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Sec.5 Exercise 4&10

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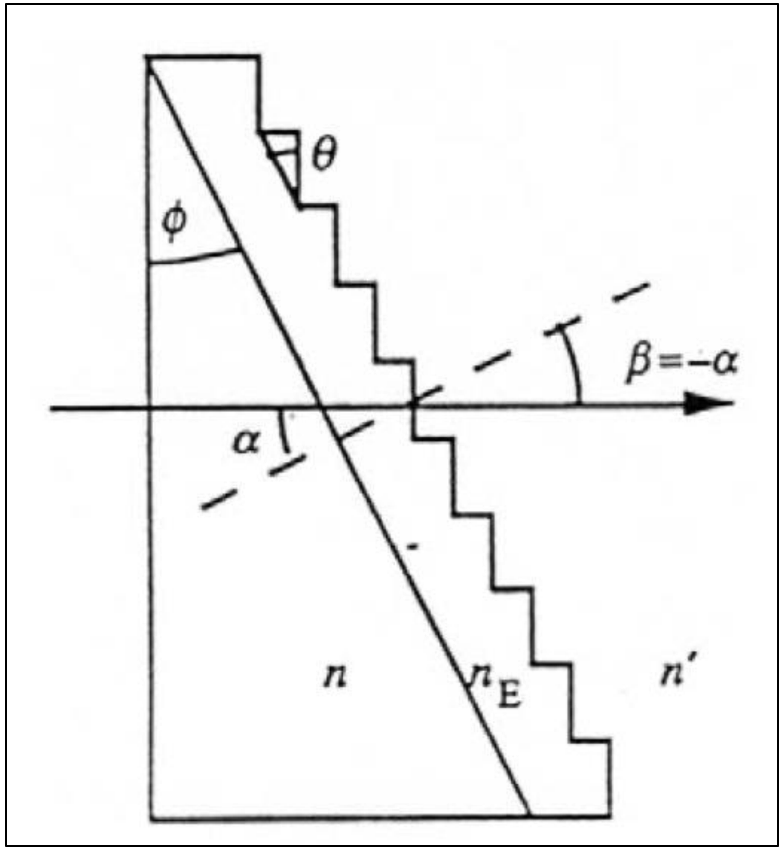
4. Describe what is meant by a grism. Design a grism with an index of refraction of 2.4 and an apex angle of 30° which will have a central wavelength of 2.2 microns in the near-infrared and a resolving power of R=500 for 2 pixels. Assume the pixel size is 27 microns.

Grism

A device that deposits a transmission grating on the hypotenuse of a right-angled prism and uses the deviation of the prism to bring the first order of diffraction on axis.



4. Describe what is meant by a grism. Design a grism with an index of refraction of 2.4 and an apex angle of 30° which will have a central wavelength of 2.2 microns in the near-infrared and a resolving power of *R*=500 for 2 pixels. Assume the pixel size is 27 microns.

The basic relationships required to design a grism are the following two.

$$m\lambda_c T = (n-1)\sin\phi \qquad\qquad R = \frac{EFL}{2d_{\mathrm{pix}}}(n-1)\tan\varphi$$

where λ_c : the central wavelength, T (=1/d) : the number of lines per millimeter of the grating, n : the refractive index of the prism material, ϕ : the prism apex angle, EFL : the effective focal length of the camera system, d_{pix} : the pixel size

Here, λ_c = 2.2 um, n = 2.4 , ϕ = 30° , R = 500, d_{pix} = 27 um, so from the first equation,

$$mT = \frac{1.4 \times 0.5}{2.2 \times 10^{-3}} = 3.2 \times 10^{2}\ [1/\mathrm{mm}]$$

When considering the first order diffraction, m = 1, so

$$T = 3.2 \times 10^{2}\ [1/\mathrm{mm}], d = 3.1 \times 10^{-3}\ [\mathrm{mm}]$$

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$$(ps)_{\rm tel} = \frac{206{,}265}{f_{\rm tel}}$$

$$(ps)_{\rm det} = \theta_{\rm pix}/d_{\rm pix};$$

EFL is described as follows;

$$EFL = \frac{(ps)_{\rm tel}}{(ps)_{\rm det}} f_{\rm tel} = 206265\,\frac{d_{\rm pix}}{\theta_{\rm pix}} = 206265\,\frac{d_{\rm pix}}{\theta_{\rm see}/p}$$

$$\theta_{\rm pix} = \theta_{\rm see}/p$$

So from the second equation,

$$500 = \frac{206265 \times 1.4 \times p \times \tan\varphi}{2\theta_{\rm see}}$$

If we determine θ_{see} (seeing size [arcsec]) and p (sampling factor [pixels]), we can obtain φ.

