

# What's behind the success of the soccer 'Knuckleball'

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What makes soccer star Cristiano Ronaldo's "knuckleball" shot so unpredictable and difficult to stop? At the American Physical Society's (APS) Division of Fluid Dynamics (DFD) meeting, November 18 – 20, 2012, in San Diego, Calif., a team of researchers investigating this phenomenon will reveal their findings.

A "knuckleball" in soccer refers to a ball kicked at very low spin, which results in a zigzag trajectory. Along its straight path, the ball deviates laterally by roughly the diameter of a ball (0.2 m). The deviation direction appears to be unpredictable, which is extremely frustrating for goalkeepers attempting to block it.

Variations of the knuckleball are also used in baseball and volleyball, so many players and coaches want to understand the physics at play during its zigzag trajectory.

"We decided to study the knuckleball because the physics of sports is such a new field and there are many discoveries to be made," explains Caroline Cohen, a Ph.D. student at École Polytechnique's [Hydrodynamics](#) Laboratory (LadHyX) in France.

After trying other experiments, Cohen and colleague Baptiste Darbois Texier, also a Ph.D. student, working with Christophe Clanet, a research director at France's Centre National de la Recherche Scientifique (CNRS), focused on an approach that involves dropping steel beads into a tank of water and studying their [trajectory](#). They discovered that the

knuckleball phenomenon occurs, but at much shorter distances. This makes it easier to observe with an ultrafast camera, which lets you see things you can't with the "naked" eye.

"The big surprise is that every bead makes a zigzag – from a little plastic bead to a steel weight of 7 kg (15.4 lbs)," says Cohen. "We wouldn't have bet on this occurring before we tried it, so it was quite exciting to actually see it by doing a simple experiment."

The team demonstrated that – contrary to popular belief – the "knuckle effect" isn't a result of [deformations](#) at the site of foot impact or ball seams. What's really going on is that the aerodynamic lift forces that act on a smooth sphere can fluctuate and cause the zigzagging.

At the DFD meeting, Darbois Texier will also describe the significant role the knuckle effect may have played in historic experiments trying to prove the Earth's rotation. "One way to attempt this is to measure the East deviation of a sphere in free fall – from a height of 150 m (492 ft) the deviation is about 3 cm (1.18 in)," he notes. "We found that the results of these experiments were very scattered, and we believe this is because of the lateral deviation caused by the knuckle effect."

**More information:** The talk, "How Cristiano Ronaldo performs his knuckleball?," is at 8 a.m. on Monday, Nov. 19, in Room 30E.

[http://absimage.aps.org/image/DFD12/MWS\\_DFD12-2012-000981.pdf](http://absimage.aps.org/image/DFD12/MWS_DFD12-2012-000981.pdf)

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