Website address:
https://www.gesundheitsindustrie-bw.de/en/article/press-release/3d-microscopy-laser-rotates-samples-contact-free

3D Microscopy: Laser Rotates Samples Contact-Free

Until now, it has been technically nearly impossible to rotate highly sensitive samples in all directions under a microscope without making contact. Researchers at the Karlsruhe Institute of Technology (KIT) have developed a new laser-based technique that allows microscopic samples such as cells to be rotated contact-free in all three spatial directions. The laser creates tiny temperature differences in the liquid, which trigger gentle fluid flows that move the sample. This protects delicate samples and enables more accurate three-dimensional images—an important step for basic medical research.

Modern optical microscopes can produce extremely sharp images in a single plane, comparable to a photograph, but depth information is often imprecise. To overcome this limitation, samples must be imaged from multiple viewing angles and the images combined into a three-dimensional model. This requires rotating the object under investigation. The new method makes it possible to do this in an exceptionally gentle manner.

Rotation without physical contact

The research team led by Professor Moritz Kreysing and Dr. Fan Nan at the KIT’s Institute of Biological and Chemical Systems uses a laser to locally heat the liquid in which the sample is suspended. This creates subtle fluid flows that can be used to precisely move freely floating microscopic objects—entirely without mechanical microtools such as tiny pipettes, needles, or grippers. “We do not manipulate the sample directly,” says Nan. “Instead, we control the movement of the surrounding liquid so that the object aligns itself.”

Laser-driven flows have been known for some time, but previously only enabled motion within a single plane. Now, controlled rotation in three-dimensional space is also possible: by rapidly scanning the laser, the researchers generate a spiral flow that gently rotates objects—similar to a small paper boat spinning on its own in a tiny whirlpool.

Benefits for medicine and technology

Three-dimensional control allows cellular structures to be captured more effectively from different perspectives. “When samples can be aligned more precisely, we see more details,” says Kreysing. “This is a key prerequisite for better understanding biological structures and processes.” In the long term, the method could also become relevant for contact-free micromanipulation, microscopic robotics, or highly precise manufacturing at the smallest scales, according to Kreysing.

Publication:
Fan Nan, Weida Liao, Adrián Puerta, Josephine Spiegelberg, Elena Erben, Ralf Mikut, Stephan Allgeier, Martin Wegener, Eric Lauga & Moritz Kreysing: Helical opto-thermoviscous flows drive out-of-plane rotation and particle spinning in a highly viscous micro-environment. Light Sci Appl, 2026. DOI 10.1038/s41377-026-02303-8.

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