MAR14-2013-020646

Abstract for an Invited Paper
for the MAR14 Meeting of
the American Physical Society

The mechanics of trick roping[1]

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Trick roping evolved from humble origins as a cattle-catching tool into a sport that delights audiences the world over with its complex patterns or "tricks," such as the Merry-Go-Round , the Wedding-Ring, the Spoke-Jumping, the Texas Skip... Its implement is the lasso, a length of rope with a small loop ("honda") at one end through which the other end is passed to form a large loop. Here, we study the physics of the simplest rope trick, the Flat Loop, in which the motion of the lasso is forced by a uniform circular motion of the cowboy's/cowgirl's hand in a horizontal plane. To avoid accumulating twist in the rope, the cowboy/cowgirl rolls it between his/her thumb and forefinger while spinning it. The configuration of the rope is stationary in a reference frame that rotates with the hand. Exploiting this fact we derive a dynamical "string" model in which line tension is balanced by the centrifugal force and the rope's weight. Using a numerical continuation method, we calculate the steady shapes of a lasso with a fixed honda, examine their stability, and determine a bifurcation diagram exhibiting coat-hanger shapes and whirling modes in addition to flat loops. We then extend the model to a honda with finite sliding friction by using matched asymptotic expansions to determine the structure of the boundary layer where bending forces are significant, thereby obtaining a macroscopic criterion for frictional sliding of the honda. We compare our theoretical results with high-speed videos of a professional trick roper and experiments performed using a laboratory "robo-cowboy." Finally, we conclude with a practical guidance on how to spin a lasso in the air based on the results of our analysis.

[1]With the support of Univ. Paris Sud (Lab. FAST/CNRS) and UPMC (d'Alembert/CNRS).