How Do You Make Practical Use of Light to Solve Problems?

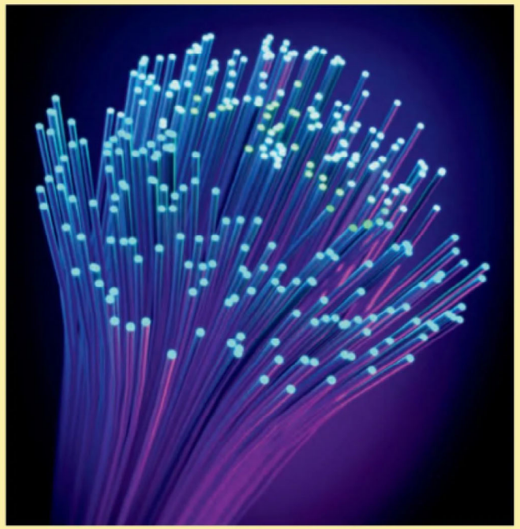

IMAGE BY ONIMATE / ISTOCK

FROM SPEEDING UP THE FLOW OF INFORMATION THROUGH FIBER OPTIC CABLES to studying the modulation of brain circuits, the many practical uses of light are on display at BU's **Photonics Center**.

"You can think of it as an umbrella for research where light plays a pivotal role," says Professor **Tom Bifano (ME, MSE, BME, ECE)**, the center's director. "That doesn't necessarily mean that your research is on making an optical system or understanding photonics better—it might be about treating cancer, and that cancer research requires you to use a light-based approach."

The center has been a natural home for convergent research since it opened in 1996, says Bifano.

Most of its 60 faculty are affiliated with multiple ENG departments and divisions. (Bifano, who is a professor of mechanical engineering, materials science and engineering, biomedical engineering, and electrical and computer engineering, is not at all atypical for the center.) Many come from physics, chemistry or other departments of the College of Arts & Sciences, or from the School of Medicine. Along with more than 100 grad students and postdocs, the faculty work on research and technology development encompassing lasers, nonlinear optics, photonic materials and devices and more. A typical Photonics project "requires sophisticated advances in two or more areas," Bifano says, "so an expert in one area or the other is not sufficient to make the progress that's needed."

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In all Photonics projects, Bifano adds, researchers are solving real-life problems. "We're teaching our students to function not only in a university but also in the larger world," he says. "That's really at the heart of the Societal Engineer."

Yannis Paschalidis (top) brings his data expertise to bolster an invention of metamaterials pioneer Xin Zhang (bottom).

$37 MILLION
IN GRANTS LAST YEAR FOR THE PHOTONICS CENTER

How do you make a better MRI—and bring it to remote villages?

If emergency techs could scan a stroke sufferer's brain on the spot, rather than transporting them to the hospital, it would be a boon for healthcare, says Professor **Stephan Anderson (MED, ME)**, a radiologist, imaging expert and member of the Photonics Center.

That vision for a better magnetic resonance imaging (MRI) scanner might be realized with ultra-low-field MRI, meaning it would use a much smaller magnet than is typical in hospital-based machines today. So far, though, attempts at producing ultra-low-field MRI have been hamstrung by the low field's low signal-to-noise ratio.

Enter Photonics Center faculty member Distinguished Professor of Engineering **Xin Zhang (ME, ECE, BME, MSE)**. She has invented a metamaterial—a material engineered to have properties not found in nature—that interacts with electromagnetic fields to strengthen the signal and reduce the noise in an imaging system, improving the ratio by up to a factor of 10.

"MRI uses the radio frequency band of the electromagnetic spectrum, and light uses the optical band—higher frequency, lower wavelength—of that same spectrum," says Tom Bifano, Photonics Center director, in explaining MRI's place within light-based research. "The physics of both are the same."

So, Zhang can boost the signal to be gained from a weaker magnet. But there's still a lot of noise to cut through. That's where Distinguished Professor of Engineering **Yannis Paschalidis (ECE, SE, BME)** comes in. Paschalidis is an expert in using machine learning and data science techniques to extract valuable signal from what appears to be noise.

This is why the three professors have received a $1.5 million award from the BU Kilachand Fund for Integrated Life Sciences and Engineering to develop low-field MRI. If successful, the team's technology will be not only cheaper but also safer, and portable. That also means their scanners could become widely available in developing countries, where MRI is rare today.

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