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Behind the Success of the Soccer 'Knuckleball'

San Diego, Calif., Nov. 16 – What makes soccer star Christiano Ronaldo's "knuckleball" shot so unpredictable and difficult to stop? At the American Physical Society's (APS) Division of Fluid Dynamics (DFD) meeting, held Nov. 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."

Presentation: “How Cristiano Ronaldo performs his knuckleball?” is at 8 a.m. on Monday, Nov. 19, in Room 30E.
Abstract: http://meeting.aps.org/Meeting/DFD12/Event/177995

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MORE MEETING INFORMATION
The 65th Annual Meeting of the American Physical Society (APS) Division of Fluid Dynamics will take place from November 18-20, 2012, in San Diego, Calif. It will bring together researchers from across the globe to address some of the most important questions in modern astronomy, engineering, alternative energy, biology, and medicine. All meeting information, including directions to the Convention Center, is at: http://apsdfd2012.ucsd.edu/

USEFUL LINKS
Main Meeting Web Site: http://apsdfd2012.ucsd.edu/
Searchable Abstracts: http://meeting.aps.org/Meeting/DFD12/APS_epitome
Directions and Maps: http://apsdfd2012.ucsd.edu/?page=Venue_and_Maps

PRESS REGISTRATION
Credentialed full-time journalists and professional freelance journalists working on assignment for major publications or media outlets are invited to attend the conference free of charge. If you are a reporter and would like to attend, please contact Charles Blue (dfdmedia@aps.org, 301-209-3091).

SUPPORT DESK FOR REPORTERS
A media-support desk will be available. Press announcements and other news will be available in the Virtual Press Room (see below).

VIRTUAL PRESS ROOM
The APS Division of Fluid Dynamics Virtual Press Room will be launched in mid-November and will feature news releases, graphics, videos, and other information to aid in covering the meeting on site and remotely. See: http://www.aps.org/units/dfd/pressroom/index.cfm

GALLERY OF FLUID MOTION
Every year, the APS Division of Fluid Dynamics hosts posters and videos that show evocative images and graphics from either computational or experimental studies of flow phenomena. The outstanding entries are selected for their artistic content, originality, and ability to convey information. They will be honored during the meeting, placed on display at the 2013 APS March Meeting, and appear in the annual Gallery of Fluid Motion article in the American Institute of Physics' journal, Physics of Fluids.

Selected entries from the Gallery of Fluid Motion will be hosted as part of the Fluid Dynamics Virtual Press Room. In mid-November, when the Virtual Press Room is launched, another announcement will be sent out.

This release was prepared by the American Institute of Physics (AIP) on behalf of the American Physical Society’s (APS) Division of Fluid Dynamics (DFD).

ABOUT THE APS DIVISION OF FLUID DYNAMICS
The Division of Fluid Dynamics of the American Physical Society (APS) exists for the advancement and diffusion of knowledge of the physics of fluids with special emphasis on the dynamical theories of the liquid, plastic and gaseous states of matter under all conditions of temperature and pressure. See: http://www.aps.org/units/dfd/