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Optical Resolution (sharpness, blur)

$$\text{spectral Resolution } \mathcal{R} = \frac{\lambda}{\Delta\lambda}$$

– Prism with $L \equiv \text{base length}(\text{angle} \equiv \varepsilon)$:

$$\frac{\lambda}{d\lambda} = -L \frac{d\eta}{d\lambda}$$

$$-\text{Diffraction Lattice : } \frac{\lambda}{\delta\lambda} = nN \quad (1)$$

$$-\text{Interferometer : } \frac{\lambda}{\Delta\lambda} = n \cdot \frac{\pi \cdot r}{1 - r^2} = nN_e$$

$$-\text{Planparallel Plate : } \frac{\lambda}{d\lambda} = \frac{x}{2d \tan(\beta)} \left(n - \frac{2d}{\cos(\beta)} \frac{d\eta}{d\lambda} \right)$$

a) object is self-luminescent, lightwaves are incoherent and resolution is restricted:

Tele) object far and big, min. size for resolution:

$$\Delta y_{min} = 1.22 \cdot f^{Obj} \cdot \frac{\lambda}{D} \quad (2)$$

where “Diameter stop” $\equiv D$ and view angle min. for “tele” resolution (object far and big):

$$\Delta\varepsilon_{min} = \frac{\Delta y_{min}}{f^{Obj}} = 1.22 \cdot \frac{\lambda}{D} \quad (3)$$

\Rightarrow optical resolution “Tele”:

$$\mathcal{R}_{Tel} = \frac{1}{\Delta y_{min}} = 0.82 \cdot \frac{1}{f^{Obj}} \cdot \frac{D}{\lambda} \quad (4)$$

Mikro) object close and small, min. size for resolution:

$$\Delta y_g^{min} = \frac{1.22}{2} \cdot \frac{\lambda}{\eta} \cdot \frac{1}{\sin(u_g^{max})} = \frac{1}{2} \cdot \frac{\Delta s}{\eta} \cdot \frac{1}{\sin(u_g^{max})} = 0.61 \frac{\lambda}{A} \quad (5)$$

where aperture angle from sender (source, “Obj”) $\equiv u_g$, opposed to view angle $\equiv \varepsilon$ from receiver (observer, “Oku”) and “Path difference” $\equiv \Delta s$ and “Aperture stop” $\equiv A = \eta \cdot \sin(u_g^{max})$

\Rightarrow optical resolution “Mikro endo-luminescent”:

$$\mathcal{R}_{Mik(endo)} = \frac{1}{y_g^{min}} \stackrel{backlit}{=} \frac{A}{\lambda} \stackrel{luminесcent}{\approx} 0.82 \cdot 2 \frac{A}{\lambda} = 0.82 \cdot 2 \sin(u) \frac{\eta}{\lambda} \quad (6)$$

b) object has no self-luminosity and is illuminated externally, lightwaves interfere coherently after diffraction:

Mikro) object close and small, min. size for resolution:

$$\Delta y \cdot \sin(u_g) = n \cdot \lambda \quad n \in \mathbb{N} \quad (7)$$

$$\Delta y_{min} = \frac{\lambda}{A} = \frac{\lambda}{\sin(u_g)} = \frac{\lambda}{\frac{\lambda}{\Delta y}} = \Delta y \quad A \equiv Aperture \quad (8)$$

\Rightarrow optical resolution “Mikro exo-illuminated”:

$$\mathcal{R}_{Mik(exo)} = \frac{1}{\Delta y_{min}} = \frac{A}{\lambda} = \frac{\sin(u_g)}{\lambda} \quad (9)$$