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A
Relations between angles in a isosceles prism

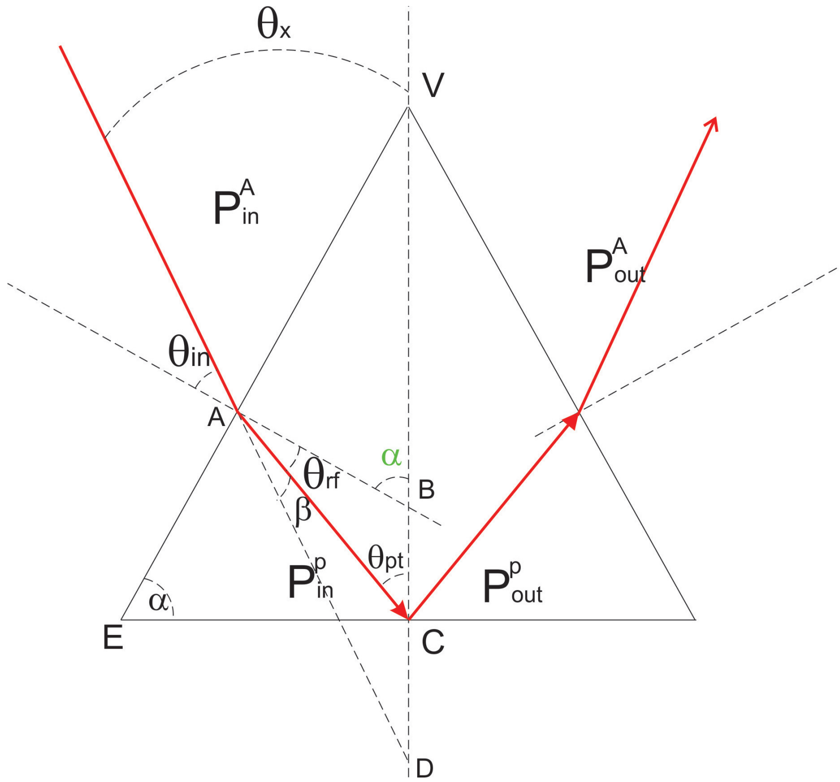


Figure A.1: Light beam impinges on prism. The characteristic angle of prism is *alpha*

Considering the triangle ACD, we have

$$\theta_x + (180 - \theta_{pt}) + \beta = 180, \quad (1)$$

$$\theta_x = \theta_{pt} - \beta. \quad (2)$$

At the interface(Point A), we have

$$\beta = \theta_{in} - \theta_{rf}, \quad (3)$$

and from Snell's law, considering a ray of light moving from air to prism, with ($n_1 = 1, n_p$ =refractive index of prism)

$$\frac{\sin\theta_{in}}{\sin\theta_{rf}} = n_p \qquad \Rightarrow \qquad \theta_{in} = \arcsin\left(n_p \sin\theta_{rf}\right). \tag{4}$$

By the use of (1), (3) and (4) we obtain

$$\theta_x = \theta_{pt} + \theta_{rf} - \arcsin\left(n_p \sin\theta_{rf}\right). \tag{5}$$

The line AB is perpendicular to the line EA, and the line EC is perpendicular to the line BC, then the angle ABV is α. So, in the triangle ABC

$$\theta_{rf} + \theta_{pt} + 180 - \alpha = 180 \qquad \Rightarrow \qquad \theta_{pt} = \alpha - \theta_{rf}, \tag{6}$$

and the angle θ_x is given by equation

$$\theta_x = \alpha - \arcsin\left(n_2 \sin\left(\alpha - \theta_{pt}\right)\right). \tag{7}$$

From the last equation, and using the relation (4), the relation between θ_{in} and θ_x is given by

$$\theta_x = \alpha - \theta_{in}. \tag{8}$$

The relation between θ_{pt} and θ_x is obtained inverting equation (7),

$$\theta_{pt} = \alpha - \arcsin\left(\frac{1}{n_2}\sin\left(\alpha - \theta_x\right)\right). \tag{9}$$

