Physics challenge 02: The Magic Coin

Andrei Galiautdinov

Department of Physics and Astronomy, University of Georgia, Athens, GA 30602, USA

(Dated: November 29, 2015)

Here we meet Magic Hoop’s little sister, The Magic Coin, whose behavior looks suspiciously familiar... Or does it?

Contents

I. Meet Magic Hoop’s little sister — The Magic Coin 1

II. The meaning of the physical intuition 1

III. Disclaimer 2

IV. Additional paradox 2

V. Pause 2

I. MEET MAGIC HOOP’S LITTLE SISTER — THE MAGIC COIN

If you are still thinking about the Magic Hoop from “Coffee hour physics challenge 01”, here’s another question to ponder about: Is the hoop’s motion physically the same as the motion of a wobbling coin on a table?

If so, is the table ice-coated (slippery), rubber-coated (no slipping), or jelly-coated (something in-between)? Can the coin “eigen”-spin in the direction “opposite” to its wobbling direction?

I have no definitive answers to any of the above, but I would suggest you attack these questions using the same strategy: experiment, visualize, draw free-body diagrams, use Newton’s Laws.

What made me think of this example is the observation, depicted in Fig. 1, that both the precessing hoop and the wobbling coin look almost like “mirror” images of each other: both are constrained to “roll” under/on a horizontal plane and both experience horizontal torques. In the case of the hoop, the constraint and the torque are due to the string (tension force); in the case of the coin, the constraint and the torque are due to the table (normal force).

II. THE MEANING OF THE PHYSICAL INTUITION

Why is this example important?

It is important because if we “convince” ourselves that the motion of the two siblings are similar and essentially the same then the mysterious behavior of the Magic Hoop from “Coffee hour physics challenge 01” will suddenly become less mysterious and intuitively obvious. After all, what’s so special about a wobbling coin?? Right?

Well... Actually, wrong. But at least the wobbling coin seems familiar, happens all the time, and is almost intuitively obvious. Maybe it could make the magic hoop intuitively obvious too?

Let’s say it does. Then that would be an example of how the intuitive understanding of an unfamiliar phenomenon often emerges: you start with an explanation of something mysterious (precessing hoop) in terms of basic physical laws (see “Coffee hour physics challenge 01”), then you make an analogy with something less mysterious (wobbling coin), and then, once the analogy is firmly embedded in your mind, the original phenomenon itself becomes less mysterious. The new intuition then can be used for the description and understanding of even more complicated systems and processes. [Sometimes you take a slightly different route by going over to the analogy first: unfamiliar → analogy → explanation using basic laws → back to unfamiliar, which is by now intuitively obvious.]

You see, physicists and astronomers (?), unlike other
humans, get a kick out of making things less mysterious and more obvious. That’s our source of thrill and excitement in life. Well..., apart from climbing, of course! — *wink-wink* at Mike Geller:-)