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Quantum dots, dopants, defects - measuring properties using atomic force microscopy

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Understanding and pushing ultimate limits is one of the joys of Physics. Atomic Force Microscopy (AFM) is a well-established technique that can image individual atoms and thus determine the atomic structure of even insulating surfaces and molecules in almost any environment. To gain fundamental insight into 'how stuff works'and to apply these insights to purposeful engineering one needs to go beyond structure and measure properties.

I will introduce how the measurement of electrostatic forces allows properties to be measured and will illustrate the resulting capabilities with a few examples. Specifically, I will discuss the measurement of single electron charging energies of quantum dots, individual dopants in silicon, atomic defects at the SiOx-Si interface and the observation of random telegraph noise of a single trap. When AFM is combined with a fast pulsed laser, we demonstrated a temporal resolution of 100fs (limited only by the laser pulse length) by measuring the light induced non-linear polarization in the sample. This opens the exciting possibility of correlating the atomic scale structural and electronic properties down to a single defect in many materials on a 10fs time scale.

Keyword-1

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Keyword-2

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Keyword-3

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