

Flying insects defy aerodynamic laws of airplanes, researchers find

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The maneuvers of flying insects are unmatched by even the best pilots, and this might be due to the fact that these critters don't obey the same aerodynamic laws as airplanes, a team of New York University researchers has found.

"We've known for quite a while that the aerodynamic theory for airplanes doesn't work so well in predicting the force of lift for flapping wings," says Leif Ristroph, an assistant professor at NYU's Courant Institute of Mathematical Sciences who directed the study. "We found that the [drag](#) or wind resistance also behaves very differently, and we put together a new law that could help explain how [insects](#) move through the air."

"To double its [flight speed](#), an airplane must increase its thrust four-fold to counter the stronger wind resistance," Ristroph explains in outlining the law. "In contrast, we found that flapping wings have a drag that is in direct proportion to its flight speed - to go twice as fast, an insect simply needs to double its thrust."

The study, which appears in the journal *Physical Review Fluids*, also included: Natalie Agre, the lead author and an undergraduate in NYU's College of Arts and Science; Stephen Childress, an emeritus professor at the Courant Institute; and Jun Zhang, a professor at the Courant Institute and NYU Shanghai.

The significance of [aerodynamic drag](#) and its strong increase with speed

has been known since before the Wright brothers took flight. This fact is summarized by a mathematical law that posits [wind resistance](#) increases as the square of speed; hence, moving twice as fast requires four times the thrust to overcome the higher drag.

Previous studies of flying insects, which beat their wings hundreds of times a second, suggested that these creatures do not obey this same relationship.

To make this sense of this discrepancy, the researchers in Courant's Applied Math Lab built a robotic wing apparatus for measuring the motions, flows, and forces. The apparatus allowed the team to compare steady motions of a wing, as would occur for airplane flight, to the maneuvers of insects, in which their wings flap as they move through air.

The team's results showed that the back-and-forth motions cause the drag to resist the movement in some instances; however, at other times the drag is actually directed forward, more like a thrust. The net force that results depends on the flight speed as well as the flapping motions, all of which the authors include in a new drag law.

This law may not be news to insects, which have been flying with [flapping wings](#) for hundreds of millions of years. But the authors think that their findings could help guide the design of tiny flying robots that mimic the wing motions of insects.

Provided by New York University

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