APS Division of Fluid Dynamics 71st Annual Meeting
Georgia World Congress Center in Atlanta, Nov. 18-20

Helping Marvel Superheroes to Breathe

New analysis shows that the superheroes Ant-Man and the Wasp would have some serious issues when bug-sized -- but science may have the solution.

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WASHINGTON, D.C., November 18, 2018 -- Marvel comics superheroes Ant-Man and the Wasp -- nom de guerre stars of the eponymous 2018 film -- possess the ability to temporarily shrink down to the size of insects, while retaining the mass and strength of their normal human bodies. But a new study suggests that, when bug-sized, Ant-Man and the Wasp would face serious challenges, including oxygen deprivation.

Those challenges, along with their solution-microfluidic technologies, will be described by engineering mechanics graduate student Max Mikel-Stites of Virginia Tech at the American Physical Society's Division of Fluid Dynamics 71st Annual Meeting, which will take place Nov. 18-20 at the Georgia World Congress Center in Atlanta, Georgia.

Mikel-Stites and his advisor, Anne Staples, an associate professor in the biomedical engineering and mechanics department at Virginia Tech, normally study biological fluid dynamics, with a particular focus on insect respiration and insect-scale fluid flows. Staples' lab has developed microfluidic devices inspired by insect respiratory systems in which the flow rate and direction of flow through individual channels in the device can be controlled without the use of valves.

The work, which will be discussed in a separate presentation at the DFD meeting (http://meetings.aps.org/Meeting/DFD18/Session/D24.1), could reduce the actuation machinery needed for microfluidic devices used in many different scientific fields, and make them more portable and cost-efficient. "Applying that perspective to Ant-Man and the Wasp seemed like a straightforward thing to do," said Mikel-Stites.

In their analysis, the researchers determined that the atmospheric density -- basically, the number of molecules (say, of oxygen) in a given volume of air -- experienced by the bug-sized heroes is reduced to a level nearly identical to that of Mt. Everest's so-called "death zone," where there is not enough oxygen for a human to breathe. "While the actual atmospheric density is the same for an insect and a human, the subjective atmospheric density experienced by a human who shrinks to insect size changes," Mikel-Stites explained. "For example, a normal-sized person taking a deep breath can expect to inhale some number of oxygen

molecules. However, when that person is shrunk down to the size of an ant, despite still needing the same number of oxygen molecules, far fewer are available in a single breath of air.

The “death zone” begins for a normal-sized human about 8,000 meters above sea level. The shrunken superheroes, the researchers calculated, would feel like they were at an altitude of 7,998 meters, and that would make for a serious -- if not deadly -- case of altitude sickness.

“For someone not acclimated, symptoms of altitude sickness range from headache and dizziness to the buildup of fluid in the lungs and brain, and possibly death. This occurs in part because people may respond by trying to breathe more rapidly, to increase their oxygen intake, and because the body is attempting to function with less oxygen than it normally does,” he said.

And that’s not the extent of Ant-Man’s and the Wasp’s problems, the team found. Based on a relationship known as Kleiber’s law, which correlates the metabolic rate of an animal to its size, the researchers found that the metabolic rates per unit mass of the superheroes at bug size would increase by approximately two orders of magnitude -- as would their oxygen demands.

But all is not lost -- thanks to science. According to Mikel-Stites, the use of microfluidic components such as Knudsen pumps (which are driven by temperature gradients) and microscale gas compressors, could be embedded into the helmets of Ant-Man and the Wasp to help them breathe at the microscale.

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Presentation E19.3, “Why Ant-Man and the Wasp Need Helmets to Breathe” by Maxwell Mikel-Stites and Anne Staples, will be Sunday, Nov. 18, 5:36 p.m. in Room B306 of the Georgia World Congress Center in Atlanta. Abstract: http://meetings.aps.org/Meeting/DFD18/Session/E19.3

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---------- MORE MEETING INFORMATION ----------

USEFUL LINKS

Main meeting website: https://www.apsdfd2018.org/
Meeting technical program: http://meetings.aps.org/Meeting/DFD18/SessionIndex2
Invited talks: http://meetings.aps.org/Meeting/DFD18/APS_Invited
Hotel information: https://www.apsdfd2018.org/hotels/

GALLERY OF FLUID DYNAMICS

At the Annual Meeting, The Gallery of Fluid Motion will consist of posters and videos submitted by attendees illustrating the science and beauty of fluid motion. More information can be found here: https://gfm.aps.org/.

PRESS REGISTRATION

We will grant free registration to credentialed journalists and professional freelance journalists. If you are a reporter and would like to attend, contact Rhys Leahy or the AIP Media Line (media@aip.org, 301-209-3090). We can also help with setting up interviews and obtaining images, sound clips or background information.

LIVE MEDIA WEBCAST

A press briefing featuring a selection of newsworthy research will be webcast live from the conference Monday, Nov. 19. Times and topics to be announced. Members of the media should register in advance at http://apswebcasting.com/webcast/registration/aps1118.php.

ABOUT DFD

The Division of Fluid Dynamics of the American Physical Society, established in 1947, exists for the advancement and diffusion of knowledge of the physics of fluids with special emphasis on the dynamical theories of the liquid, plastic and gaseous states of matter under all conditions of temperature and pressure. For more information about DFD, visit https://www.aps.org/units/dfd/.

ABOUT APS

The American Physical Society (APS) is a nonprofit membership organization working to advance and diffuse the knowledge of physics through its outstanding research journals, scientific meetings, and education, outreach, advocacy, and international activities. APS represents over 55,000 members, including physicists in academia, national laboratories, and industry in the United States and throughout the world. For more information about APS, visit https://www.aps.org/.