Ultrasensitive nanoelectromechanical mass detection.

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Recommended and a Commentary by Albert Migliori, Los Alamos National Laboratory.

In this paper, highlighted in "The Economist", Ekinci et al. demonstrate unprecedented sensitivity in a mass-determination experiment. What is measured is the resonance shift in a SiC beam clamped at both ends while Au is evaporated onto it in ultra high vacuum. The frequencies are about 30MHz, and quality factors of several thousand are reached.The basic principles, once again, involve mechanical vibrations in nano structures, which seem to be emerging as a tool more sensitive than direct electrical measurements. I conjecture that this is possibly because noise sources in such a system are correlated more exactly with intrinsic thermal noise, and more resistant to spurious noise effects such as 1/f and shot noise. The reason may be that this resonator is a phonon-based (boson) system and operates with many more quanta n than one where electrons are the measured quantity, enabling a closer approximation to true thermal noise because (n)-1/2 is the smallest possible number for any measurement quantum I can think of.

I note that Ekinci did not discuss the elastic response of his atoms to the beam. It can be expected that the resonator shift is not determined solely by mass loading, but also by the force constants that stick the atoms to the resonator. These force constants depend on the attraction between Au and SiC. There then remains the possibility, in a sub-monolayer deposition, that these force constants might also be measurable by precoating many monolayers of a one material and then adding a sub-monolayer of another material. Differences in frequency shift between different coatings per unit mass loading could measure directly the relative strengths of these forces.

I also note that the fed-back system used in which frequency shifts are generated by using a phase locked loop to keep the system on resonance during deposition are prone to excess phase noise, as the authors hint. Use of a swept-sine system to map out the resonance would greatly reduce phase noise and increase the ultimate sensitivity. I await the next development.