



Writing about Research: *Physics Today's* Publishing Process

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Physics Today



- Published by AIP
- Written for the physics community
- Many editors have PhDs
- Magazine and online

The Writing Process



- 1. Research**
- 2. Writing**
- 3. Editing**



Research: Finding a Story

- **Where do we look?**
- **How do we identify possible stories?**
- **How do we pick one to write about?**

Energy loss and jerk on the loop-the-loop

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In its usual form, the loop-the-loop (LtL) problem involves a uniform solid sphere rolling from rest down a linear ramp that transitions into a circular loop. The task is to find the minimum height from which the ball must be released in order to roll completely around the loop without breaking contact. The answer, found using the conservation of mechanical energy and Newton's second law, is invariably less than the actual measured height. The difference, attributed to non-conservative forces, is consistently larger than the experimental uncertainty. To get a more detailed understanding of the effects of dissipative forces on the loop-the-loop, we made high speed video recordings of balls moving on the commercial LtL apparatus and used video analysis to study their motion in detail. We present our results along with a simple model to predict the motion of the ball on an LtL track taking energy losses into account. Calculations based on the model are in excellent agreement with our measurements. © 2021 Published under an exclusive license by American Association of Physics Teachers.

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Research: Gathering Info

- Academic paper
- Paper notes
- Interview quotes
- Other resources



Energy loss and jerk on the loop-the-loop

14 pages

by, Appalachian State University, Boone, NC 28608

125 February 2012

(LIL) problem into a circle in order to derive the formula for the loop. The ball loses at least 50% from drop height to top of loop

Karl: "The ball loses at least 50% from drop height to top of loop"

Karl: "We got to thinking how can we understand this energy loss we assumed that it was going to be a fairly continuous loss over the whole track, but when we made some high-speed video of the motion, we found out very quickly that a very large fraction of the loss occurs at a very specific point, and that point is where the linear portion of the track joins the circular portion. And that seemed very surprising at first, and we wondered why, and it occurred to me that at that point there is an enormous change in the acceleration of the ball."

Karl: "On the linear portion of the track, its acceleration, the acceleration of the ball is just what you would expect for a ball on an incline, but then when the ball encounters the circle, there's all of the sudden a centripetal force involved. And it turns out that the normal force on the ball increases by almost a factor of 10 at that point, and the change is almost instantaneous. So that dramatic change in the normal force, we thought, would somehow change the energy of the ball. So we set enough, we concluded that what happens is that the large increase in the normal force, it's provided by the track, and the reaction to that force causes the ball to deform somewhat. And that deformation comes at the expense of the energy of the ball, and so then we were able to account for the dramatic drop in the ball's energy as it entered the loop itself."

Karl: "They digitized the data from the high-speed video, got displacement versus time curves and velocity vs time curves for the motion and also total energy vs time and then they looked to determine a model that would agree with measured data. And they came up with it and the agreement is quite good."

Toby: "What's shocking to me is that I've been teaching for over 30 years and so has Karl and the hundreds and hundreds of other physics professors and we all use that equipment. And so the equipment came from being around the...mid 1800s, so here we have over a hundred and thirty years, students had been using this and teachers had been saying that the predicted value is this and then look here it is that goes and but for all that period of time there was a terrible correlation between the theory and the experiment. And evidently all of us over the years just didn't even bother to notice...it's rather embarrassing."

Paper Notes:

- The researchers examine the loop apparatus that's widely used in intro physics demonstrations and find previously unidentified sources of energy loss—which likely explains why the ball often doesn't behave the way simple mechanics says it should.
- Mechanical energy loss as a ball does a loop (roller coaster track)
 - Loses some as it rolls down the track (rolls and slips)
 - This is from the start of the loop (rolls and slips)
 - Loses some from the start of the loop to the bottom of the loop
 - Loses some on the loop, but not that much (rolls without slipping)
 - Loses some from a acceleration aka jerk
 - Loses some on the loop, but not that much (rolls without slipping)
- They look at a track made of bent aluminum right angle stock
 - They found what the acceleration should be if there's no slipping, it's more than that, therefore we must conclude the ball is slipping. Aka the frictional force is not strong enough for pure rolling
 - They find the coefficient of friction and it is in agreement with observed. This CoF predicts an acceleration consistent with their observations
- Point T (end of incoming slide) to first bottom of loop:
 - A simple way to model this loss is in terms of a non-conservative force F_{nc} that is due to the complex interaction between the ball and track following the abrupt force increase at the tangent point. The reduction in the total mechanical energy of the ball in that short region is reduced due to the work done by F_{nc} .
 - Transitions from rolling with slipping to rolling without slipping -> very complex
- Top of the loop:
 - We can approximate the loop as rolling without slipping
 - We can use this to relate radius of the loop with initial height of the ramp
 - Then find that without non-conservative forces (aka friction), the height would be .58 m
 - But the initial height is actually .9 m
 - Therefore, non-conservative forces play a huge role (aka a LOT of energy is dissipated on the track)
- Filmed it with an phone se lol
 - Transitions from rolling with slipping to rolling without slipping -> very complex
 - They assume a linear transfer between the two forces/motors
 - Anything else is beyond the scope of this paper

