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The Asymmetric Rotating Saddle Potential as a Mechanical Analog to the RF Paul Trap AIDAN CAREY, Harvard University — Under the right set of conditions, a rotating saddle potential can be used to confine the movement of a particle moving on its surface. A time varying hyperbolic potential of this type is generally considered the go-to mechanical analog to the RF Paul trap. The work done so far has concentrated on symmetric saddles, which are characterized by equal curvatures along the trapping and anti-trapping directions. However, the vast majority of applications using the RF Paul trap, ranging from atomic clocks to quantum computing and simulations, require an asymmetry in the saddle-like electric potential. This asymmetry (or break in the degeneracy) is required for laser cooling and various quantum manipulations. Therefore, an asymmetric rotating saddle may be a more appropriate mechanical analog to the RF Paul trap. In this paper, we investigate the motion of trapped particles in asymmetric saddles. We find that the motion is highly sensitive to the degree of asymmetry in the saddle potential. Notably, we find that asymmetry in curvature between the trapping and anti-trapping directions arising from manufacturing defects can lead to significant changes in the particleâ^{TM}s trajectory. We explore the impact of asymmetry on precession and discuss similarities and differences in the stability of motion for the rotating saddle and RF Paul trap. Lifetime measurements in rotating saddles with varying degree of symmetry are used to trace out key aspects of the a-q stability diagram, which include counterintuitive demonstrations of stability for saddles with negative symmetry.

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