

There's a science to making 'Ant-Man'

A quantum physicist was enlisted to help the sequel look smart — when he could

BY DARRYN KING

Several months before production began on the new sequel "Ant-Man and the Wasp," the director Peyton Reed and a room full of writers, artists and producers assembled in the Marvel Studios offices in Burbank, Calif., to listen to a quantum physicist explain the science of getting really, really small.

Recalling the meeting recently, the quantum physicist, Spyridon Michalakis of the Institute for Quantum Information and Matter at Caltech, said that he described the subatomic realm as "a place of infinite possibility, an alternative universe where the laws of physics and forces of nature as we know them haven't crystallized." He had suggestions about how it might be visualized on a movie screen: "beautiful colors changing constantly to reflect transience."

The movie's producer, Stephen Broussard, said, "I'm not completely sure I have my head around it yet, but it certainly sparked some interesting ideas for what this place could be."

In the first "Ant-Man" movie (2015), Scott Lang, the title character, played by Paul Rudd, wields the power to shrink to the size of a Tic Tac under the tutelage of the scientist Hank Pym (Michael Douglas) and his daughter, Hope van Dyne (Evangeline Lilly). "When you're small, energy's compressed," Hope tells Scott. "So, you have the force of a 200-pound man behind a fist a hundredth of an inch wide. You're like a bullet."

If an explanation of molecular density seems like an odd fit for a training montage in a superhero movie, it speaks to the way that science, including the latest developments in quantum theory, has informed and inspired the "Ant-Man" series.

In "Ant-Man and the Wasp," with Hope taking on the nimble wings and identity of the similarly minuscule Wasp, one character suffers from a (fictional) condition referred to as "molecular disequilibrium." Two others fuse together across a great distance, much in the way particles do in the actual phenomenon of quantum entanglement. There's talk of tardigrade fields and time vortexes, and Laurence Fishburne delivers a technically sound lecture on something called quantum decoherence.

And yes, a character does shrink so small as to be plunged into the Quantum Realm, named after and based on sci-



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Above, Ant-Man (Paul Rudd), left, and the Wasp (Evangeline Lilly) in the new film. At left, the pair with their helmets off.

entific reality, where the laws of classical physics break down.

"Marvel really has gone out of their way to incorporate real, interesting science," Dr. Michalakis said. "I think they realize that so much real science almost feels like science fiction." Along with the entomologist Steven Kutcher, who suggested ways to film live ants, Dr. Michalakis worked as a scientific consultant on the first "Ant-Man." He was even more closely involved in the sequel, collaborating with Erik Sommers and Chris McKenna, two of the writers developing the script. He also consulted on "Spider-Man: Homecoming" (2017) and "Captain Marvel," due in 2019.

Persuasive science has played a major role at the movies this year. The cosmologist Stephon Alexander consulted on the sci-fi fantasy "A Wrinkle in Time,"

the geneticist Adam Rutherford advised on the multifarious mutations in the sci-horror movie "Annihilation," and the paleontologist Jack Horner lent his expertise to "Jurassic World: Fallen Kingdom."

What's perhaps surprising is that superhero movies, fueled as they are by fantastic impossibilities, are increasingly incorporating scientific detail and authenticity. Most recently, the astronomer-physicist Adam Frank advised on wormholes and interstellar travel for "Thor: Ragnarok," while the anthropologist Jim Ferguson and the aerospace engineering expert Daniel Bodony consulted on "Black Panther." Since its start in 2008, the National Academy of Sciences' Science and Entertainment Exchange, which has provided such experts for more than 2,300 television and

movie projects, has played scientific matchmaker for several Marvel movies and television series, including "Agent Carter," "Luke Cage" and "Agents of S.H.I.E.L.D."

Historically, Marvel comics have tended to present at least the sheen of science, with much of the superheroics tied to characters' skills as scientists, inventors and engineers: Tony Stark, a.k.a. Iron Man, is an alumnus of the Massachusetts Institute of Technology, while T'Challa (Black Panther) has a Ph.D. in physics from Oxford University.

"I can't speak to the accuracy of the comics," Mr. Sommers, the writer, said, "but there's definitely a willingness, over the decades, to latch onto new ideas and new theories. Ant-Man in particular involves a very specific technology that shrinks you down to an atomic and subatomic level so, now at least, making sure the science is as accurate as possible is especially important."

In fact, there's a scientific logic to the design of the Ant-Man suit in the movies that wasn't in the original comics: The helmet is fully contained, with a mouthpiece that presumably allows the shrunken protagonist to metabolize regular-sized but relatively giant air molecules.

Not that the Ant-Man movies completely unpack the science. They go into relatively little detail about the "organic atom reduction," apparently reducing the distance between atoms, that makes Ant-Man shrink, or what happens to his mass when that takes place. "That's the least credible part," Dr. Michalakis said. "How does a 160-pound man ride on ants, if he hasn't somehow converted his mass into something else? You cannot just convert it into energy without con-

taining it. Otherwise you have a nuclear bomb of unprecedented destructive power."

Mr. Broussard, the producer, acknowledged that "the movies have to work as movies, so we take a lot of liberties." He added, "We have the philosophy that the most fun idea wins. And what's great is that we'll get in the room with someone like Spiros, and we'll pitch them an idea that has no basis in science fact, and they'll be the first to say, that's cool, do that. Which usually tells us we're on the right track."

