

Confocal Infrared Microspectroscopy: Enhancing Contrast with Schwarzschild Optics

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The present limit on spatial resolution for infrared microspectroscopy with the synchrotron source is set by diffraction. All infrared microscopes employ Schwarzschild-type reflecting objectives having a secondary mirror that obscures the central portion of the system aperture. Diffraction calculations have been performed for a Schwarzschild objective using ZEMAX optical code, and the resulting diffraction pattern differs from the familiar Airy pattern. For example, the Schwarzschild diffraction pattern has a slightly narrower central (zero order) peak, but more importantly, it has much larger 1st and higher order diffraction "rings" (see top portions of the figures below). The intensity contained outside the central maximum can be quantified by calculating a radial integral. The resulting "encircled sensitivity" is shown in the bottom halves of the figures. The calculation reveals that approximately 50% of the Schwarzschild's sensitivity is outside the central diffraction peak. Fortunately, operating the microscope in a confocal mode reduces the contributions from the higher order diffraction maxima, and should produce images with both higher resolution and contrast (dashed curves in both figures).

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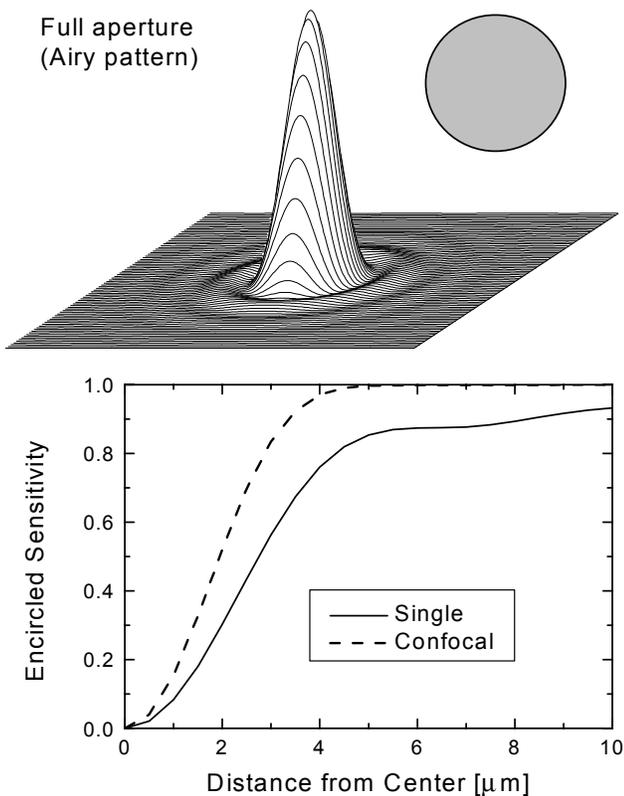


Figure 1. *Top:* Diffraction pattern for $\lambda = 4 \mu\text{m}$ light and a normal objective. *Bottom:* The resulting encircled sensitivity for this objective. About 85% of the sensitivity falls within the zero order peak (the Airy disk). Confocal operation increases this to nearly 100%.

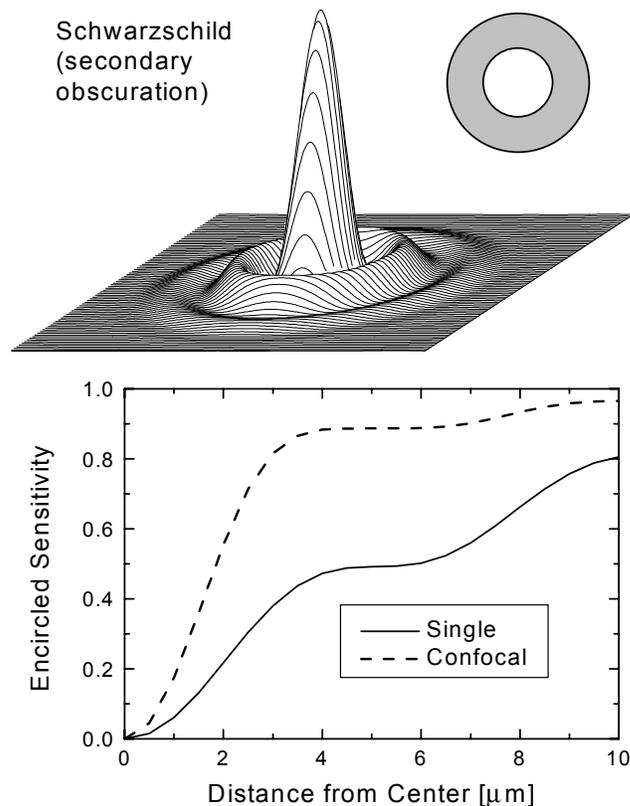


Figure 2. *Top:* Diffraction pattern for $\lambda = 4 \mu\text{m}$ light and a Schwarzschild objective. *Bottom:* The resulting encircled sensitivity for this objective. Only 50% of the sensitivity falls within the zero order peak. Confocal operation increases this to almost 90%.