# Scott received issued U.S. patents and trade secret filing certs on a technology that uses ions to move vehicles and spacecraft and NASA has proven that it works

# This Overlooked Theory Could Be The Missing Piece That Explains How The EM Drive Works

What if it *doesn't* break the laws of physics?

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Ever since the EM drive first made headlines, science lovers have puzzled over how the propulsion system seems to produce thrust, despite the fact it's 'impossible' according to one of the most fundamental laws of physics - Newton's third law of motion.

Now a team of physicists have put forward an alternative explanation - it turns out the EM drive could actually work without breaking any scientific laws, if we factor in a weird and often overlooked idea in quantum physics - pilot wave theory.

For those who need a refresher, the crux of the problem here is that the EM, or electromagnetic, drive appears to produce thrust without any fuel or propellant.

That's awesome because it means we can get to space with way less pay load - it's proposed it could even get us to Mars within 72 days.

But it's also perplexing, because, according to Newton's third law, every action must have an equal and opposite reaction. So without pushing any propellant out one end, the drive shouldn't be able to produce thrust in the opposite direction.

Still, as a NASA peer-reviewed paper showed last year, the drive *does* produce thrust, at least as far as we can currently tell. And a relatively large amount of thrust at that. We just don't know how.

So either our understanding of physics isn't right, or we're missing a big piece of the puzzle when it comes to the EM drive.

A new paper published in *The Journal of Applied Physical Science International* makes the argument that what we're missing is pilot wave theory - a slightly controversial alternative interpretation of quantum mechanics.

Researchers José Croca and Paulo Castro from the Centre for Philosophy of Sciences of the University of Lisbon in Portugal suggest that not only could pilot wave theory explain the mysterious behaviour of the EM drive, it could help to make it even more powerful.

"We have found that applying a pilot wave theory to NASA's EM drive frustum [or cone], we could explain its thrust without involving any external action applied to the system, as Newton's third law would require," Castro told ScienceAlert via email.

So what is pilot wave theory? Currently, the majority of physicists subscribe to the Copenhagen interpretation of quantum mechanics, which states that particles do not have defined locations until they are observed.

Pilot wave theory, on the other hand, suggests that particles do have precise positions at all times, but in order for this to be the case, the world must also be strange in other ways – which is why many physicists have dismissed the idea.

But in recent years, the pilot wave theory has been increasing in popularity. The team has shown in its latest paper this theory could be tweaked slightly to apply to something bigger. Say, the EM drive. And it could explain the results we've been seeing.

Basically, pilot wave theory says that an object radiates a wave field, and it is then pulled or attracted to regions of that field that have higher intensity or energy density. In that way, the wave field is actually 'piloting' the object, hence the name.

Through modelling, the team showed that a sufficiently strong and asymmetrical electromagnetic field could act as a pilot wave. And that's exactly what the EM drive generates.

Because the cone, or frustum, of the EM drive is asymmetrical, it would also generate an asymmetrical wave field. As a result, the walls of the EM drive would move towards the areas of higher intensity, creating thrust.

While that might sound pretty out there, this was also actually a possible solution put forward by the NASA Eagleworks researchers in their seminal paper last year where they first reported the thrust generated by their device:

> "[The] supporting physics model used to derive a force based on operating conditions in the test article can be categorised as a nonlocal hidden-variable theory, or pilot-wave theory for short."

To be clear, the researchers from the University of Lisbon haven't tested their proposal in a real device as yet.

They've only shown that it's possible, from a modelling point of view, for a pilot wave to guide the EM drive. But they've also shown how the idea could actually be tested in future.

"At the moment the most stringent empirical evidence comes from the EM drive behaviour," Castro told ScienceAlert. "However, we have also devised an experiment to detect and modulate subquantum waves."

Importantly, if the hypothesis is confirmed, it would mean the EM drive would *not* have to break Newton's third law. And the team hopes this might result in the device being taken seriously and more widely tested.

"EM drive is the future of space propelling motors," they said. "[Although] it will perhaps find its initial application in nano satellites or nano drones, at least before the effect can be scaled up to heavier machines."

Importantly, if a pilot wave does explain the thrust behind the device, then it could also lead to a way to make the propulsion system even more powerful in future, and it's as simple as tweaking the shape.

"We have seen that the effect could be enhanced using a different shape for the frustum," said Castro. "In fact a trumpet exponential form is expected to increase the thrust."

The team is now considering building its own experimental set up to study the phenomena and has invited anyone interested in the project to get in touch.

In the meantime, the NASA Eagleworks team continues to test out its device. And there are also groups looking to test the EM drive in space - or according to some rumours, already doing so - which would really show once and for all whether it works.

There's a lot we have yet to learn about the mysterious EM drive and it's a topic that continues to divide the science world. But whether or not it ends up being the future of space travel, at least it's teaching us more about the physics that govern our world.

The new research has been published in *The Journal of Applied Physical Science International*.