TP B.17
Maximum Drag-Enhanced Sidespin Tip Contact Point

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"The Illustrated Principles of Pool and Billiards"
http://billiards.colostate.edu
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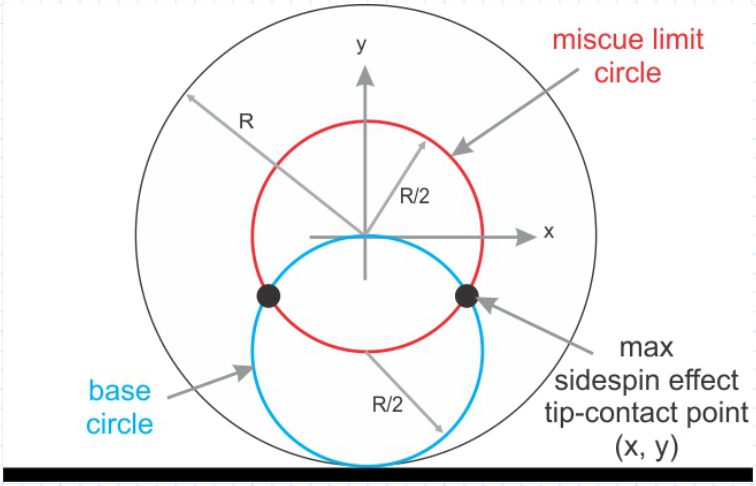

From TP A.12, right sidespin imparted to the CB, based on CB speed (v) is:

$$\omega_y = \frac{5 \cdot x \cdot v}{2 \cdot R^2}$$

and backspin imparted to the CB is:

$$\omega_x = \frac{-5 \cdot y \cdot v}{2 \cdot R^2}$$

From TP A.1, the final CB speed after the CB stops sliding (due to drag) and achieves natural foward roll is:

$$v' = \frac{5}{7} \cdot v - \frac{2}{7} \cdot R \cdot \omega_x = \frac{5}{7} \cdot v - \frac{2}{7} \cdot R \cdot \left(\frac{-5 \cdot y \cdot v}{2 \cdot R^2} \right) = \frac{5}{7} \cdot v \cdot \left(1 + \frac{y}{R} \right)$$

To get the largest effective sidespin, the spin-to-speed ratio after drag should be as high as possible. The final spin-speed ratio (AKA spin-rate-factor or SRF) is:

$$SRF = \frac{\omega_y}{\left(\frac{v'}{R} \right)} = \frac{\frac{5 \cdot x \cdot v}{2 \cdot R^2}}{\frac{\frac{5}{7} \cdot v \cdot \left(1 + \frac{y}{R} \right)}{R}} = \frac{7 \cdot x}{2 \cdot (R + y)}$$

For the maximum possible spin, the tip contact point must be at the miscue limit, which is a half-ball radius from center. In other words, the tip contact point must be on the miscue-limit circle given by the following equation:

$$x^2 + y^2 = \left(\frac{R}{2}\right)^2$$

Finding the maximum of the spin-speed ratio is equivalent to finding the maximum of the square of the spin-speed ratio (Z):

$$SRF^2 = \frac{7 \cdot x^2}{2 \cdot (R+y)^2} = \frac{7 \cdot \left(\left(\frac{R}{2}\right)^2 - y^2\right)}{2 \cdot (R+y)^2}$$

The maximum occurs where the derivative of SRF^2 is 0:

$$y := \left(\frac{\mathrm{d}}{\mathrm{d}y} \frac{7 \cdot \left(\left(\frac{R}{2}\right)^2 - y^2\right)}{2 \cdot (R+y)^2} = 0\right) \xrightarrow{solve,\, y} -\frac{R}{4}$$

The value of x corresponding to this is:

$$x := \sqrt{\left(\frac{R}{2}\right)^2 - y^2} \xrightarrow{simplify} \frac{\sqrt{3} \cdot \sqrt{R^2}}{4}$$

So the angle below the horizontal to the tip contact point is:

$$\tan\left(\frac{y}{x}\right) = tan\left(\frac{1}{\sqrt{3}}\right) = 30\ °$$

Therefore, the required tip contact point for maximum sidespin effect is at "4 o'clock" for right spin and "8 o'clock" for left spin.

Per Ron Shepard's "Amateur Physics for the Amateur Pool Player" (Problem 3.7), it can be shown that this point (x, y) lies on a "base circle" through the resting point and center of the CB:

$$x^2 + \left(y + \frac{R}{2}\right)^2 \rightarrow \frac{R^2}{4}$$

Per the illustration above, the intersection of the miscue-limit and base circles provides and easy way to visualize the required tip contact point for maximum drag-enhanced-spin.