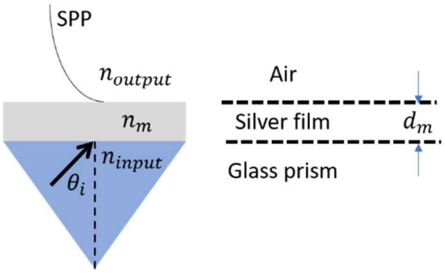
LAB EXERCISE: Excitation of a surface plasmon polariton (SPP)

Use the MATLAB function "tmm.m" to respond to steps 1-3. The goal is to excite a SPP at the boundary between a silver film and air in the Kretschmann configuration – see the setup described in the figure below. **The signature of the excitation is the appearance of a dip in the plot of reflectance as a function of angle of incidence.** When the reflectance is minimum, the absorption in the metal is maximum and the coupling to the SPP is maximum. The goal is to find the thickness of metal that maximizes the power coupling to the SPP (minimum reflectance or maximum absorption). This coupling is optimized when the **reflectance dip** due to the excitation reaches a value **very close to zero**.



The parameters of the simulation are:

- Input medium: glass, $n_{input} = 1.5$
- Output medium: air, $n_{output} = 1$
- Wavelength: 532 nm
- Silver film relative permittivity $\epsilon_m = -10 - j1$
- The thickness d_m of the metal film is variable

Step 1. Let's start by considering $d_m = 70$ nm. Plot the reflectance as a function of the angle of incidence and identify the dip. Take note of the angle at which the dip occurs (θ_{dip}) and the value of reflectance minimum at the dip (R_{dip}). Write these values in the table below.

Step 2. Repeat Step 1 for $d_m = 60, 50, 40, 30, 20, 10$ nm. Fill the table below.

d_m	θ_{dip}	R_{dip}
70 nm		
60 nm		
50 nm		
40 nm		
30 nm		
20 nm		
10 nm		

Step 3. Find the theoretical value of $\theta_{SP} = \operatorname{asin} n_{sp}/n_{input}$ that induces an SPP on the silver-air interface in the Kretschmann configuration (Hint: first calculate the air-silver SPP effective index, n_{SP}). Compare θ_{SP} with the values of θ_i written in the table above. Finally, find the SPP propagation length, $L_{sp} = 1/[2Im(k_{sp})]$.

$n_{sp} =$ _______ $\theta_{SP} =$ _______ $L_{sp} =$ _______