A.1 Correction factor for the reflections of the beams at air/prism interfaces

From the Fresnel equations [Jackson99], for TM polarization the transmission coefficient from air to prism

$$t_{A,P} = \frac{2\sin\theta_{rf}\cos\theta_{in}}{sin(\theta_{in} + \theta_{rf})\cos(\theta_{in} - \theta_{rf})}, \tag{10}$$

and from the prism to air is

$$t_{P,A} = \frac{2\sin\theta_{in}\cos\theta_{rf}}{sin(\theta_{rf} + \theta_{in})\cos(\theta_{rf} - \theta_{in})}, \tag{11}$$

where θ_{in}, θ_{rf} are the incident and refracted angle respectively. The fraction of the incident intensity that is transmitted when light enters a dieletric of refractive index n is not given directly by the square of the relative amplitude. The total energy flux in the refracted beam is its intensity times its area, and the latter differs from that of the incident or reflected beams in the ratio $\cos\theta_{rf}/\cos\theta_{in}$ [Jenkins01]. The conservation of energy is given by

$$r^2 + n\frac{\cos\theta_r}{\cos\theta_i}t^2 = 1 \tag{12}$$

In our case is necessary consider two cases: light propagates from air to prism (case I) and light propagates from prism to air (case II). For the first case

$$P^p_{in} = P^A_{in}\frac{\cos\theta_{rf}}{\cos\theta_{in}}t^2_{A,P}, \tag{13}$$

for the second case

$$P^A_{out} = \frac{P^P_{out}}{n_p}\frac{\cos\theta_{in}}{\cos\theta_{rf}}t^2_{P,A}. \tag{14}$$

In equations (13), (14) P^A is the power measured in the air and P^p is the power inside the prism, as sketched in figure A.1. Applying equations (10) and (12) to the relations (13) (14), the incident power inside the prism is described by

$$P^p_{in} = \left[n_p\frac{4\sin^2\theta_{ref}\cos^2\theta_{in}}{\sin^2(\theta_{ref}+\theta_{in})\cos^2(\theta_{in}-\theta_{ref})}\right]\frac{\cos\theta_{ref}}{\cos\theta_{in}}P^p_{in}, \tag{15}$$

while the power detected by the home-made detector is

$$P^A_{out} = \left[\frac{4\sin^2\theta_{in}\cos^2\theta_{ref}}{n_p\sin^2(\theta_{ref}+\theta_{in})\cos^2(\theta_{ref}-\theta_{in})}\right]\frac{\cos\theta_{in}}{\cos\theta_{ref}}P^p_{out}. \tag{16}$$

The actual reflectivity inside the prism is R_A, defined as P^p_{out}/P^p_{in}, whereas and the reflectivity measured directly in the laboratory is R_M, defined as P^A_{out}/P^A_{in}. The relation between the reflectivities is

$$R_A = \frac{\sin^4(\theta_{ref}+\theta_{in})\cos^4(\theta_{in}-\theta_{ref})}{\sin^2(2\theta_{ref})\sin^2(2\theta_{in})}R_M \tag{17}$$

B
Text of the Program for the Two-(Substrates, Colors, Media) Method

This program was developed in Mathematica 8.0. It is assumed a system of four layers (prism, metal, dielectric (Alq_3) and solvent (or air)). The first part is to define the characteristics of the system. The angles are obtained from *Winspall*.

The definition of the system

```
ClearSystemCache[]
Clear["Global`*"]
ClearAll[lambda1, lambda2, er1, er1i, er2, er2i, e41,
 e42, deltak1, deltak2, a1, a2, kx0, Kx1c, Kx2c]   (*kx1c+kx2c*)

(*-----------------------------------------------*)
(*                 1  Prism                      *)
(*-----------------------------------------------*)
(*                  2 Metal -er+ier              *)(*j  is the imaginary part*)
(*-----------------------------------------------*)
(*           3-   Dielectric  e3                   *)
(*-----------------------------------------------*)
(*     4-  Dielectric= air, water, solvent=    e4    *)
(*-----------------------------------------------*)

(*Triangular prism.   alpha is the characteristic angle*)
```

Parameters of the first measurement

```
(*Sample1*)  (*Silver*)
(*Ressonance conditions*)
alpha1metal := 44.994 Degree (* Prism angle for the case without dielectric*)
(*Just need to change the number, don´t delete the word Degree*)
thetax1metal := 38.6714 Degree  (*ressonance angle,
SP without dielectric,thetax from winspall*)
alpha1alq3 := 45.0655 Degree     (* Prism angle for the case with dielectric*)
thetax1alq3 := 44.454 Degree    (*ressonance angle,
SP with dielectric ,thetax from winspall*)
lambda1 := 632.8                   (*Wavelenght of the laser used on sample1*)
er1 := 17.24     (* absolute value of real part
 of metal dielectric function of sample 1 at lambda 1*)
er1i := 0.70      (* imaginary part of metal
 dielectric function of sample 1 at lambda 1*)
e41 := 1               (*Dielectrio function of medium 4*)
n1 := 1.574           (*Refractive index of the prism at Lambda1*)
a1  := 0                (* Parameter used to shift the dielectric function
                                  when lambda1 is different of lambda 2*)
                     (*use it just when you have two wavelenghts or two thickness.
                       It is related with difference between dielectric fuctions*)
```

