“Demonstrations of the Falling Cat Problem Can Fail, So can Experiments on Driving Stability: Non-Holonomic Stability and Rotation with Zero Angular Momentum”
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Biography:

Andy Ruina is a professor of Mechanical Engineering at Cornell. He studied friction. Now he’s mainly interested in biomechanics, dynamics and robotics. This includes collisions, bicycles, human walking and walking robots. His lab’s robot Ranger walked 65 km on a single battery charge. Google Andy Ruina.

Note from Andy: This is not a research talk, nor does it match papers or discoveries. Just curious/puzzling things.

Abstract:

There are two classes of interesting, at least to me, physical behavior that follow from the impossibility of integrating some formulas that involve derivatives. I learned of both of them from Tom Kane. First, systems with wheels or ice skates can conserve energy yet still act damped. This occurs despite the supposed theorem that conservative systems cannot have such stability. In fact (energy conserving) cars, flying arrows, skateboards and bicycles can have this stability. Second is the well-known possibility that a system with zero angular momentum can, by appropriate deformations, rotate without any external torque. This is the falling cat problem: a cat dropped upside down can turn over. Both rolling contact and constancy of angular momentum are examples of the "non-integrability" of a "non-holonomic" equation. There are various simple demonstrations of these phenomena that can go bad. Cars can crash, bikes can fall over. And, in terrestrial angular-momentum experiments, various sometimes-subtle effects can swamp that which one wants to demonstrate. The talk describes the basic theory and also various simple experiments that fail various ways for various reasons. With luck the talk will be somewhat accessible to perky undergraduates, and somewhat amusing to pros.