Jump rope aerodynamics

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Jump ropes are used by kids for fun and by athletes for training. But what about the underlying physics? How do jump ropes work? Can important engineering principles be studied?

Jeff Aristoff and Howard Stone of Princeton University have built themselves a robotic jump rope device that controls all the rope parameters -- rope rotation rate, rope density, diameter, length, and the distance between "hands." They capture the motion of the ropes by high-speed cameras, one to the side and one at the end. Then they compare the observed behavior with predictions made by their equations -- work they are presenting today at the American Physical Society Division of Fluid Dynamics (DFD) meeting in Long Beach, CA.

"Our main discovery is how the air-induced drag affects the shape of the rope and the work necessary to rotate it," says Princeton researcher Jeff Aristoff. "Aerodynamic forces cause the rope to bend in such a way that the total drag is reduced." (Leaves do this too when they bend out of the wind.) This deflection or twisting is most important in the middle of the rope and the least at the ends. If the rope is too light it might not clear the body of the jumper.

"Implications for successful skipping will be discussed, and a demonstration is possible," said Aristoff about his presentation at the meeting. "Fluid dynamic effects on long flexible filaments occur in both engineered structures and many natural systems, so insights from the jump rope will hopefully inform other common situations," he added.

More information: The presentation, "The aerodynamics of jumping rope" is on Sunday, November 21, 2010. Abstract: meetings.aps.org/Meeting/DFD10/Event/132630

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