Abstract Submitted
for the MAR09 Meeting of
The American Physical Society

Direct measurement of the non-conservative force field generated by optical tweezers PINYU WU, RONGXIN HUANG, University of Texas - Austin, Austin, TX USA, CHRISTIAN TISCHER, ALEXANDR JONAS, ERNST-LUDWIG FLORIN, University of Texas - Austin, Austin, TX USA — Optical tweezers have been widely used in soft condensed matter physics and biophysics to measure forces in molecular processes on the single molecule level. The usual assumption is that the force applied to a particle confined with the tweezers is directly proportional to the displacement of the particle from the trapping center, which would imply that the force field of the tweezers is conservative. However, the Gaussian beam model indicates that this force field is actually non-conservative, yet no experiments have measured this effect. We developed a new experimental method that can directly measure the force field with femtonewton precision without assuming its conservative character. We successfully obtained the 3-D force field for an optically trapped Rayleigh particle with 10 nm resolution by analyzing its Brownian motion. We found a non-conservative contribution that increases as the trapped particle moves away from the optical axis. In the light of this finding, optical trapping experiments that assumed a conservative force field may need careful reevaluation.

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Date submitted: 21 Nov 2008 Electronic form version 1.4