Solutions to exam in Optical Physics 101018

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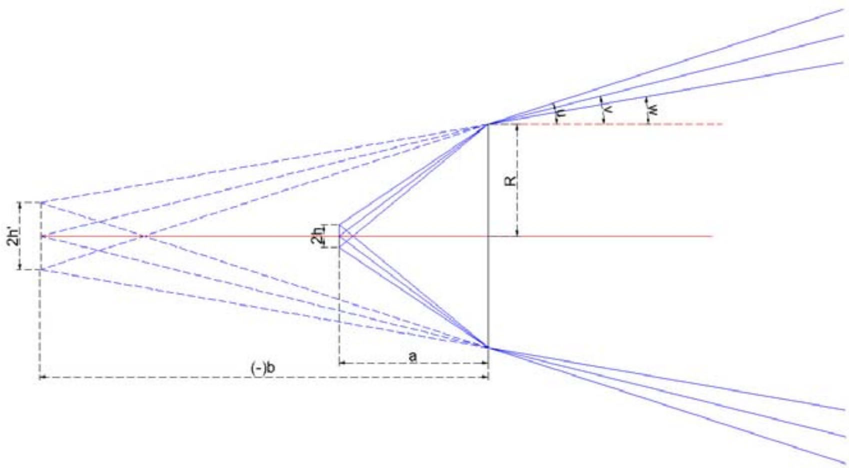

Compare the figure for a general case. In our case a is 75 mm which forms an image at (virtual) image distance -300 mm. In our case having the diameter 2h'= 8 mm.

All rays after the lens can be seen as coming from the virtual image without refracting in the lens (the lens acts as a window)

This gives for the angle of full illumination

tan w=21 mm / 300 mm

while the angle for any illumination at all is given by tan u = 29 mm / 300 mm

This means that the radius for full illumination is 25 mm + 21/300 * 10 m = 725 mm, while the radius for any illumination is 25 mm + 29/300 * 10 m = 992 mm

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Coherence function is given by

$phasefactor \cdot \mathrm{sinc}\left(\frac{2\pi da}{\lambda D'}\right)$ where the second factor is the visibility. In order to make that 0.8 the argument should be 1.12 (can be found numerically or graphically), which with d=1.2 mm, λ=647 nm and a = 100 µm gives

$$D' = \frac{2\pi da}{1.12\lambda} = 1.04\,\mathrm{m}\,.$$

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The system focal length of the two first lenses is given by

$$\frac{1}{f_{syst}} = \frac{2}{f} - \frac{d}{f^2} \Rightarrow f_{syst} = 2.25\,\mathrm{mm}$$

The second lens is the aperture stop. We can use either of two methods:

I. Calculating size and position of the entrance pupil and the take the resolved angle from that.
II. Calculating diffraction by the AS into the intermediate image and then go backwards with the magnification.

Both give the same result, of course. The radius of the airy spot in the intermediate image is

$$\frac{1.22 \cdot 200\,\mathrm{mm}}{2\,\mathrm{mm}}\lambda = 122\lambda$$

Magnification backwards gives

$$separation = 122\lambda \cdot \frac{2.25}{200} = 1.37\lambda$$

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Put the time derivative to zero in the equation and solve: $E = E_0 e^{-Qz}$

Using imaginary part of index of refraction, k, gives

$$E = E_0 \exp\left[i\left(\frac{2\pi nz}{\lambda} - \omega t\right)\right]\exp\left(\frac{-2\pi\kappa z}{\lambda}\right) \Rightarrow Q = \frac{2\pi}{\lambda}\kappa$$

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550 nm is obviously not transmitted, but wavelengths on both sides are. So it will be violet.