

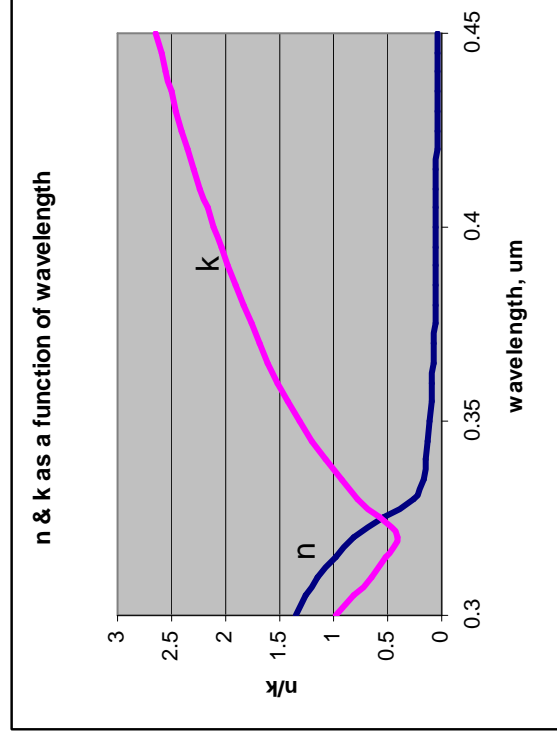
# Simulation of Surface Plasmon Resonance in Nanoparticle Array Using EM Explorer

# Overview

- The interaction of planewaves with an array of nano-particles was simulated using EM Explorer, an FDTD-based 3D EM solver.
- The surface plasmon resonance was found at wavelength  $\sim 367\text{nm}$  for a square array of silver spheres (50nm diameter, 300nm center-to-center distance) in air.
- The EM field around the particle at the resonance wavelength was examined in detail in this work and was compared with that of a wavelength far off the resonance.

# Optical Properties of Bulk Silver

- The following  $n$  &  $k$  properties of the bulk silver material (P.B. Johnson and R.W. Christy, Phys. Rev. B. 6(12) 4370-4379, 1972) was used in the simulation.

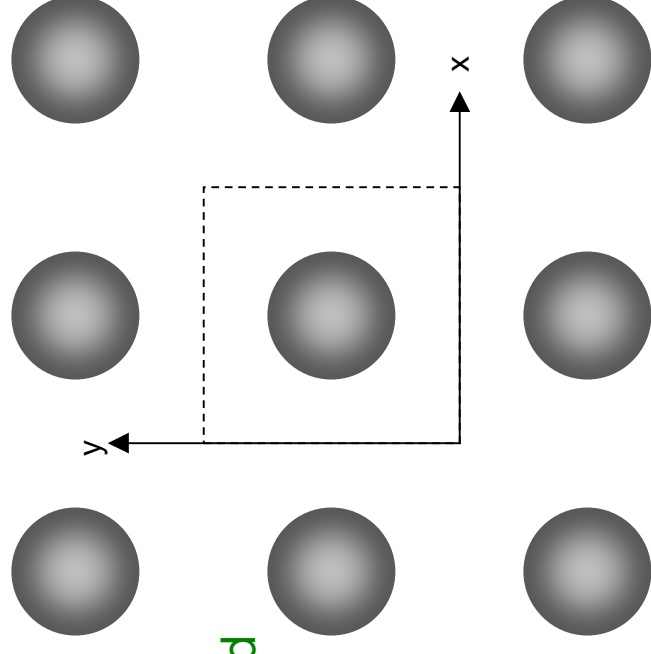


- The data indicates that the resonance wavelength of a single Ag particle in air is  $\sim 354\text{nm}$  (Metal nanoparticle arrays for near field optical lithography, Pieter G. Kik, Andrea L. Martin, Stefan A. Maier, and Harry A. Atwater, Proceedings of SPIE 4810 (2002))

