

Sports Aerodynamics: Cricket Ball & Badminton Shuttlecock

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Abstract:

I will begin with a comparison of flow characteristics of the projectiles used in various sports such as golf, field hockey, soccer, baseball, tennis, cricket, volleyball, and badminton. Much of the data is from the experiments conducted in the National Wind Tunnel Facility at IIT Kanpur. Duck-feather shuttlecocks are used in professional badminton. However, they are expensive and brittle. Nylon shuttlecocks are widely used even though their “feel” is different from the “real thing”. The aerodynamic difference between the synthetic and duck-feather shuttlecocks will be explained via the role of fluid-structure interactions. Moving on to the cricket ball, I will explain the phenomenon of swing and reverse-swing. One of the questions that we address is “Can a new cricket ball reverse?” The results from our wind-tunnel experiments as well as Large Eddy Simulations will be presented to explain the phenomenology. Often the cricketers are spotted “shining” the cricket ball by rubbing it against their clothing. This is to enable the ball to undergo “contrast-swing”. Experiments on balls with differential roughness of the two hemi-spheres of the ball are utilized to study the phenomenon. Force measurements are carried out on a new cricket ball as well as one whose surface is manually roughened to resemble a ball that has been in play for about 40 overs. I will explain as to how the regimes of conventional- and reverse-swing depend on the surface roughness of the ball. The “knuckleball” has gained popularity in cricket in recent times. I will show that the current usage of this term in cricket is a misnomer. Taking inspiration from baseball, a model to explain the trajectory of a knuckleball delivery is proposed. The key parameters are the seam angle, speed, and spin rate of the ball at the time of its release. The optimal combination of these parameters that result in a knuckleball, which is likely hard for the batter to play, is identified. I will end the talk with some insights in the flow past a frisbee.