4. Describe what is meant by a grism. Design a grism with an index of refraction of 2.4 and an apex angle of 30° which will have a central wavelength of 2.2 microns in the near-infrared and a resolving power of *R*=500 for 2 pixels. Assume the pixel size is 27 microns.

Then, use the relational expression when the grating efficiency is a maximum

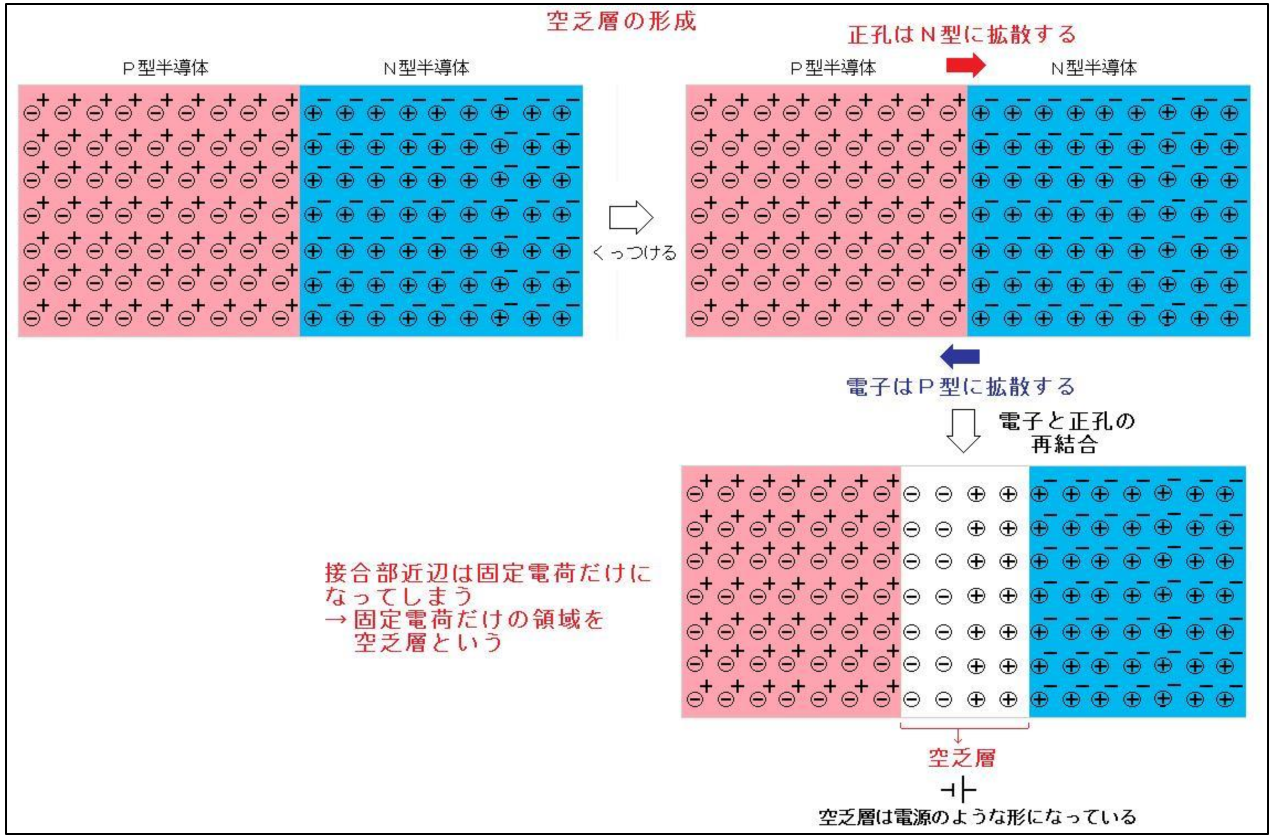
$$m\lambda_B = 2d \sin \theta_B \cos(\varphi/2)$$

From this equation, we can obtain θ_B (blaze angle of the grating) because we have already got the values of d and φ.

