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Progress in studying matter on the atomic scale

The scanning tunneling microscope (STM), invented in 1981 by Binnig and Rohrer, has provided direct access to the world of atoms. STM relies on vacuum tunneling with an exponential increase of a tunneling current between two biased conductive electrodes at a factor of ten per Å. If a tip has one atom that sticks out one Å more than all the others, this front atom carries ten times more current than the other atoms. The monotonic decrease of current with distance facilitates distance feedback and allows to scan the tip across a sample with atomic precision. In 1986, Binnig, Gerber and Quate introduced atomic force microscopy (AFM), a method that also images insulators by relying on forces. Unlike the current, the force between tip and sample is non-monotonic and includes long- and short range components. AFM has been inferior in resolution to STM for a long time. Today, it exceeds STM in spatial resolution. That progress was enabled by advances in measuring small forces and by the isolation of chemical bonding forces from strong background forces.

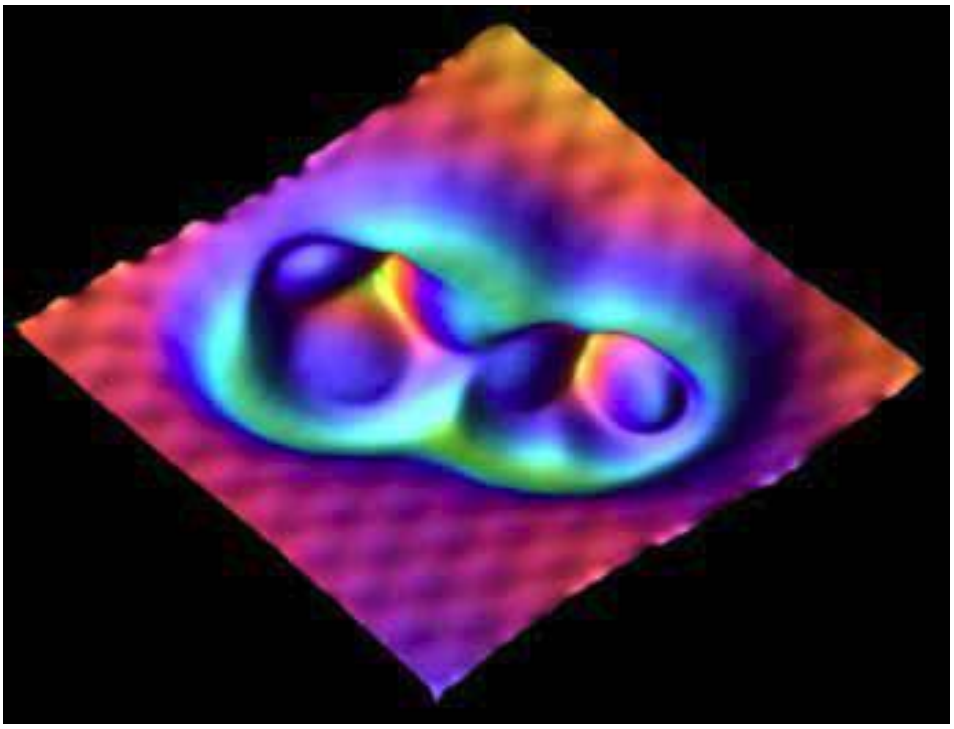

Figure: AFM image of an Fe_3 and Fe_2 cluster on a Cu(111) surface.