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Unlabelled super-resolution imaging using polarisation-contrast super-oscillatory microscopy
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Super-resolution microscopy is an important new tool for the biosciences, but current techniques require addition of fluorescent probes. We have developed a new technique for optical super-resolution imaging of unlabelled living cells. Optical super-oscillations allow us to create an arbitrarily small hotspot using precisely engineered interference of light. Super-oscillatory hotspots are, however, surrounded by side-bands that contain a fraction of the optical power – trading efficiency for resolution. We replace the conventional focusing lens in a confocal microscope with a super-oscillatory lens and use the pinhole to reject the light scattered from the side-bands, giving us an image with resolution determined by the size of the super-oscillatory hotspot.

To image unlabelled cells, we combine this with an advanced form of polarisation-contrast imaging. We capture four super-resolved images of the sample with different incident polarisations, from which we calculate the anisotropy magnitude and orientation. This highlights those parts of a cell with significant molecular structuring, such as actin filaments, microtubules, and even protein enriched lipid bilayers such as vesicles and cell membranes.