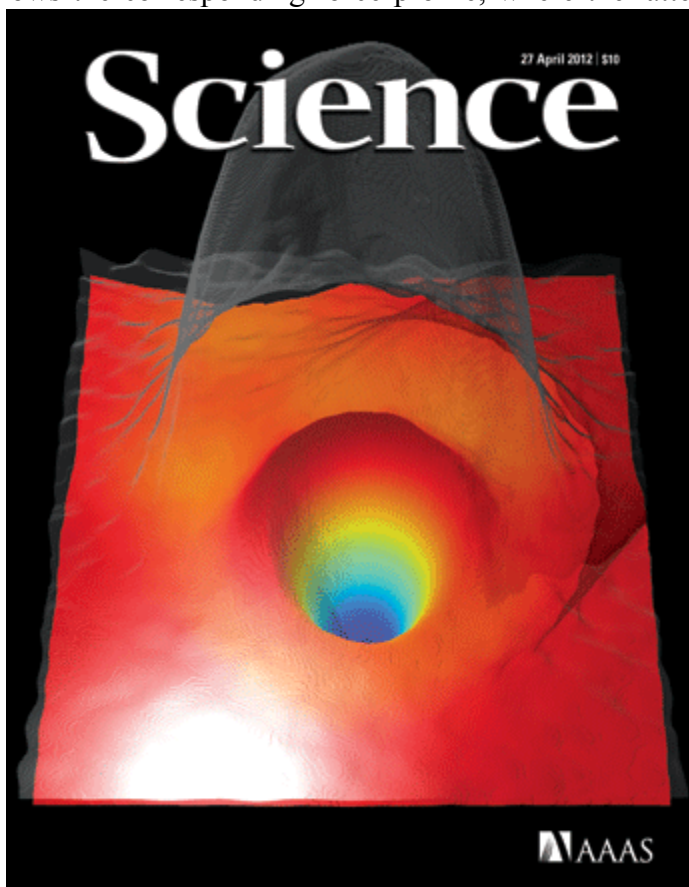


## Combined AFM and STM – a view on two distinct aspects of the atomic structure of matter

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Frequency-modulation AFM can be combined with scanning tunneling microscopy, yielding a simultaneous data set for current and average force gradient. Ternes et al. [1] have shown that for some metallic contacts, force and current are proportional. The cover of the April 27 2012 issue of *Science* [2] shows an example, where combined AFM/STM reveals two strongly distinct aspects of the atomic structure of matter. The gray veil depicts the inverted tunneling current between a CO molecule adsorbed on Cu(111) and a W tip, while the colored surface shows the corresponding force profile, where the latter is spatially much more confined [3].



While the simultaneous acquisition of current and force can reveal new information about the atomic and electronic structure of matter, two complications can arise. The first one is the phantom force [4,5], a modification of the electrostatic attraction between tip and sample, where the tunneling current leads to an alteration of the effective potential difference between tip and sample. The second complication arises when the finite bandwidth and slew rate of the current-to-voltage converter can not be neglected. This leads to a time-dependent variation of the potential from virtual ground of the electrode that collects the tunneling current.

The talk discusses the merits of combined STM/AFM as well as the pitfalls outlined in the two complications.

- [1] M. Ternes et al., *Phys. Rev. Lett.* **106**, 016802 (2011).
- [2] Created by Joachim Welker (2012).
- [3] J. Welker, F. J. Giessibl, *Science* **326**, 444 (2012).
- [4] A.J. Weymouth et al. *Phys. Rev. Lett.* **106**, 226801 (2011).
- [5] T. Wutscher et al. *Phys. Rev. B*, in press (2012).