Remarks on the Gyroball

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updated: November 14, 2006

Introduction to Baseball Aerodynamics

There have been many reports in recent weeks about the so-called gyroball, a new type of pitch in which the ball spins about an axis parallel to the direction of motion, much like a spiral pass in football or a rifle bullet. Before discussing the gyroball, it is useful to talk about a "normal" pitch, based on our knowledge of the aerodynamics of a spinning baseball. The physics tells us that a spinning baseball in flight experiences three forces, as shown in Fig. 1: the downward force of gravity (mg), the retarding force of air resistance (F_{drag}), and a lift force (F_{lift}). The drag always points opposite to the direction of motion. The lift force arises due to the spin and points in the direction that the leading edge of the ball is turning. The lift force is maximized when the spin axis is perpendicular to the direction of motion, as it the case for all "conventional" pitches. For a typical fastball with backspin, the lift is upward, opposite to gravity. Therefore a fastball does not fall as much as it would if only gravity were acting. For a typical "12-6" curveball with topspin, the lift is downward, in the same direction as gravity. Therefore a curveball drops more than it would if only gravity were acting. Other conventional pitches, such as sliders and cut fastballs, have a sideways component of spin, resulting in a left-right break of the pitch.

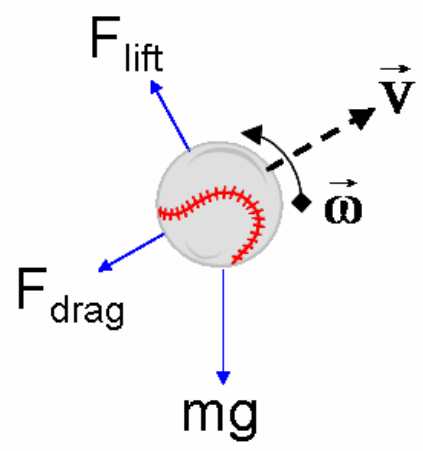

Figure 1. Forces on a spinning baseball in flight. The velocity vector **v** indicates the direction of motion and the angular velocity vector **ω** indicates the direction of the spin. The spin axis points out of the plane of the figure.

Aerodynamics of the Gyroball

The gyroball is a unique pitch in that the spin axis is aligned with the direction of motion. According to our present understanding of aerodynamics, such a pitch should experience very little lift, as explained in Figs. 2-4 below. These figures were provided me by Dr. Ryutaro Himeno, the Japanese computer scientist who discovered the gyroball through elaborate computational fluid dynamics (CFD) calculations. The captions are mine.

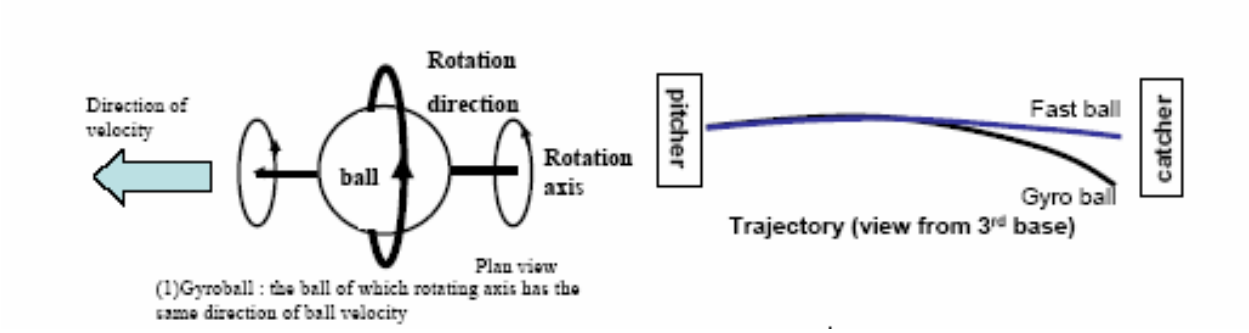

Figure 2: A "pure" gyroball in which the spin axis is exactly aligned with the initial direction of motion. The left figure shows a top view. The right figure is a side view from 3rd base. The pure gyroball has no horizontal break and no vertical "lift". A typical fastball has backspin, which gives it an upward lift, opposing gravity. Therefore, the pure gyroball drops more than a typical fastball, as shown in the right figure. In fact, the principal action is similar to that of a split-finger fastball. Actually this pitch has a very small amount of break away from a right-handed batter because the direction of motion of the ball develops a small downward component due to gravity.

