THE AUTHOR FILE

Vahid Sandoghdar

From a physicist who explores biology's unknowns, greater precision by linking two methods.

"I've jumped fields," says Vahid Sandoghdar. "I belong to several, maybe, or none." Sandoghdar directs the nano-optics division at the Max Planck Institute for the Science of Light and teaches around 200 meters away in the physics department of University of Erlangen-Nuremberg. By training he's a physicist in quantum optics. Around 2006, he began working with labs with biological materials. In 2011, Sandoghdar added a wet-lab section to his lab for sample prep, which makes collaboration with biologists easier. It strikes him as remarkable that many basic concepts in biology are unknown. "They're not known because they're not easy to study," he says. To try and change that and to draw physicists to biomedicine, a few years ago he set up the Max Planck Center for Physics and Medicine. The center is getting its own building, with construction underway. It can keep growing, he says, through a new graduate school as well. In recent work from his lab, he and his team of postdoctoral fellows and graduate students present iNTA, a method to study various types of particles in suspensions. The method combines an approach he developed called interferometric detection of scattering (iSCAT) with nanoparticle tracking analysis (NTA), which has long been used to capture and analyze the light individual particles scatter and determine diffusion constants of particles that move as a result of Brownian motion. To track suspended particles, NTA uses dark-field microscopy. "On a dark background, you see little points of light moving around," he says. Whereas NTA cannot be readily used to discern small populations of particles close together, iNTA can, he says. iSCAT uses light scattering and a reference light field to assess nanoscopic objects optically. Using the nano-shadow they throw when illuminated, the size of the particle can be calculated. With iNTA, "what we have done is we have replaced a dark field microscope with an iSCAT microscope," he says. The team assessed particles 10–30 nanometers in diameter, but smaller particles should be possible too, he says. The team tested iNTA on extracellular vesicles, which scatter weakly. "They're fluffy things," he says. These liquid-filled vesicles are tough to image in heterogeneous mixtures,

Vahid Sandoghdar. Credit: N. Bonakdar

of which urine and blood are challenging examples. When imaging extracellular vesicles with electron microscopy, it's hard to maintain vesicle integrity. Calculating vesicle cross-section with an optical method such as iSCAT on the basis of light scatter is non-trivial, he says, but they managed it. The method came about serendipitously, says Sandoghdar. Postdoctoral fellow Anna Kashkanova and PhD student Martin Blessing were double-checking the size of purchased particles and saw that iSCAT had greater sensitivity than NTA. "It was a process over a couple of months where things were getting more and more exciting," he says. iSCAT has been commercialized, and Sandoghdar hopes iNTA can be, too. It should be an automated "plug-and-play device" that does not ask a cell biologist for quantum optics know-how. The lab is working with other teams to explore the ways iNTA can be used for blood and urine analysis. Separately, the scientists are studying whether iNTA can help distinguish different SARS-CoV-2 activation states.

Sandoghdar takes a holistic approach to work, which "can completely absorb me," he says. "And that big picture kind of keeps your mind occupied all the time." He was born in Tehran, Iran; attended University of California, Davis as an undergraduate; and completed his PhD research in physics at Yale University, supervised by Edward Hinds, who is now at Imperial College London, and Serge Haroche, who later received the Nobel Prize. When Haroche, who had been splitting his time between Yale and École Normale Supérieure, moved to the latter full-time, he invited Sandoghdar to join the lab as a postdoctoral fellow. After the fellowship, Sandoghdar hit the faculty job market during a dry spell. He joined the University of Konstanz, where he completed his habilitation as a member of principal investigator Jürgen Mlynek's group. "Some of the ways that I run my group are clearly influenced by my three big advisors before I became independent," says Sandoghdar. In Konstanz, Sandoghdar developed iSCAT and saw its first signals. Even though his professional future was unclear, "that was really an amazing time," he says. The experiments there formed "my line of research over the past 20 years," he says. After Konstanz, he joined the faculty at ETH Zurich, where he felt free to try different experiments and interdisciplinary projects.

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"Vahid epitomizes for me the experimental physicist who really questions the status quo: 'Why can this not be done? Are you sure it's impossible? If you think about it and you really dig down to the basics it should work.' And then he actually does it," says Philipp Kukura, a former postdoctoral fellow in the lab, now with his own lab in the University of Oxford's Department of Chemistry. When Sandoghdar finds the time, he enjoys sports, such as jogging, skiing and swimming. "Soccer was a passion," he says, but a knee injury has kept him off the pitch. He also enjoys cooking and exploring different combinations within fusion cuisine. Another passion is lamp design. The lamps "usually try to combine functionality and aesthetics," he says. "That's a lot of fun; I like spending time in a mechanical workshop." ❐

Vivien Marx

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Reference

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