Synergy between biology and physics drives cell-imaging technology

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Developing techniques to image the complex biological systems found at the sub-cellular level has traditionally been hampered by divisions between the academic fields of biology and physics. However, a new interdisciplinary zeal has seen a number of exciting advances in super-resolution imaging technologies.

In the June issue of Physics World, Paul O'Shea, a biophysicist at the University of Nottingham, Michael Somekh, an optical engineer at Nottingham's Institute of Biophysics, Imaging & Optical Science, and William Barnes, professor of photonics at the University of Exeter, outline these new techniques and explore why their development is an endeavour that requires the best efforts of both biologists and physicists.

The traditional division between the disciplines has found common ground in the effort to image cellular functions. While some living cells are larger than 80 micrometres across, important and interesting cellular processes - such as signalling between cells - can take place at length scales of less than one micrometre.

This poses serious challenges for traditional imaging techniques such as fluorescence microscopy, whereby optical microscopes are used to observe biological structures that have been tagged with fluorescent molecules that emit photons when irradiated with light of a specific wavelength, as these offer a resolution of at best 200 nanometres. Increasingly, biologists have turned to physicists for help in breaking through this "diffraction" limit.

The result has been the development in recent years of several novel techniques to extend the reach of fluorescence microscopy. These include methods such as stimulated emission depletion microscopy (STED), stochastic reconstruction microscopy (STORM), photo-activated localization microscopy (PALM) and structured illumination microscopy, all of which are capable of resolving structures as small as 50 nanometres across. These techniques build on theoretical and experimental tools common to physics that allow the physical diffraction limits of light to be broken.

As the authors of the article explain, “What is fascinating is that the experimental needs of biology are driving developments in imaging technology, while advances in imaging technology are in turn inspiring new biological questions. Many of these developments are also going hand in hand with a revolution that is taking place in biological thinking, which intimately involves physicists.”

Source: Institute of Physics