Ant-Man and the Wasp: Small wonders lead to superhero science

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In their *Journal of Superhero Science* publication, Max Mikel-Stites (center) and Anne Staples (right) explained how Ant-Man could overcome the 'death zone dilemma' while shrinking down to a size of an insect. Afreen Khoja (left), an undergraduate biological systems engineering major, is currently researching Princess Mera's hydrokinetic powers for the group's upcoming article on DC Comics characters Aquaman and Mera. Credit: Virginia Tech

Max Mikel-Stites and Anne Staples were searching for a sequel.

This summer, Staples, an associate professor in the Department of Biomedical Engineering and Mechanics in the College of Engineering, and graduate student Mikel-Stites published a paper in the inaugural issue of the *Journal of Superhero Science* titled, "Ant-Man and the Wasp: Microscale Respiration and Microfluidic Technology."

Now, they needed a new hero.

The two were working with a team of graduate students, brainstorming who could be the superhero subject for their next scientific inquiry. Superman? Batgirl? Aquaman?

Mikel-Stites lobbied for an investigation of Dazzler's sonoluminescent powers. Staples was curious how Mera, The Princessof Atlantis, used her hydrokinetic powers.

It turns out, comic books are a great inspiration for scientific discovery.

This month, Mikel-Stites is presenting the findings of their paper at the American Physical Society's Division of Fluid Dynamics meeting.

The wonder team's paper looked at how Ant-Man and the Wasp breathe when they shrink down to insect-size and Staples' lab studied how fluids flow in nature. Insects naturally move fluids and gases efficiently at tiny scales. If engineers can learn how insects breathe, they can use the knowledge to invent new microfluidic technologies.

"Before the 2018 'Ant-Man and the Wasp' movie, my lab was already wondering about insect-scale respiration," said Staples. "I wanted to get people to appreciate different breathing mechanisms."

For most of Mikel-Stites' life, he had been nit-picking at the "science" in science-fiction movies.

"I couldn't watch 'Armageddon' once they got up to space station Mir and there was artificial gravity. Things like that have always bothered me. But for 'Ant-Man and the Wasp' it was worse," he said.

Staples and Mikel-Stites decided to join forces to research Ant-Man's microscale respiration.

Mikel-Stites was stung by what he dubbed "the altitude problem or death-zone dilemma." For Ant-Man and the Wasp to shrink down to insect size and still breathe, they would have to overcome an atmospheric density similar to the top of Mt. Everest. Their tiny bodies would also require higher metabolisms. For their survival, the Marvel comic universe had to give Ant-Man and the Wasp superhero technologies.

"I thought it would be fun to find a solution for how this small-scale respiration would work,"said Mikel-Stites."I started digging through Ant-Man's history. I looped through scenes in the 2015 movie where we could address the physics. Then I did the same thing with trailers from the 2018 movie. I used that to make a list of problems and a list of solutions."

Ant-Man and the Wasp solve the altitude problem with their superhero suits. In their publication, Mikel-Stites and Staples write that the masks in Ant-Man and the Wasp's suits contain "a combination of an air pump, a compressor, and a molecular filter including Pym particle technology," that allows them to breathe while they are insect-sized.

"This publication showed how different physics phenomena can dominate at different size scales, how well-suited organisms are for their particular size, and what happens when you start altering that," said

Mikel-Stites. "It also shows that Hollywood doesn't always get it right when it comes to science!"

Their manuscript was accepted by the *Journal of Superhero Science* before the release of the sequel, "Ant-Man and the Wasp." Mikel-Stites was concerned the blockbuster might include new technologies or change Ant-Man's canon. If the Marvel comic universe changed between the 2015 'Ant-Man' movie and the sequel, their hypotheses would be debunked and they would be forced to retract their paper.

"I went to the 2018 movie before the manuscript came out in preprint so that if the movie contradicted us we could catch it. But the 2018 movie actually supported everything we had said, which was really nice," said Mikel-Stites. Most moviegoers simply watched the special effects and left the theater entertained. But Mikel-Stitesleft the movie with confirmation of the paper's hypotheses.

The Staples lab members are not the only ones interested in tiny technologies. From lab-on-a-chip microfluidic devices to nanoparticles that deliver drugs directly to cells, consumers will ultimately benefit from this small scientific field that delivers big results.

"In both the movies and science, shrinking is a common theme and has been for the last 50-60 years. This idea is something that we all like to think about. Given enough time, we can reach the point where science can take it from the realmsof magic into something that we actually have an explanation for," Mikel-Stites said.

In fact, the Staples lab group has already done just that.

While Mikel-Stites is presenting his superhero science at the APS meeting, his colleague Krishnashis Chatterjee, who recently completed his Ph.D. in engineering mechanics will be presenting his research on

fabricating and testing four different insect-inspired micro-fluidic devices.

From fiction to function, the Staples lab likes to have fun along the way.

"I think that it is really important to connect with people and be engaged in science with topics they already know about. With this superhero science paper I wanted to support this mission," Staples said.

And who did the lab mates choose for their next superhero science subject? The Princess of Atlantis, Mera. They hope they can publish another superhero science paper that really makes waves.

More information: Ant-Man and The Wasp: Microscale Respiration and Microfluidic Technology, DOI: 10.24413/sst.2018.1.2474 , journals.library.tudelft.nl/in … ro/article/view/2474

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