Version at November 12, 2012.

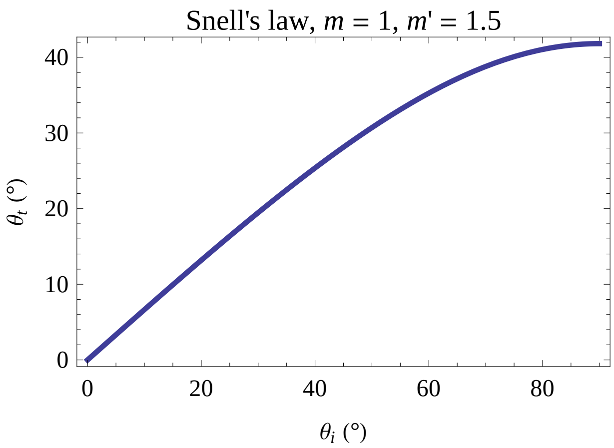
Answers for computer exercises in Electromagnetic scattering I, autumn 2012.

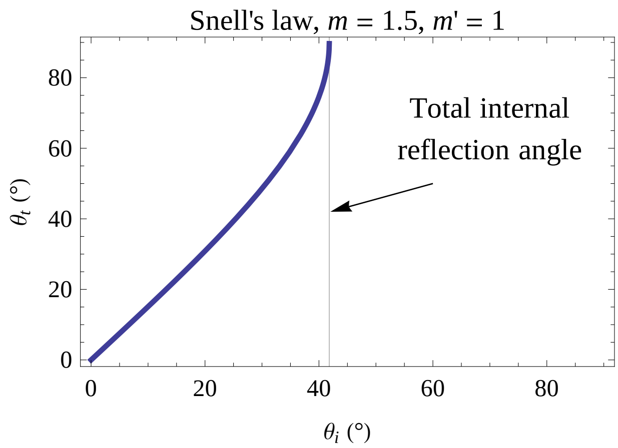
For details and questions, contact Antti Penttilä.

Ex. 1
From Snell's law a function f for the angle of transmitted wave in planar interface is simply

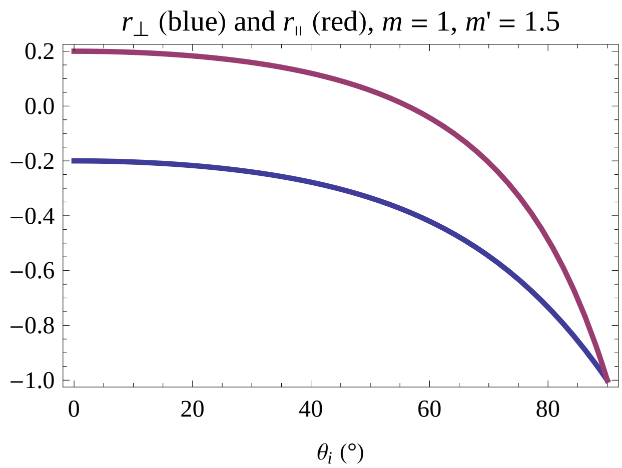
$$f(\theta_i, m, m') = \arcsin\left(\frac{m}{m'}\sin(\theta_i)\right) \tag{1}$$

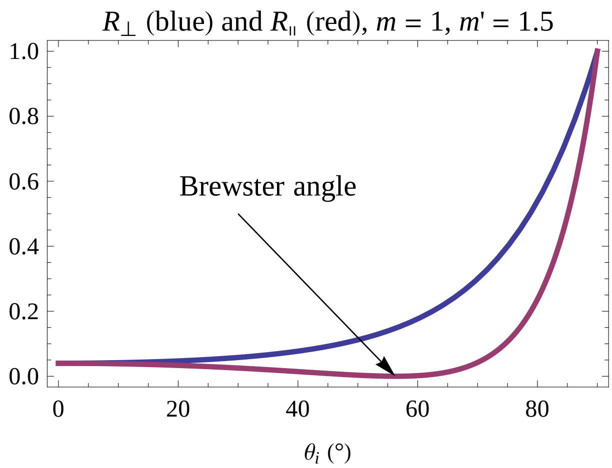
Plots for $m < m'$ and $m > m'$ could look, for example, like this:





Ex. 2
Equations for $r_\perp, r_\|, t_\perp, t_\|$ and $R_\perp, R_\|, T_\perp, T_\|$ are given in exercise handout. Plots could look like this:

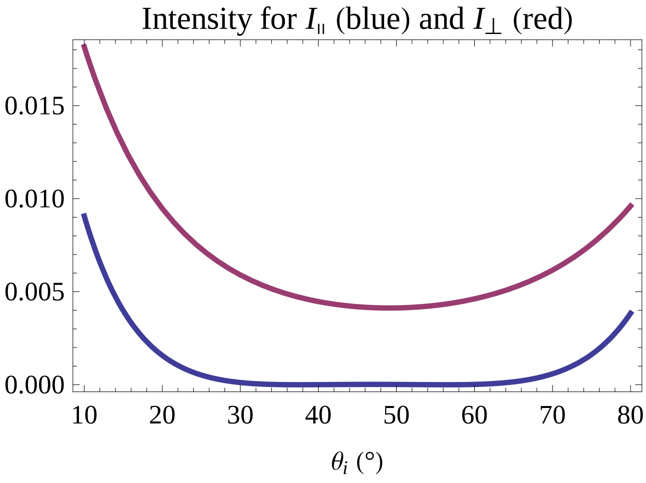




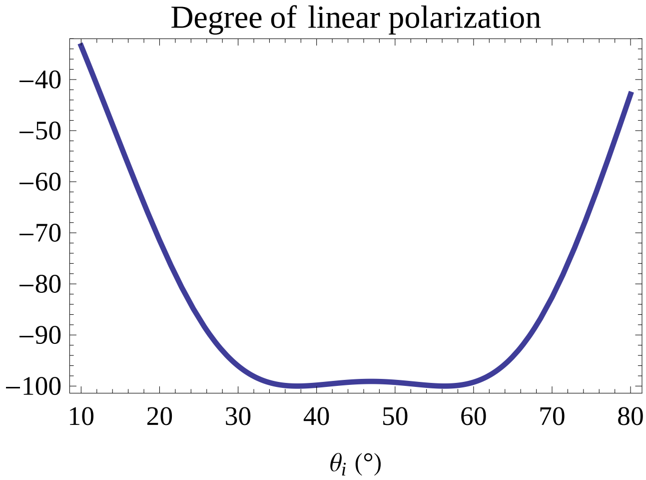
Ex. 3
Use scattering-at-interface tool with the following values: $m_0 = 1, m_1 = 1.5, m_2 = 1.3, \boldsymbol{n}_1 =$

$(0,0,1), \boldsymbol{n}_2 = (1,0,0), \boldsymbol{x}_i(\theta_i) = (-\sin\theta_i, 0, -\cos\theta_i)$ and with incident light $\boldsymbol{I}_{i\|} = (1,1,0,0)$ and $\boldsymbol{I}_{i\perp} = (1,-1,0,0)$.

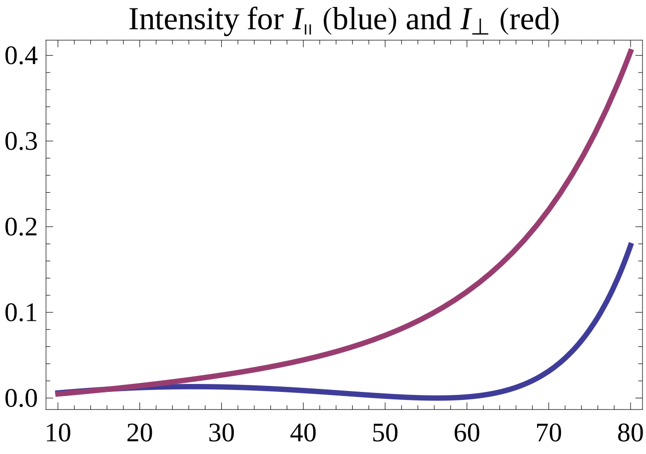
i)