# EM Explorer Simulation Conditions

## □ 2D square array of Ag spheres:

- Diameter: 50nm
- Center-to-center distance: 300nm
- Periodic boundary in x and y
  - Only one unit needs to be simulated
- Ambient: air



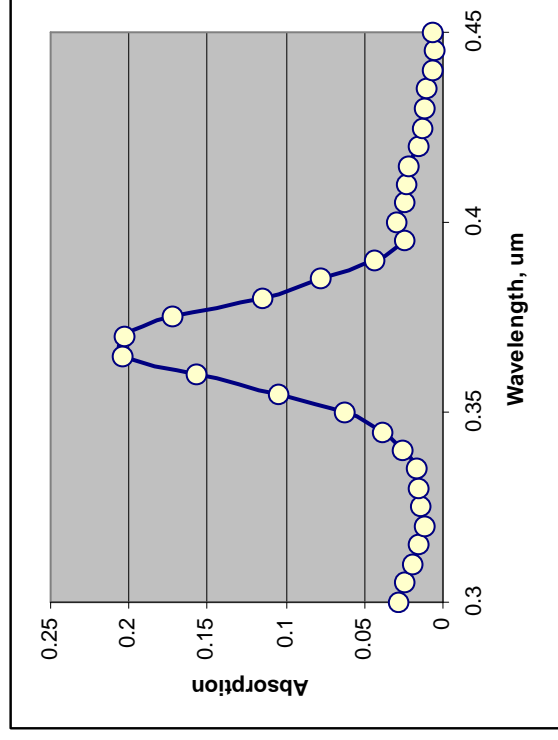
## □ Planewave illumination:

- Normal incidence (+z)
- Polarization in x direction
- Wavelength: 300nm to 450nm

