How a Wing Generates Lift

Abstract. A short explanation of lift as the result of air being turned around the wing, the circulation it creates, and how curved streamlines set up the pressure difference.

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This is a test article — just an example while I prepare the real Notebook pieces.

Ask why a wing lifts and you often get the "longer path on top" story, which turns out to be wrong. A cleaner picture is this: the wing **turns the air**, and turning air is what produces lift.

Air turns at the leading edge

As the flow reaches the wing it splits and curves sharply around the rounded *leading edge*. Hugging the upper surface, it keeps bending and leaves the *trailing edge* aimed slightly downward. The wing has deflected a stream of air downward, and by Newton's third law the air pushes back on the wing — upward.

Seen as a whole, this bending is a net *rotation* of air around the wing: the flow moves a little faster over the top and slower underneath, as if a weak vortex were bound to the wing. That bound rotation is the heart of the matter.

Curved streamlines need a pressure difference

The link between "the air curves" and "there is a force" is geometric. Whenever a streamline follows a curve of radius R, something must supply the centripetal acceleration, and the only thing available is a pressure gradient across the flow:

$$\frac{\partial p}{\partial n} = \rho \, \frac{V^2}{R}.$$

Pressure rises as you move *away* from the centre of curvature. Over the top of the wing the streamlines curve downward, with their centre of curvature below them, so pressure *falls* as you approach the surface — a suction. The tighter the curve (smaller R), the steeper the gradient and the stronger the pull. This radius-of-curvature view is the one Babinsky uses to explain lift without invoking equal transit times.[1]

Circulation makes it quantitative

The rotation around the wing is measured by the *circulation* Γ, the integral of velocity around a loop enclosing the section. The Kutta–Joukowski theorem ties it directly to lift per unit span:

[1] H. Babinsky, "How do wings work?," *Physics Education*, vol. 38, no. 6, pp. 497–503, 2003. https://doi.org/10.1088/0031-9120/38/6/001

$$L' = \rho V_\infty \Gamma.$$

What fixes the value of Γ is the *Kutta condition*: the flow must leave the sharp trailing edge smoothly, and only one amount of circulation lets it do that. Set that, and the lift follows.[2]

[2] J. D. Anderson, *Fundamentals of Aerodynamics*, 6th ed. New York: McGraw-Hill, 2017.