Astronomical Telescopes and Instruments 2010:
Exercises on Polarization
(Due on 7 January 2011 at 11:00)

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quartz at 590 nm: $n_e = 1.553$, n_o=1.544

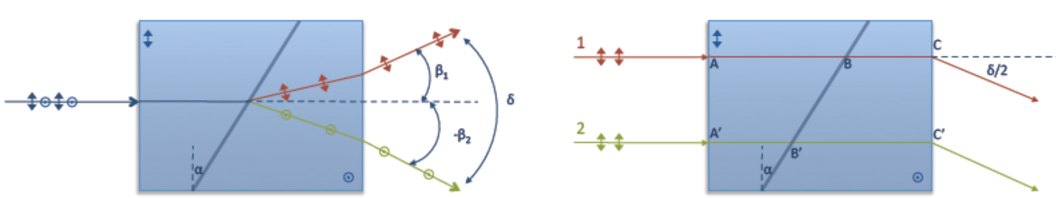
1 Wollaston prism

Express the (symmetric) splitting angle of a Wollaston prism in terms of the indices of refraction (n_e, n_o) of the used crystal and the angle α of the wedge of the prism which is the angle between the hypothenuse and the entrance face direction. Use two different approaches:
1) Compute all angles using Snell's law of refraction and the drawing on Fig.1(a).
2) Compute only the angle $\delta/2$ of both emerging beams for which any two beams that enter the prism at normal incidence are in phase after they emerge from the prism. Assume that the refraction at the hypothenuse is negligible, such that both beams traverse the entire prism in a straight line and only get refracted at the exit face (Fig.1(b)). The resulting relationship should be something like Eq.1.

Compare both results.

What is the maximum splitting angle for light with a wavelength of 590 nm one can obtain for a Wollaston prism out of quartz if you assume that α cannot become larger than 45° for practical reasons?

$$\sin\left(\frac{\delta}{2}\right) = (n_e - n_o)\tan\alpha \tag{1}$$



(a) (b)

Figure 1: Schematic drawings for approach 1 (a) and approach 2 (b).

2 Quasi-zero order retarder

Compute the thicknesses of two quartz plates that make up a quasi zero-order quarter-wave plate at 590 nm, knowing that the minimum thickness that manufacturers can polish is 750 μm.