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Three-dimensional atomic force microscopy: interaction force vector by direct observation of tip trajectory[1] GAVIN KING[2], KRISHNA SIGDEL, JUSTIN GRAYER, University of Missouri, DEPT. OF PHYSICS, JOINT WITH BIOCHEMISTRY TEAM — The prospect of a robust three dimensional atomic force microscope (AFM) holds significant promise in nanoscience. Yet, in conventional AFM, the tip-sample interaction force vector is not directly accessible. We scatter a focused laser directly off an AFM tip apex to rapidly and precisely measure the tapping tip trajectory in three dimensional space. This data also yields three dimensional cantilever spring constants, effective masses, and hence, the tip-sample interaction force components. Significant lateral forces representing 49% and 13% of the normal force were observed in common tapping mode conditions as a silicon tip intermittently contacted a glass substrate in aqueous solution; as a consequence, the direction of the force vector tilted considerably more than expected. When addressing the surface of a lipid bilayer, the behavior of the force components differed significantly from that observed on glass. This is attributed to the lateral mobility of the lipid membrane coupled with its elastic properties. Direct access to interaction components F_{x}, F_{y}, and F_{z} provides a more complete view of tip dynamics that underlie force microscope operation and can form the foundation of a three-dimensional AFM in a plurality of conditions.

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[2]Department of Physics, Joint with Biochemistry

Gavin King
University of Missouri

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