Parameters of the second measurement

```
(*Sample2*) (*Gold*)
(*Ressonance conditions*)
alpha2metal := 44.952 Degree
(* Prism angle for the case without dielectric*)
                              (*Just need to change the number,
don´t delete the word Degree*)
thetax2metal := 39.95 Degree  (*ressonance angle, SP without dielectric,
                                                     thetax from winspall*)
alpha2alq3 :=  44.891 Degree      (* Prism angle for the case with dielectric*)
thetax2alq3 := 48.0553 Degree     (*ressonance angle, SP with dielectric,
                                                     thetax from winspall*)
lambda2 := 632.8        (* absolute value of real part
              of metal dielectric function of sample 2 at lambda 2*)
er2 := 11.76    (*  lambda2 Angstrom*)
er2i := 1.57
(* imaginary part of metal dielectric function of sample 2 at lambda 2*)
e42 := 1           (*  Dielectric function of medium 4 at lambda2*)
n2 := 1.574    (*Refractive index of the prism at Lambda1*)
a2 := 0      (* Parameter used to shift the dielectric function
                                  when lambda1 is different of lambda 2*)
                     (*use it just when you have two wavelenghts or two thickness.
                       It is related with difference between dielectric fuctions*)
```

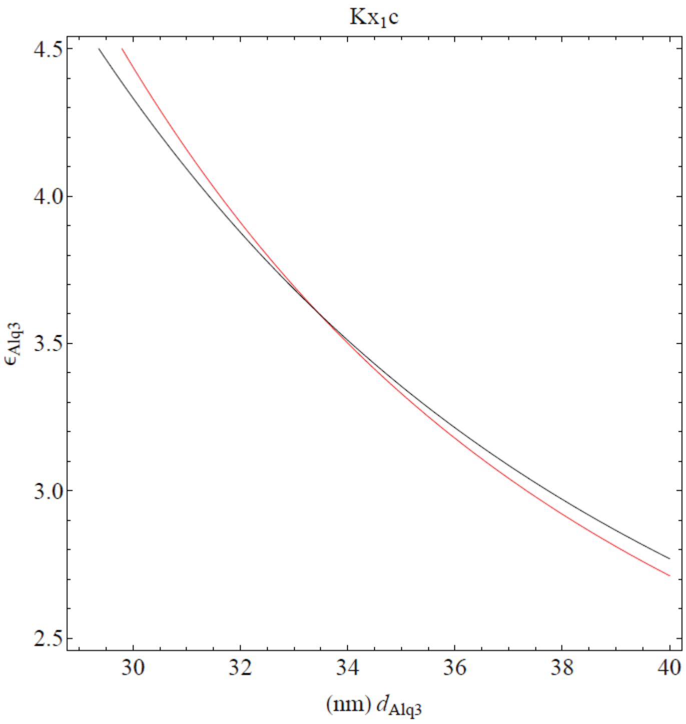
Definition of the functions [Pockrand78]

```
(*Functions*)

 (*the angle of incidence on metal  *)
(*thetapt *)
thetapt [alpha_, n_, thetax_] := alpha - ArcSin[Sin[alpha - thetax] / n]
(*the wavector *)
kx[alpha_, n_, thetax_, lambda_] := (2 * Pi * n * Sin[thetapt [alpha, n, thetax]]) / lambda

(*Difference in the wavector due dielectric layer in sample1*)
deltak1 := kx[alpha1alq3, n1, thetax1alq3, lambda1] -
                        kx[alpha1metal, n1, thetax1metal, lambda1]
(*Difference in the wavector due dielectric layer in sample2*)
deltak2 := kx[alpha2alq3, n2, thetax2alq3, lambda2] -
                        kx[alpha2metal, n2, thetax2metal, lambda2]



(*This equations are presented in a paper by Pockrand in 78*)

(*SPR condition. Metal and 4 layer*)
kx0[lambda_, er_, eri_, e4_] := (2 * Pi / lambda) * (((-er + eri * I) * e4) / ((-er + eri * I) + e4))^(1/2)
(*First order term of the shift of the wavevector*)
Kx1c[lambda_, er_, e3_, d3_, a_, e4_] := d3 * (2 * Pi / lambda)^2 * (((e3 + a) - e4) / (e3 + a)) *
                     ((-er * e4) / (-er + e4))^2 * (((e3 + a) + er) / (e4 + er)) * (er * e4)^(-1/2)
(*Second order term of the shift of the wavevector*)

Kx2c[lambda_, er_, eri_, e3_, d3_, a_, e4_] := Kx1c[lambda, er, e3, d3, a, e4] *
    (Kx1c[lambda, er, e3, d3, a, e4] / (2 * Re[kx0[lambda, er, eri, e4]]) *
      (2 * (2 * e4^2 - (e3 + a)^2) / (e4 * (e4 - (e3 + a))) + (-er + e4) / (-e4)) + (I * eri) / (2 * er))
```

