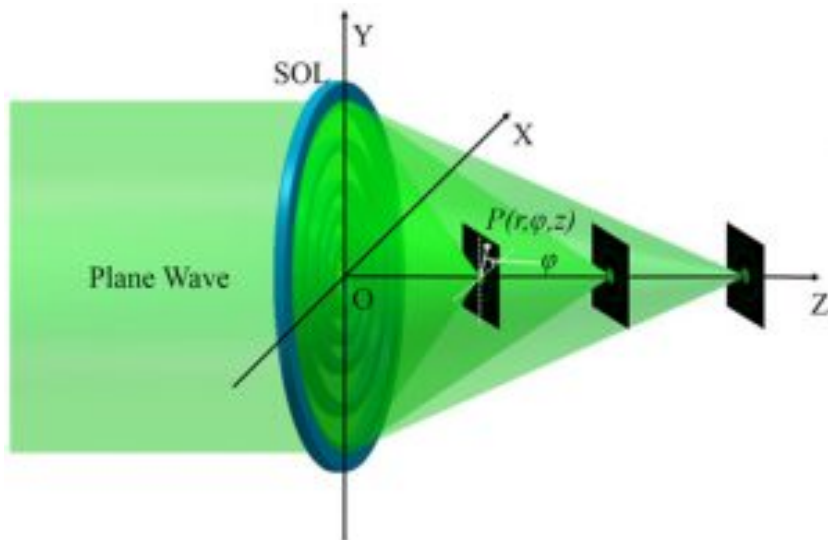


# Controllable design of super-oscillatory lenses with multiple sub-diffraction-limit foci



The conventional multifocal optical elements cannot precisely control the focal number, spot size, as well as the energy distribution in between. Here, the binary amplitude-type super-oscillatory lens (SOL) is utilized, and a robust and universal optimization method based on the vectorial angular spectrum (VAS) theory and the genetic algorithm (GA) is proposed, aiming to achieve the required focusing performance with arbitrary number of foci in preset energy distribution. Several typical designs of multifocal SOLs are demonstrated. Verified by the finite-difference time-domain (FDTD) numerical simulation, the designed multifocal SOLs agree well with the specific requirements. Moreover, the full-width at half-maximum (FWHM) of the achieved focal spots is close to  $\lambda/3$  for all the cases ( $\lambda$  being the operating wavelength), which successfully breaks the diffraction limit. In addition, the designed SOLs are partially insensitive to the incident polarization state, functioning very well for both the linear polarization and circular polarization. The optimization

method presented provides a useful design strategy for realizing a multiple sub-diffraction-limit foci field of SOLs. This research can find its potentials in such fields as parallel particle trapping and high-resolution microscopy imaging.

Source: <https://www.nature.com/articles/s41598-017-01492-y>

**Related paper:** Muyuan et al., Controllable design of super-oscillatory lenses with multiple sub-diffraction-limit foci, *Scientific Reports* **7**, Article number: 1335 (2017).