Nanophotonic Modeling
Lecture 2.9: Photonic Simulations with $S^4$

Prof. Peter Bermel
Photonic Simulations with $S^4$

Full-wave photonic simulations of arbitrary layered media, including thin-film and crystalline PV cells


https://nanohub.org/tools/s4sim/
Photonic Simulations with $S^4$

Accuracy improves systematically with computing power

S⁴: Lua Control Files

• Obtain a new, blank simulation object with no solutions:

\[
S = \text{S4.NewSimulation}()
\]

• Define all materials:

\[
S:\text{AddMaterial('name', \{eps\_real, eps\_imag\})}
\]

• Add all layers:

\[
S:\text{AddLayer('name', thickness, 'material\_name')}\]

• Add patterning to layers:

\[
S:\text{SetLayerPatternCircle('layer\_name', 'inside\_material', \{center\_x, center\_y\}, radius)}
\]
S$^4$: FMM Formulations

- Specify the excitation mechanism:

  ```
  S:SetExcitationPlanewave(
    {angle_phi, angle_theta}, -- phi in [0,180), theta in [0,360)
    {s_pol_amp, s_pol_phase}, -- phase in degrees
    {p_pol_amp, p_pol_phase})
  ```

- Specify the operating frequency:

  ```
  S:SetFrequency(0.4)
  ```

- Obtain desired output:

  ```
  forward_power, backward_power = S:GetPoyntingFlux('layer_name', z_offset)
  print(forward_power, backward_power)
  ```