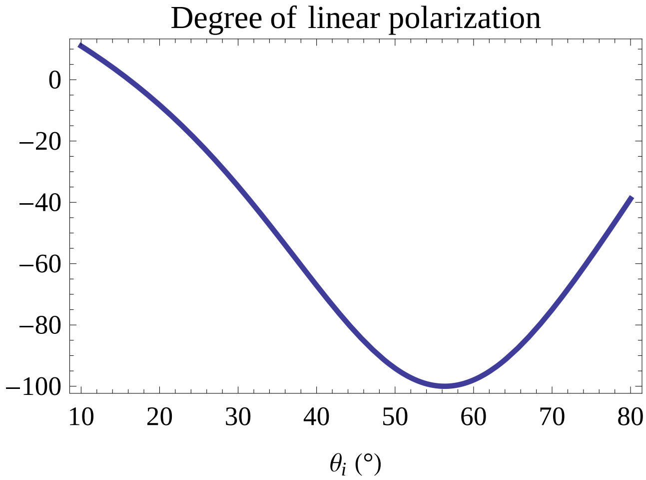
ii)



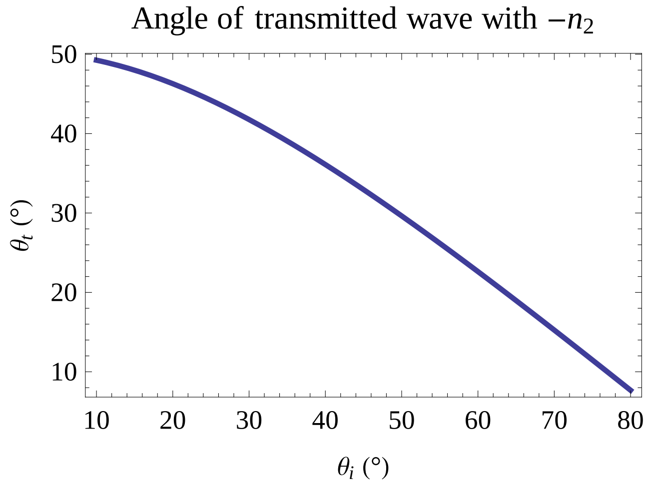
iii)



iv)



v)



Ex. 4

Let's test the `AbsSnell` with $\hat{\boldsymbol{e}}_i = (0.422618, 0.0, -0.906308)$, $\hat{\boldsymbol{f}}_i = (0.241845, 0.241845, -0.939693)$, $\hat{\boldsymbol{n}} = (0, 0, 1)$, $\widetilde{n}_1 = 1.1 + i0.1$, $\widetilde{n}_2 = 1.5 + i0.2$. If my calculations are correct, it should give

$$\hat{\boldsymbol{e}}_r = (0.422618, 0.0, 0.906308)$$
$$\hat{\boldsymbol{f}}_r = (0.241845, 0.241845, 0.939693)$$
$$\hat{\boldsymbol{e}}_t = (0.30990, 0.0, -0.95077)$$
$$\hat{\boldsymbol{f}}_t = (0.12354, 0.12354, -0.98462)$$
$$N_2 + iK_2 = 1.5007 + i0.205153$$

