The Phantom force

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The Phantom force is a phenomenon that we took note of when performing simultaneous current and force microscopy (STM and AFM) on a system with limited conductance. Our first observations were on the Si(111)-7x7 surface. While unsaturated Si atoms should appear attractive, when we applied a bias, and thus also a tunnelling current, the adatoms appeared relatively repulsive [1]. We were able to explain our observations with a model incorporating an ohmic voltage drop near the tip-sample junction [1, 2]. This model described the effect of the current on the electrostatic attractive force between tip and sample: With higher current, more of the applied bias dropped outside the tip-sample junction, decreasing the attractive electrostatic force. It has proven to be quite robust at explaining our observations, even explaining inversion of parabolae when performing Kelvin Probe Microscopy [3]. Ohm's law can explain the high resistance required for this effect, howeve r it is unintuitive that this model should be successful when describing transport on the atomic scale. It does seem likely, however, that this Phantom force can be used to measure conductance on the atomic scale.

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