COVID-19 pandemic motivates physical scientists and engineers to create global solutions

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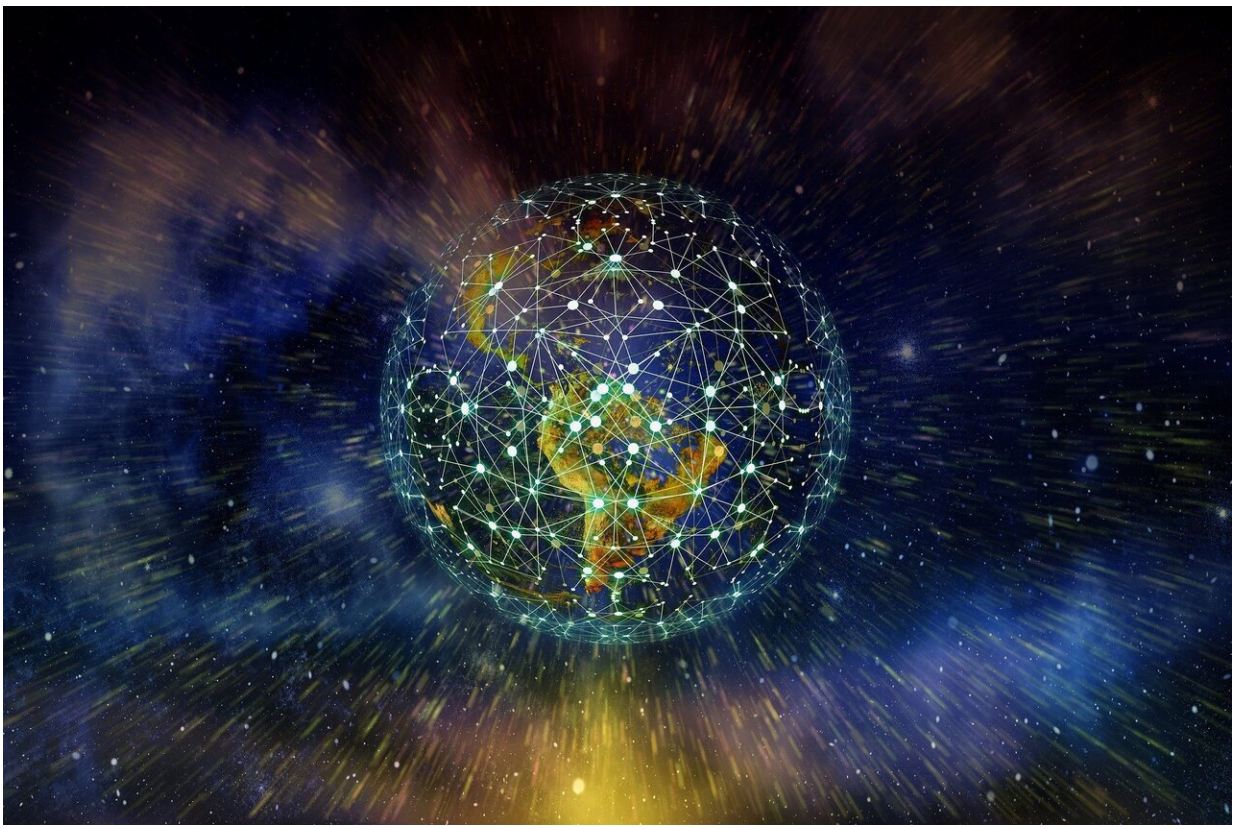

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An international team of researchers is urging physical scientists and engineers to join the fight against the novel coronavirus (COVID-19)

pandemic, and contribute toward long-term creation of knowledge and technologies for infectious respiratory diseases in general.

Led by Northwestern University's Jiaxing Huang, the team has authored a perspective article published yesterday (April 8) in the journal *ACS Nano*.

"Public health and healthcare workers are at the frontline to contain and mitigate the spread of this disease," the researchers write. "Although intervening biological and immunological responses against viral infection may seem far from physical sciences and engineering that typically work with inanimate objects, there actually is much that can—and should—be done to help in a global crisis like this."

Anxiety sparked action

Huang's early anxiety about the initial coronavirus outbreak inspired him to lead the call to action. Feeling confused and powerless, he coped by studying textbooks and medical literature about respiratory viruses.

"This exercise generated a lot of questions and ideas, and I realized a lot could be done by physical scientists and engineers to help," said Huang, a professor of materials science and engineering at Northwestern's McCormick School of Engineering. "After all, before viruses are picked up by a person, the transmission and spread occur in the physical space and in the material world."