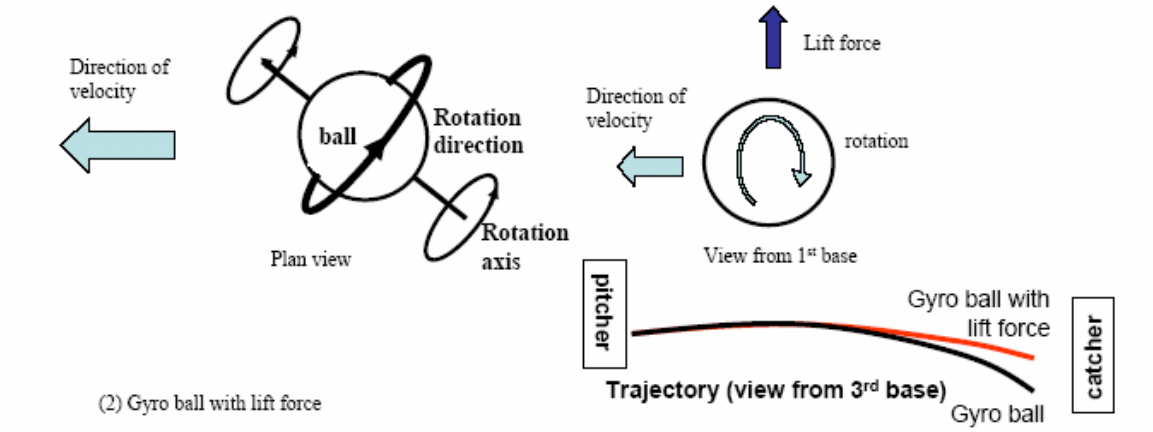

Figure 3: A gyroball in which the spin axis is slightly tilted horizontally to the right (i.e., toward 3rd base) relative to the direction of motion. The left figure shows a top view. The top right figure shows a side view from 1st base and the bottom right figures shows a side view from third base. The horizontal tilting of the spin axis gives the ball a little backspin which gives the ball lift. Therefore the ball drops a little less than a pure gyroball but still significantly more than a fastball. As with the pure gyroball, there is no horizontal break. Himeno call this pitch the "gyroball with lift force."

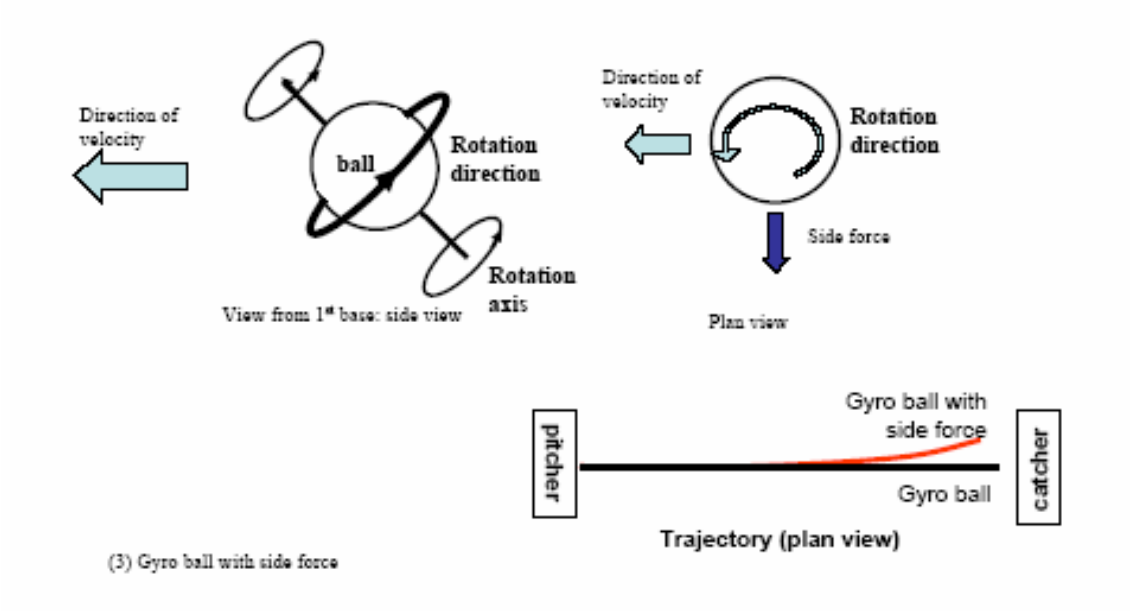

Figure 4: A gyroball in which the spin axis is slightly tilted upward. The left figure shows a side view from 1st base. The top right and bottom right figures show a top view. Such a pitch will have a slight sidespin, causing it to break to the left, away from a right-handed batter, similar to a cut fastball. As with the pure gyroball in Figure 2, the ball drops more than a typical fastball with backspin. If instead the spin axis were tilted slightly downward, the ball would break in the opposite direction, toward a right-handed hitter. Himeno call his pitch the "gyroball with side force."

Conclusions:

The foregoing analysis suggests that there is very little sideways break of a gyroball, a conclusion that is at odds with many of the claims I have seen on the web. The primary motion of the pitch is that it drops much more than a typical fastball.