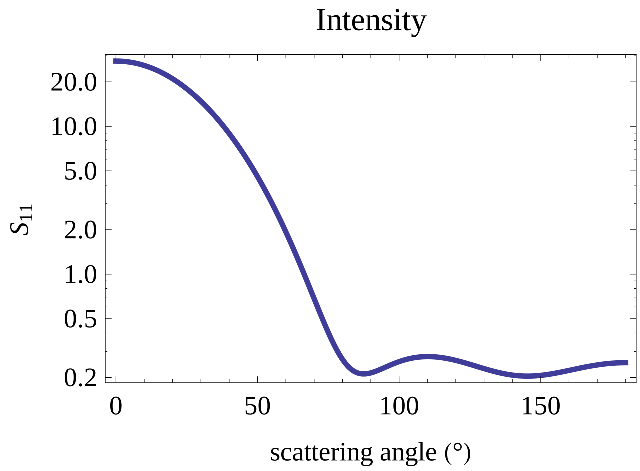
and then the `AbsFresnel` should give

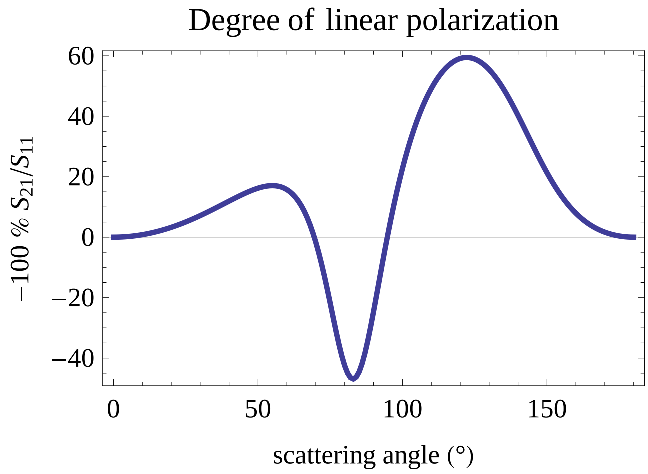
$$r_\perp = -0.179696 - i0.0204315$$
$$t_\perp = 0.820304 - i0.0204315$$
$$r_\parallel = 0.132535 + i0.0204199$$
$$t_\parallel = 0.826534 - i0.0197277$$

Please note that I have not checked these results against any other source.

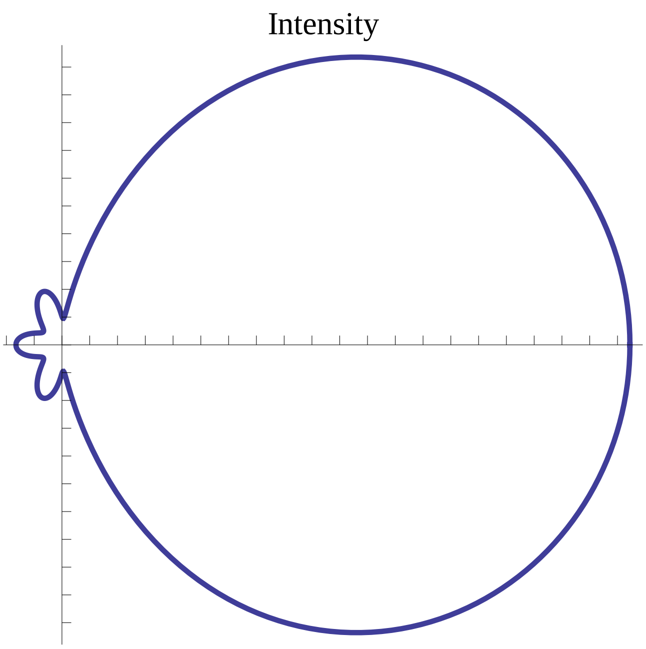
Ex. 5

i)





ii) Polar plot in logarithmic scale. Incident wave in coming from left, from $-x$.



iii) Extinction efficiency. The small perturbations in the curve would be smoother if I would have computed more values for the range. Extinction cross-section is the 'area' of the incident field that is affected (absorbed or scattered) by the presence of the particle. Efficiency is ratio of that 'scattering area' to the geometrical area of the particle. Note that it is quite soon above one, and approaches the value two. Value of two is due to scattering and absorbtion ($\sim$1 for large particles) plus diffraction (1) that will also affect to the incident field.