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What is the diffraction limit? From Airy to Abbe using direct numerical integration. Y. M. CALM, J. M. MERLO, M. J. BURNS, K. KEMPA, M. J. NAUGHTON[1], Boston College — The resolution of a conventional optical microscope is sometimes taken from Airy's point spread function (PSF), $0.61\lambda/NA$, and sometimes from Abbe, $\lambda/2NA$, where NA is the numerical aperture[2], however modern fluorescence and near-field optical microscopies achieve spatial resolution far better than either of these limits[3]. There is a new category of 2D metamaterials called planar optical elements (POEs), which have a microscopic thickness ($< \lambda$), macroscopic transverse dimensions ($> 100\lambda$), and are composed of an array of nanostructured light scatterers. POEs are found in a range of micro- and nano-photonic technologies[4], and will influence the future optical nanoscopy. With this pretext, we shed some light on the 'diffraction limit' by numerically evaluating Kirchhoff's scalar formulae (in their exact form) and identifying the features of highly non-paraxial, 3D PSFs. We show that the Airy and Abbe criteria are connected, and we comment on the design rules for a particular type of POE: the flat lens.

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[2]J. W. Strutt (Lord Rayleigh), *Phil. Mag.* **8**, 261 (1879)
[3]S. W. Hell, *Science* **316**, 1153 (2007)
[4]A. Kildishev, A. Boltasseva, & V. Shalaev, *Science* **339**, 1289 (2013)

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