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In the Lab

By Asian Scientist Newsroom

## An Optical Ruler For Nanoscale Measurements

A research group in Singapore has developed an optical ruler that can be used to make ultra-high resolution measurements.



*AsianScientist* (Oct. 2, 2019) – Scientists at Nanyang Technological University (NTU), Singapore, have developed a method to measure distances at the nanoscale. They reported their findings in the journal *Science*.

The smallest distance that optical devices can reliably image is equal to half the wavelength of the light used, known as the diffraction limit, which is more than 400 nanometers. However, since scientists are interested in observing extremely small

objects like viruses and nanoparticles that range in size from 10-100 nanometers, an optical resolution of 400 nanometers is insufficient.

Currently, nanometer-scale measurements are made using indirect or non-optical methods, such as scanning electron microscopy, which are not always feasible, can be time-consuming and require costly equipment to operate.

In the present study, researchers led by Professor Nikolay Zheludev and Dr. Yuan Guanghui at NTU discovered that infrared light can be used to directly observe displacements of just one nanometer. To achieve this, they cut more than 10,000 tiny slits in a 100 nanometer-thick gold film, which was then used to diffract laser light, exploiting an optical phenomenon known as 'superoscillation' for ultra-high resolution imaging.

“Our device is conceptually very simple,” said Yuan. “What makes it work is the precise pattern in which the slits are arranged. There are two types of slits within the pattern, oriented at right angles to each other. When polarized laser light strikes the gold film, it creates an interference pattern containing extremely tiny features, much smaller than the wavelength of light.”

Their theoretical calculations indicate that devices based on this method could ultimately measure distances down to  $1/4000$  the wavelength of light, to roughly the size of a single atom.

“This method of optical measurement will be very useful in future, such as in the manufacturing and quality control of electronics, where extremely precise optical measurements are required, and to monitor the integrity of nano-devices themselves,” said Zheludev.

Moving forward, the team aims to develop a compact version of their apparatus using optical fibers. They also intend to commercialize the technology as a new type of ultra-precise optical ruler, which would be beneficial to advanced manufacturing processes which are the backbone of the telecommunications industry.

The article can be found at: [Yuan & Zheludev \(2019\) Detecting Nanometric Displacements With Optical Ruler Metrology.](#)

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Source: [Nanyang Technological University](#); Photo: Shutterstock.

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