Tutorial Note

On The Resolving Power of a Grating

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(Received May 4, 1990)

An expression for the resolving power of a grating is obtained from the knowledge of the width of the principal maxima ; in order to arrive at the width of the principal maxima the expression for the intensity distribution at the focal plane of a lens is required. Here we suggest a simple and intuitive way for looking at the resolving power of the grating. Let us consider a grating consisting of N equidistant slits. The intensity distribution at the focal plane is due to the interference of wavefronts that are diffracted by N slits. Therefore both spatial and temporal coherence should exist for the interference to occur for all the N wavefronts. The condition of spatial coherence is realized by illuminating the grating from an extremely narrow slit placed at the focal of a collimator. The size of the slit is taken equal to that governed by the diffraction at the lens. The grating is assumed to be of smaller size than the lense so that spatial coherence exists at the whole grating aperture.

Let us now assume that we are interested in the beams that are diffracted in the directions of m_{th} order i.e.,

$$d \sin \theta = m\lambda$$

where d is the grating pitch. Since the diffracted pattern of a grating arises due to interference of large number of diffracted beams, the first and last diffracted beams (from Nth slit) can only interfere

if the path difference of $Nm\lambda$ between the first and diffracted beams is with in the coherence length $\lambda^2/\Delta\lambda$, where $\Delta\lambda$ is the spectral width. Therefore

$$\frac{\lambda^2}{\Delta\lambda} = Nm\lambda$$

or

$$\frac{\lambda}{\Delta\lambda} = Nm$$

Thus the resolving power of a grating in the mth diffracted order is obtained by the product of N and order m ; this is a well know result. This picture clearly shows that the incident beam should illuminate the grating in such a way that the illumination is spatially coherent over the whole grating aperture. In otherwords the size of the input slit is governed by diffraction. Increasing the slit would decrease the size of the coherently illuminated patch and hence less number of beams will participate in interference (decrease in N) and the resolving power is reduced.

Same arguments can be applied while discussing the resolving power of a Fabry-Perot interferometer/etalon. The number of beams participating interference is determined by the reflectivity of the mirror surfaces. The only difference is that the interfering beams are of not equal amplitude and hence an effective number of beams is to be computed.