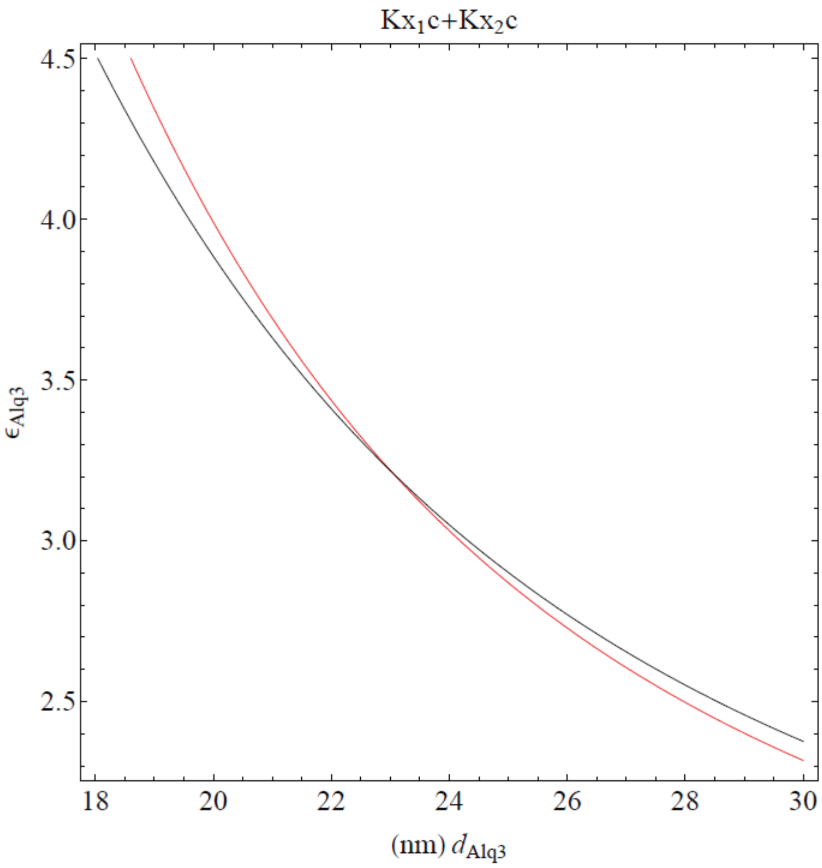
Generating graphics

```
(*Graphics: You can change the interval for d3, e3*)
(*Kx1c*)
ContourPlot[{ Kx1c[lambda1, er1, e3, d3, a1, e41] == deltak1,
              Kx1c[lambda2, er2, e3, d3, a2, e42] == deltak2
            }    , {d3, 29, 40}, {e3, 2.5, 4.5}, WorkingPrecision → MachinePrecision,
         ContourStyle → {Red, Black }, FrameLabel → { {ϵAlq3, ""}, {dAlq3 "(nm)", "Kx1c"}},
         LabelStyle → Directive[22]]

(*Kx1c+Kx2c*)
ContourPlot[{ Kx1c[lambda1, er1, e3, d3, a1, e41] +
    Re[Kx2c[lambda1, er1, er1i, e3, d3, a1, e41]] == deltak1,
               Kx1c[lambda2, er2, e3, d3, a2, e42] +
    Re[Kx2c[lambda2, er2, er2i, e3, d3, a2, e42]] == deltak2
            }    , {d3, 18, 30}, {e3, 2.3, 4.5}, WorkingPrecision → MachinePrecision,
 ContourStyle → {Red, Black},
               FrameLabel → { {ϵAlq3, ""}, {dAlq3    "(nm)", "Kx1c+Kx2c"}},
               LabelStyle → Directive[22]]

(*Green, Red→Silver, Red Black→ Gold*)
```

Using the first order term in the approximation. Curves obtained with the mean values of the dielectrics function of Silver and Gold as a reported in table V.5.



Using the second order term in the approximation Curves obtained with the mean values of the dielectrics function of Silver and Gold as a reported in table V.5. The intersection point is (23.03 nm, 3.214)


Kx1c+Kx2c
4.5
4.0
3.5
3.0
2.5
ϵAlq3
18
20
22
24
26
28
30
(nm) dAlq3