Sub-attonewton force detection in three dimensions with a single atom sensor

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— Ultra-sensitive force measurements are a crucial tool for investigating fundamental physical limits. Here we demonstrate a sub-attonewton force sensor based on a single trapped ion that can resolve all three dimensions components of an applied force through super-resolution imaging. The force is detected by measuring the ion displacement with nanometer precision with a sensitivity of 372 +/- 9 zN/√Hz in one direction, and (335, 359) +/- 14 zN/√Hz and (779, 836) +/- 42 zN/√Hz for the other two axes. After characterizing our system in all three dimensions, we demonstrated its accuracy by measuring a light pressure force on the ion of 95 zN.

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