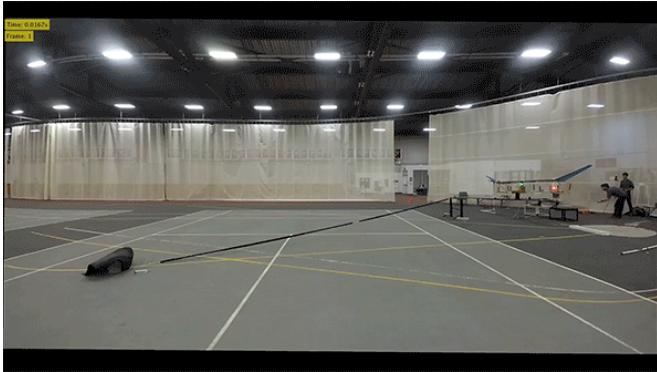


# Engineers fly first-ever plane with no moving parts

21 November 2018, by Jennifer Chu



Undistorted camera footage from flight 9, with position and energy from camera tracking annotated. Sped up 2x. Credit: Steven Barrett

Since the first airplane took flight over 100 years ago, virtually every aircraft in the sky has flown with the help of moving parts such as propellers, turbine blades, and fans, which are powered by the combustion of fossil fuels or by battery packs that produce a persistent, whining buzz.

Now MIT engineers have built and flown the first-ever plane with no moving parts. Instead of propellers or turbines, the [light aircraft](#) is powered by an "ionic wind"—a silent but mighty flow of ions that is produced aboard the plane, and that generates enough thrust to propel the plane over a sustained, steady flight.

Unlike turbine-powered [planes](#), the [aircraft](#) does not depend on fossil fuels to fly. And unlike propeller-driven drones, the new design is completely silent.

"This is the first-ever sustained flight of a plane with no moving parts in the propulsion system," says Steven Barrett, associate professor of aeronautics and astronautics at MIT. "This has potentially opened new and unexplored

possibilities for aircraft which are quieter, mechanically simpler, and do not emit combustion emissions."

He expects that in the near-term, such ion wind propulsion systems could be used to fly less noisy drones. Further out, he envisions ion propulsion paired with more conventional combustion systems to create more fuel-efficient, hybrid passenger planes and other large aircraft.

Barrett and his team at MIT have published their results in the journal *Nature*.

## Hobby crafts

Barrett says the inspiration for the team's ion plane comes partly from the movie and television series, "Star Trek," which he watched avidly as a kid. He was particularly drawn to the futuristic shuttlecrafts that effortlessly skimmed through the air, with seemingly no moving parts and hardly any noise or exhaust.

"This made me think, in the long-term future, planes shouldn't have propellers and turbines," Barrett says. "They should be more like the shuttles in 'Star Trek,' that have just a blue glow and silently glide."

About nine years ago, Barrett started looking for ways to design a propulsion system for planes with no moving parts. He eventually came upon "ionic wind," also known as electroaerodynamic thrust—a physical principle that was first identified in the 1920s and describes a wind, or thrust, that can be produced when a current is passed between a thin and a thick electrode. If enough voltage is applied, the air in between the electrodes can produce enough thrust to propel a small aircraft.

For years, electroaerodynamic thrust has mostly been a hobbyist's project, and designs have for the most part been limited to small, desktop "lifters" tethered to large voltage supplies that create just

enough wind for a small craft to hover briefly in the air. It was largely assumed that it would be impossible to produce enough ionic wind to propel a larger aircraft over a sustained flight.

"It was a sleepless night in a hotel when I was jet-lagged, and I was thinking about this and started searching for ways it could be done," he recalls. "I did some back-of-the-envelope calculations and found that, yes, it might become a viable propulsion system," Barrett says. "And it turned out it needed many years of work to get from that to a first test flight."

### Ions take flight

The team's final design resembles a large, lightweight glider. The aircraft, which weighs about 5 pounds and has a 5-meter wingspan, carries an array of thin wires, which are strung like horizontal fencing along and beneath the front end of the plane's wing. The wires act as positively charged electrodes, while similarly arranged thicker wires, running along the back end of the plane's wing, serve as negative electrodes.

The fuselage of the plane holds a stack of lithium-polymer batteries. Barrett's ion plane team included members of Professor David Perreault's Power Electronics Research Group in the Research Laboratory of Electronics, who designed a power supply that would convert the batteries' output to a sufficiently high voltage to propel the plane. In this way, the batteries supply electricity at 40,000 volts to positively charge the wires via a lightweight power converter.

Once the wires are energized, they act to attract and strip away negatively charged electrons from the surrounding air molecules, like a giant magnet attracting iron filings. The air molecules that are left behind are newly ionized, and are in turn attracted to the negatively charged electrodes at the back of the plane.

As the newly formed cloud of ions flows toward the negatively charged wires, each ion collides millions of times with other air molecules, creating a thrust that propels the aircraft forward.

The team, which also included Lincoln Laboratory staff Thomas Sebastian and Mark Woolston, flew the plane in multiple test flights across the gymnasium in MIT's duPont Athletic Center—the largest indoor space they could find to perform their experiments. The team flew the plane a distance of 60 meters (the maximum distance within the gym) and found the plane produced enough ionic thrust to sustain flight the entire time. They repeated the flight 10 times, with similar performance.

"This was the simplest possible plane we could design that could prove the concept that an ion plane could fly," Barrett says. "It's still some way away from an aircraft that could perform a useful mission. It needs to be more efficient, fly for longer, and fly outside."

Barrett's team is working on increasing the efficiency of their design, to produce more [ionic wind](#) with less voltage. The researchers are also hoping to increase the design's thrust density—the amount of thrust generated per unit area. Currently, flying the team's lightweight plane requires a large area of electrodes, which essentially makes up the plane's propulsion system. Ideally, Barrett would like to design an aircraft with no visible propulsion system or separate controls surfaces such as rudders and elevators.

"It took a long time to get here," Barrett says. "Going from the basic principle to something that actually flies was a long journey of characterizing the physics, then coming up with the design and making it work. Now the possibilities for this kind of [propulsion system](#) are viable."

**More information:** Haofeng Xu et al. Flight of an aeroplane with solid-state propulsion, *Nature* (2018). [DOI: 10.1038/s41586-018-0707-9](https://doi.org/10.1038/s41586-018-0707-9)

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