DATE: JULY 7, 2021 — FOR IMMEDIATE RELEASE
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NOTE: Press passes are available for verified journalists who wish to attend the virtual 2021 M&M Physical Science Plenary Session, featuring Dr. Ondrej Krivanek, 2020 Kavli Prize Laureate.

Building on Galileo's gaze: What will come into focus next?
Kavli Prize Laureate Ondrej Krivanek to speak on current projects at August conference

RESTON, Va. — Ondrej Krivanek already brought the world of electron microscopy into atomic focus, and received the Kavli Prize for his work, but he has no plans to stop improving the tools that allow researchers to visualize how the smallest components of our world work in different configurations and how they can be manipulated for next-generation technology.

He will speak about his recent work on Aug. 3, during the virtual 2021 Microscopy & Microanalysis Physical Science Plenary Session. The conference is co-sponsored by the Microscopy Society of America and the Microanalysis Society.

"Galileo took the tool the Dutch used to keep an eye on enemy ships, improved it, and pointed it at the night sky — fundamentally changing our understanding of the universe," Krivanek said. "He found a new application for interesting technology. We're doing exactly the same thing."

Krivanek was one of the researchers who, in 2002, obtained the first aberration-corrected, atomic-level resolution electron microscope images of gold nanoparticles. Optic aberrations, or irregularities, can make it difficult to see an intended target, similar to near or far-sightedness in a person. Aberration correction is like eyeglasses for the microscope, Krivanek said.

"Before aberration correction, we were looking at samples through electron lenses with the quality of the bottoms of beer bottles," Krivanek said. The correctors he and collaborator Niklas Dellby first built were cylinders six inches in diameter and seven inches tall, containing some 40 different electron-optical elements. They were incorporated in the microscopes, allowing for crisper and finer imaging by correcting the optics of the electron beam. "Ultimately, if you want to really understand a piece of material, you need to see it atom-by-atom."

Krivanek serves as co-founder and president of Nion, a Washington-based company that facilitates the research and development of electron microscopes and other instruments that use electrons to visualize target samples with high spatial resolution. He frequently collaborates with researchers from universities and laboratories around the globe. In recent years, Krivanek and his collaborators have turned their attention to elucidating even more information with electron microscopy through vibrational spectroscopy.

Similar to how our fingers pluck guitar strings to produce various notes, vibrational spectroscopy uses fast electrons to "ping" materials, revealing their precise characteristics.

"These techniques are powerful: they can analyze bonding arrangements, identify chemical compounds, and probe many other important properties of materials," Krivanek said. "We are combining vibrational spectroscopy with high spatial resolution to open up the study of localized vibrational modes in many different types of nanostructures."

There are now several powerful examples of the techniques applied, including identifying target molecules in minute quantities of organic material at nano-level resolution. The technique also enabled the detection of vibrational modes of a single silicon atom embedded in graphene — a feat thought impossible prior to Krivanek and his collaborators developing an aberration-corrected microscope capable of vibrational spectroscopy.

"Centuries after Galileo's work, we're still adapting and improving our tools to better see the building blocks of our universe," Krivanek said. "In this work, we have abilities that were completely unthinkable just ten years ago. Think what we'll have in another few years."