## □ Post-processing: Absorption $A = (I - T - R) / I$

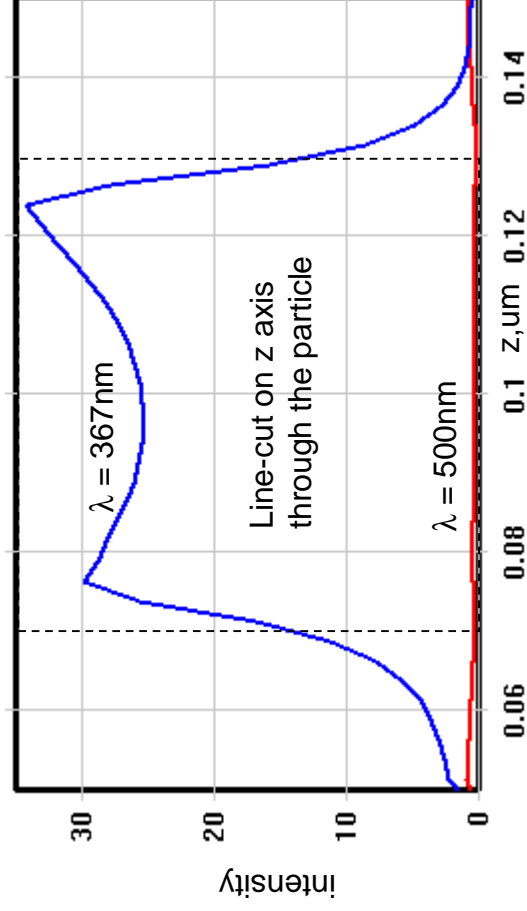
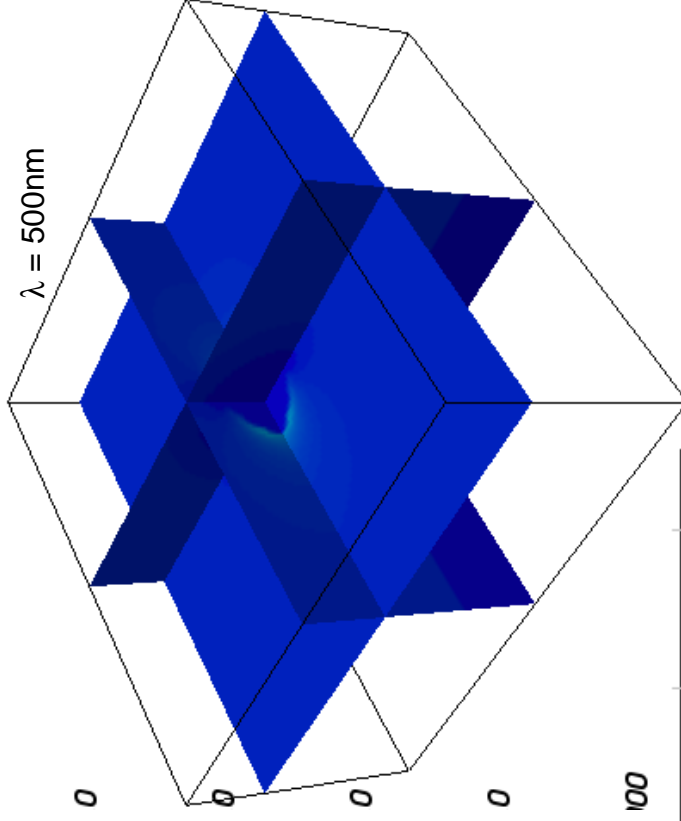
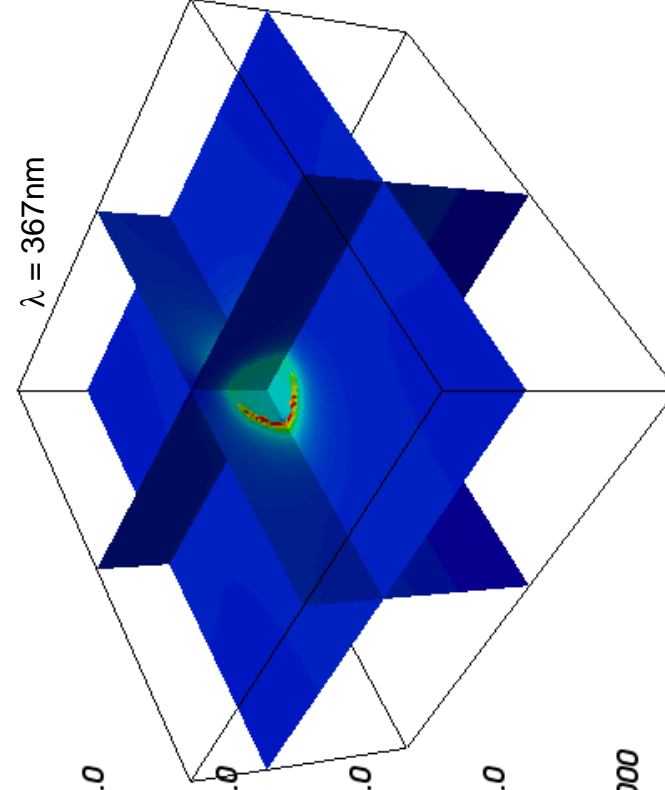
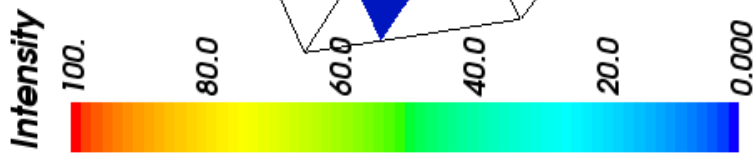
- $I$  = incident energy,  $T$  = transmitted energy,  $R$  = reflected energy