Huang's early effort motivated Haiyue Huang, a graduate student in his laboratory at Northwestern, to join him to conduct intensive reading, analysis and brainstorming.

"Intellectually, it was a very stimulating period of time," she said. "I was amazed by how our physical intuitions—and sometimes wild

guesses—can connect with observations in medical literature."

Solution receives NSF RAPID grant

The two first drafted the call to action for physical scientists and engineers, and incorporated part of it in a white paper to the National Science Foundation (NSF).

"The NSF is perfectly positioned to rally physical scientists and engineers to act on the challenges associated with a crisis like COVID-19," said Huang, "I received warm encouragement from the division of materials research, and coincidentally, NSF quickly released a call afterwards for proposals through their RAPID mechanism.

Huang's laboratory received a RAPID grant, and Haiyue Huang became one of the designated "essential" researchers working around the clock to explore an on-mask chemical modulation method that can reduce the infectiousness of virus-laden respiratory droplets.

Building connections around the globe

To validate their hypotheses and ideas, Huang consulted with a team of biomedical researchers and frontline clinicians in China to understand the problems they encountered in their battle against COVID-19, and to further polish strategies. Dr. Xin Zheng, a Northwestern alumna, and currently a professor and physician in Wuhan, China, quickly answered Huang's call. In the early days of COVID-19, she had been puzzling over the virus' unexpected features and behaviors.

"We were under extremely high pressure those days, but we chose to fight this virus," Zheng said. "Being physicians, everyone here is a soldier in this battle."

Zheng is the director of the Department of Infectious Disease at the Union Hospital in Wuhan, which is affiliated with Huazhong University of Science and Technology. She said physical scientists and engineers can focus on three key elements: blocking the source of viruses, breaking the chain of spread and protecting the most vulnerable populations.

"We all wear personal protective equipment daily," she added. "We know there is much room for improvement by physical scientists and engineers."

Areas of opportunity

In the perspective article, the researchers outline areas where scientists and engineers could help:

- Insert new barriers along the infection pathways based on physical sciences and engineering;
- "Pollute" the exhaled respiratory droplets with antiviral compounds, reducing the viability of virus at the source;
- Engineer stimuli-responsive surfaces to accelerate the inactivation of viruses deposited on doorknobs, touch screens, countertops, and other areas inside hospitals and homes;
- Make personal protective equipment (PPE) more effective, including goggles that won't fog and masks and suits that won't cause allergic reactions or accelerate fatigue of frontline clinicians, who are already under tremendous stress;
- Invent smart PPE with enhanced protective, communication and monitoring functions for clinicians working in the most dangerous situations;
- Develop degradable materials and more sustainable approaches to process plastic PPE waste safely;
- Think ahead about high-throughput, reconfigurable and flexible

manufacturing that can handle the explosive surge in demand for critical medical supplies;
- Develop distributed testing systems with rapid sample-in-result-out turnaround, and fast automatic data acquisition to better equip public health workers and policy makers for making faster and more accurate decisions;
- Develop new model systems to better understand how viruses transmit, spread and physiochemically interact with their surroundings.

The authors emphasize that researchers can still contribute even if they have little or no experience with infectious diseases. This message resonated with Hua-Li Nie, another Northwestern alumna from Huang's group, and currently an associate professor at Donghua University in Shanghai.

"When I was contacted by Professor Huang, who is my former adviser, I was stuck at home at the time." Nie said. "My field is not directly related to infectious diseases. But I was intrigued by Professor Huang's suggestion, and started to study the topics. Soon I realized that there were things I could do to help, too. Eventually, we were able to connect to a few frontline clinicians through friends of my friends and conduct meaningful discussions remotely."

Proactive preparation

At Northwestern, Huang has already encouraged students in his Conducting Polymers class this past Winter Quarter to think about ways to contribute.

"I want engineering students to be proactive and think of what they can do to help the society," said Huang, "Haiyue happened to be my teaching assistant in that course, so she supervised two students to demonstrate a

concept of sanitizing facial masks by electro-heating through a conducting polymer coating.

"Crisis like the COVID-19 pandemic transcends all types of boundaries," said Huang, "I hope to see people breaking the boundaries and working together to create solutions."

More information: Haiyue Huang et al. COVID-19: A Call for Physical Scientists and Engineers, *ACS Nano* (2020). DOI: 10.1021/acsnano.0c02618

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