In this way, we can calculate two parameters, the number of lines per unit length of the grating (or the spacing of adjacent grooves) and the blaze angle of the grating, both of which are necessary to design a grism.

10. Explain the basic process in a p-n junction that leads to charge separation and the creation of an internal electric field. What happens if a positive voltage is applied to the p-side of the junction?

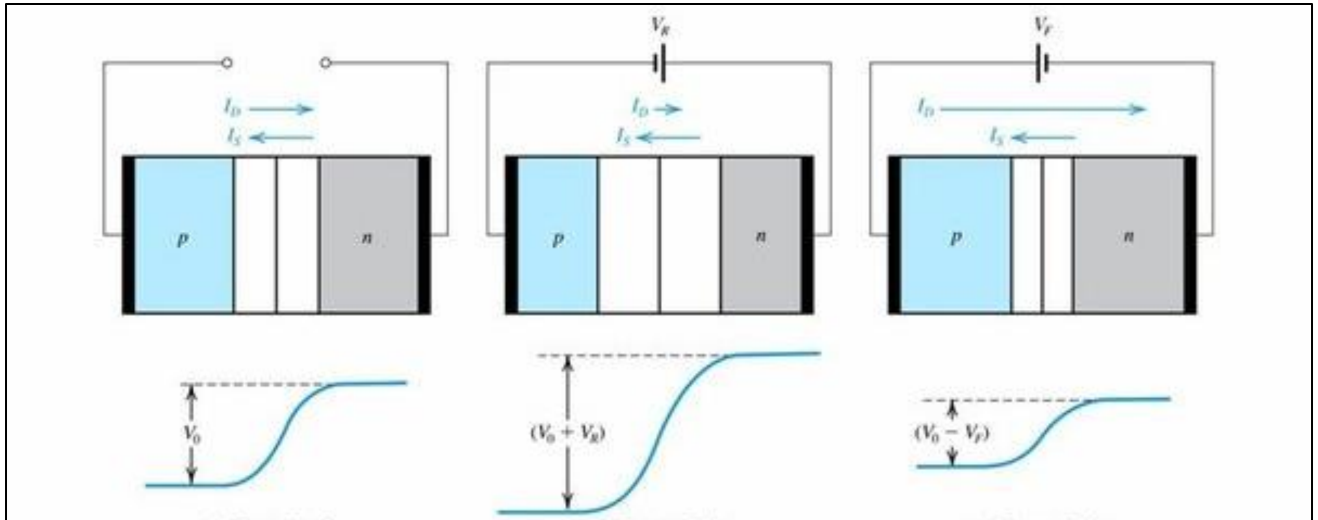
- When a p-n junction is formed, electrons from the n region tend to diffuse into the p region near the junction. Similarly, the diffusion of holes from the p-side to the n-side happens.
- Then, in a narrow region close to the junction, recombination of electrons and holes occurs, and the majority charge carriers are “depleted”.
- In this depletion region, positively charged ions are left on n-side and negatively charged ions are left on p-side.
- These ions create an internal electric field.



http://imasaracmosanalog.blog111.fc2.com/blog-entry-94.html

10. Explain the basic process in a p-n junction that leads to charge separation and the creation of an internal electric field. What happens if a positive voltage is applied to the p-side of the junction?

- This internal electric field builds up an electrostatic potential barrier (V_0) which restrains the flow of electrons from the n-type region, that is to say, repels further diffusion.
- If a positive voltage is applied to the p-side of the junction it will tend to counteract or reduce the built-in potential barrier.
- This results in a thinner depletion region, which means lower resistance and larger current.



(a) Open-circuit (Equilibrium) (b) Reverse Bias (c) Forward Bias

https://www.quora.com/Does-a-P-N-junction-diode-conduct-in-reverse-bias