# Simulated Absorption Spectrum

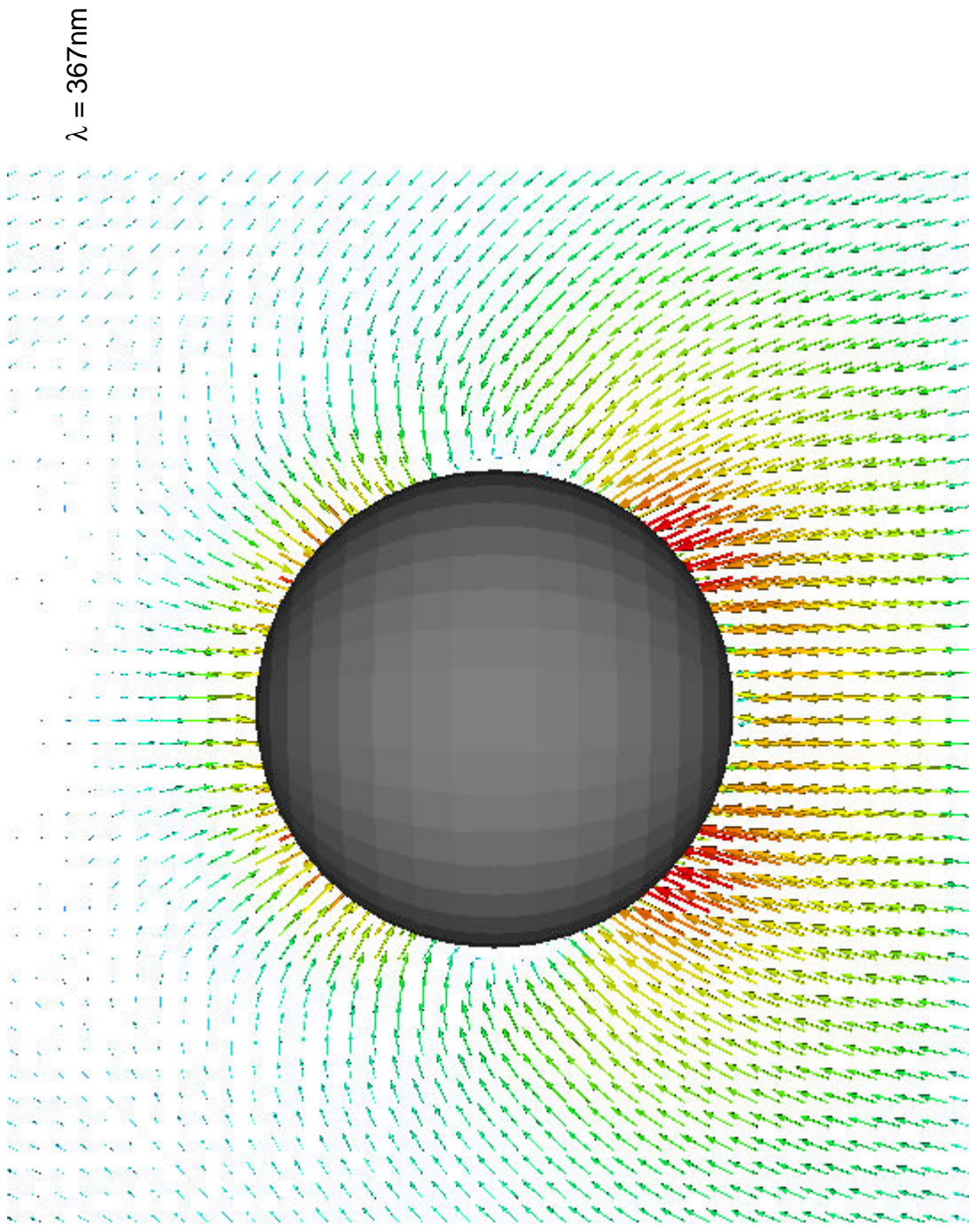


□ The data indicates resonance wavelength of ~367nm

