing 23)*. Friction at shaking nanoparticles is responsible for part of this improved performance.
8. The application of multifrequency schemes in Atomic Force Microscopy does not only improve sensitivity, but also gives access to otherwise unobtainable information.
9. The quantification of measurements obtained with a microscope that does not rely on an explicit, unique physical contrast mechanism requires detailed (numerical) calculations and/or complementary experiments; this dimishes the attractiveness of such a microscope.
10. The development of fast scanning probe microscopes is mostly limited by the electronics and by the non-ideal behavior of the mechanical elements at high imaging frequencies.
11. Speculations and (false) assumptions must be treated with care, as they have the habit to blur the truth. Separating *false* from *true* is an extremely difficult art, which only few people have mastered.
12. Theism or atheism can be a guide in life, but should never become a way of living.
13. After birth, life has only one certainty: death. Everything before death is uncertain and, moreover, is determined by the choices one makes. Unfortunately, these choices are often enforced by others.
14. Being a physicist and working in science is like being a professional sportsman.