5



Writing: Words on the Page

- **Outlining**
- **The story's angle**
- **Introduction**
- **Transitions**
- **Conclusion**

Jerk causes energy loss on the loop-the-loop

Researchers used high speed video analysis to characterize the iconic physics demonstration's motion.

According to Toby Dittrich of Portland Community College, loop-the-loops have been used for physics demonstrations since the mid 1800s. But these apparatuses need a larger starting height than predicted to ensure the ball completes the loop. Somewhere, the ball loses energy. The energy loss is usually dismissed as "non-conservative forces," says Karl Mamola of Appalachian State University.

But this hand waved explanation wasn't good enough for Dittrich and Mamola, both of whom have taught physics for over 30 years. In a recently published paper, the pair used high speed video analysis to reveal finer details of the physics of a loop-the-loop and create a model describing the motion.

The forces that govern the loop-the-loop are, in theory, fairly straightforward. Gravity points down, the normal force points out of the surface, and friction opposes the motion. Combined, however, they form a complicated system with many possible sources of energy loss.



Editing: It's Brutal

- Does it make sense?
- Does it sound good?

Jerk causes energy loss on the loop-the-loop

Researchers used high-speed video analysis to characterize a ball's motion in the iconic physics demonstration's motion.

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But that is hand waved explanation wasn't good enough for Dittrich and Mamola, both of whom have taught physics for over more than 30 years. In a recently published paper, the pair used high-speed video analysis to reveal finer details of the physics of a loop-the-loop and create a model describing the motion.

The forces that govern the loop-the-loop are, in theory, fairly straightforward. Gravity points pulls down, the normal force points pushes up from out of the track surface, and friction opposes the motion. Combined, however, they form a complicated system with many possible sources of energy loss.

At first, Dittrich focused on only on geometric considerations. The researchers' track was made

Editing: Repeat

- Editors
- Researchers
- Copy editing
- Proofreading

Jerk causes energy loss on the loop-the-loop

Researchers used high-speed video analysis to characterize a ball's motion in the iconic physics demonstration.

Loop-the-loops have been found in physics books since the mid 1800s. In the [setup](#), a ball or cart starts from rest at a certain height, travels down a track, and completes a vertical loop. But the apparatuses need a larger starting height than predicted by simple energy conservation. Somewhere, the ball loses energy. That loss is usually dismissed as arising from "non-conservative forces," says Karl Mamola of Appalachian State University in North Carolina.

But that hand-wavy explanation wasn't good enough for Mamola and his collaborator, Toby Dittrich of Portland Community College in Oregon, both of whom have taught physics for more than 30 years. In a [recently published paper](#); in the *American Journal of Physics*, the pair used high-speed video analysis to reveal finer details of the ball's motion through the loop and found

The forces that govern the loop-the-loop are, in theory, straightforward. Gravity pulls down, the normal force pushes up from the track, and friction opposes the motion. Combined, however, they form a complicated system with many possible sources of energy loss.

Dittrich started the research by focusing only on geometric considerations. His track was made of a long, flat strip of aluminum folded at a right angle to form a [V-shaped trough](#). The resulting track was then bent into the loop-the-loop shape. "It occurred to me that the effective radius for rolling is less than the radius of the ball," he said. "So I did some calculations."

But that modification didn't close the gap entirely. Dittrich then turned to Mamola, who recorded the ball's motion and performed video analysis to [uncover](#) [gather](#) data about its

Andrew Grant 12:07 PM Jul 19

You mention this here but not in the article. Keep in mind that some readers may skip past the dek.

From imported document

Andrew Grant 12:08 PM Jul 19

Similar to above. Try to bring up the ubiquity of this as a physics demonstration here. You can bring up the 1800s thing later to point out that it's surprising we still don't fully understand the physics involved.

From imported document

Christine Middlet... 10:41 AM Jul 19

Replace: "it" with "the setup"

Finally Posted!



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Jerk causes energy loss on the loop-the-loop

High-speed video analysis helps researchers characterize a ball's motion in the iconic demonstration.

Madison Brewer

0 COMMENTS

TOOLS

PREV NEXT



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Thank you to SPS for choosing me for this internship, Christine and Andrew for mentoring me, and all of the *Physics Today* staff for making this summer amazing.



Thanks!

Any questions?