It helps if the scientific consultant appreciates the needs of dramatic storytelling. It was Dr. Michalakis who mentioned the microscopic creatures known as tardigrades as something striking that one might encounter in the movie's Quantum Realm. "They remind me of the massive worms from 'Dune,'" he said. And he approves of the movie's particular take on quantum entanglement, which is a stretch scientifically but narratively satisfying. "It's actually a good example of how real science can move the story forward."

For the record, he does have a possible explanation for the science behind Ant-Man's organic atom reduction. (It involves replacing electrons with their heavier cousins, muons, reducing each atom to two-hundredths of its original size.) There will be plenty of time to delve deeper into the science in future installments, though. For now, he's excited to see science play a part in a summer popcorn movie, where it might ignite the imagination of young audiences.

"When I think about science outreach, I can't think of a more fun way to do it than with superheroes."

Paul Rudd calls himself a superhero in fake life

BY KATHRYN SHATTUCK

Paul Rudd came prepared to talk about a whole lot of nothing.

"I can't tell you anything," he said, explaining the confidentiality clauses that prohibited him from divulging more than a glimmer of the story line and techno-wizardry behind "Ant-Man and the Wasp."

"I feel terrible for you," he added, unleashing the dazzling nice-guy smile instantly recognizable to fans of "Clueless," "This Is 40" and "I Love You, Man."

Here's what we know: As this sequel begins, the ex-con Scott Lang (Mr. Rudd), who becomes the minuscule Ant-Man thanks to a suit invented by Dr. Hank Pym (Michael Douglas), is under house arrest for violating laws that regulate superheroes. But after surviving the quantum realm in the original film, Scott is sent back in with Pym's daughter, Hope van Dyne (Evangeline Lilly) — outfitted as the Wasp, complete with wings and blasters — to rescue her mother and Pym's long-missing wife, Janet (Michelle Pfeiffer).

Riding the wave of women's empowerment, the film is one of the rare instances when a female superhero has landed in the title of a Marvel movie.

"Ant-Man and the Wasp, we're a team," Mr. Rudd said.

"She is, in the first film, somebody who I think was probably so much better suited for the job than I was and finally has been given the wherewithal to be who she was born to be, which is a badass and the rightful heir to the throne."

Looking natty in a crisp summer suit

at an Argentine bistro in the TriBeCa neighborhood of New York, just around the corner from where he lives with his wife, Julie, and their children, Jack, 13, and Darby, 8, Mr. Rudd, 49, talked about his midlife foray into superheroism, the spoils of fame and the burden of being so darn likable.

Here are edited excerpts from the conversation.

I've read that you don't like the interview process.

I'll be honest with you: I never feel totally comfortable talking about myself in this kind of setting, and there's always some kind of filter. I've done it for so many years now that I wonder if my own narrative is even true anymore or if I'm just going off of answers I've given in interviews. Like, is that really how it started? Is this really how I feel about things or is that because I answered this question once and now it has become true? No, I don't love it, but it really is part of the gig, isn't it?

It is when you're a superhero. Or do you prefer the term action figure?

I call myself an action figure in real life and a superhero in fake life.

What's it like moving into that realm at what we might call the midpoint of your career?

I hope not. If it is, we've just predicted my death. [Laughing] I was very excited by it. It was so out of left field and something so different than anything I've done, and I thought this would be the first thing that my kids would be able to watch.

My career, it's weird. I definitely have been on film sets and looked around and realized I'm the veteran of



TONY CENCOLA/THE NEW YORK TIMES

the group. It just kind of happened without me noticing. But when I look back I realize my career has had several left turns. Before "Anchorman" happened, I was never really in comedies like that, so that whole [Judd] Apatow chapter of my career is a left turn. As an actor, I've always wanted to do different roles and different genres and things that were interesting to me but certainly not the same thing.

And then you ended up helping to write the screenplay for both the original and this sequel. What did you bring that wasn't already there?

All the good stuff. That's going to play real well in print. The tongue-in-cheek humor and sarcasm.

I imagine there's a whole training and diet regimen for a role like this.

While we were shooting, I was eating way more salmon than any one person

should eat and a lot of beets. Beets are something that came to me as an adult. I love them. I never ate them as a kid. There was always something way too intimidating, maybe just that the color would bleed everywhere. And I think about things in terms of cardio, like any kind of exercise where you sweat to get your heart rate up and then maybe an hour of weight training. Oh God, listen to me. I hate myself right now. If I start talking in terms of lats and delts and reps and sets, kill me.

Someone called the latest Hasbro action figure the most realistic likeness of you yet. Is having your own toy the pinnacle of success?

Somebody showed me a picture where it's smirking, right? I have a Mr. Potato Head of Ant-Man. And one of the coolest things was the Lego figure. I grew up playing with Lego and my kids have Lego, and that one stopped me in my tracks. I was also in a New York Times crossword puzzle. I was an answer and that was incredible. I love crossword puzzles and I do them, and then to do the puzzle and discover myself was... there were a couple of moments when you're like, "You know what? This is working out." And that was one of them.

Did you immediately recognize yourself as the answer to the question?

What if I didn't? I put down Judd. I thought the question was about Wynonna Judd. No, I got it. To be fair somebody had alerted me to it and said, "Dude, you're 21 Across!"

You're famously likable. Even the bartender here told me so. Does that ever grow irksome?

There is something a little milquetoast and benign about that phrase. As far as likability, I don't think that I have more than most people, but I try not to be rude. I like when people are polite and kind to other people. I just think life is so hard, why make it harder?