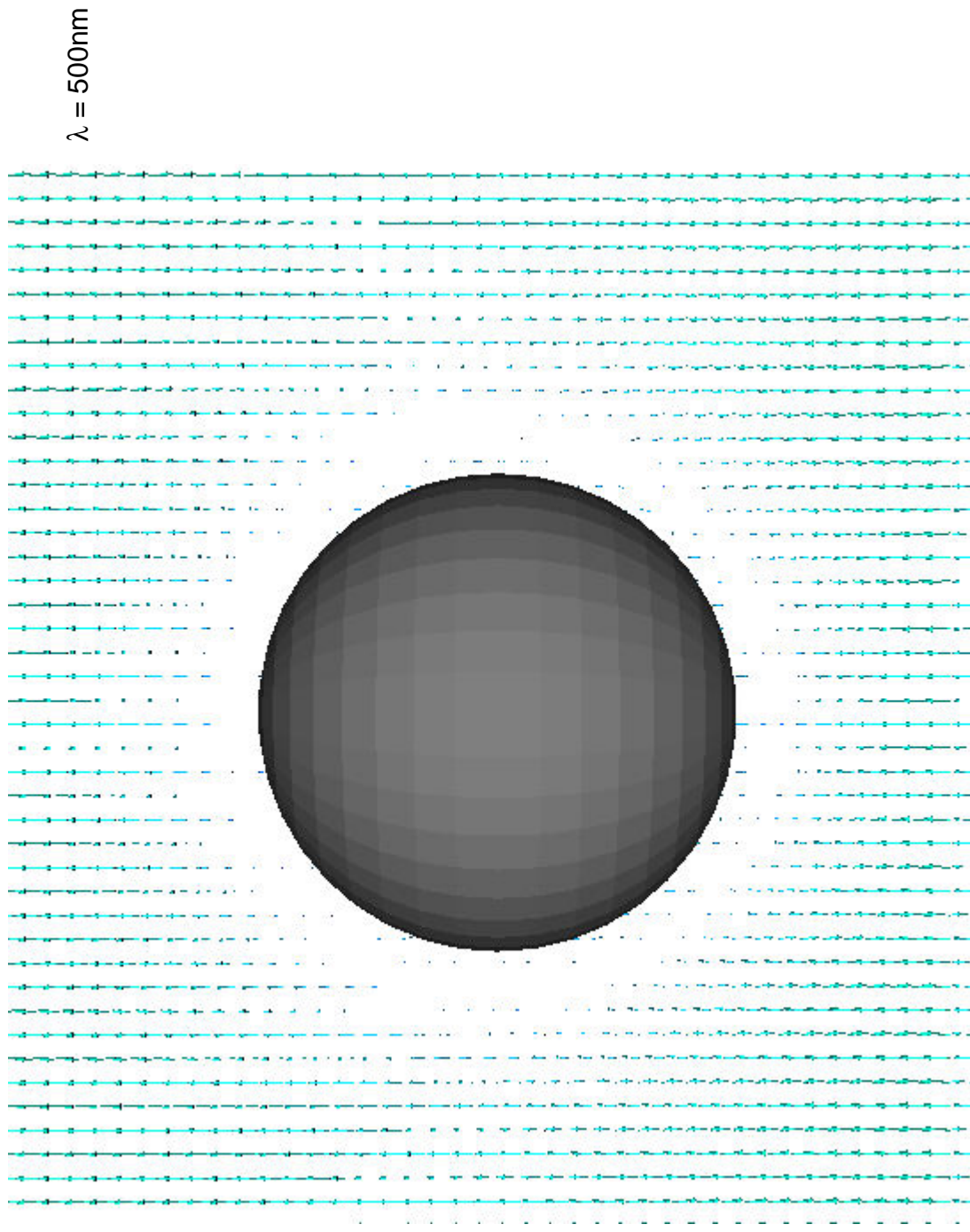
## Electric Field Intensity



# Poynting Vector (in y-z plane)



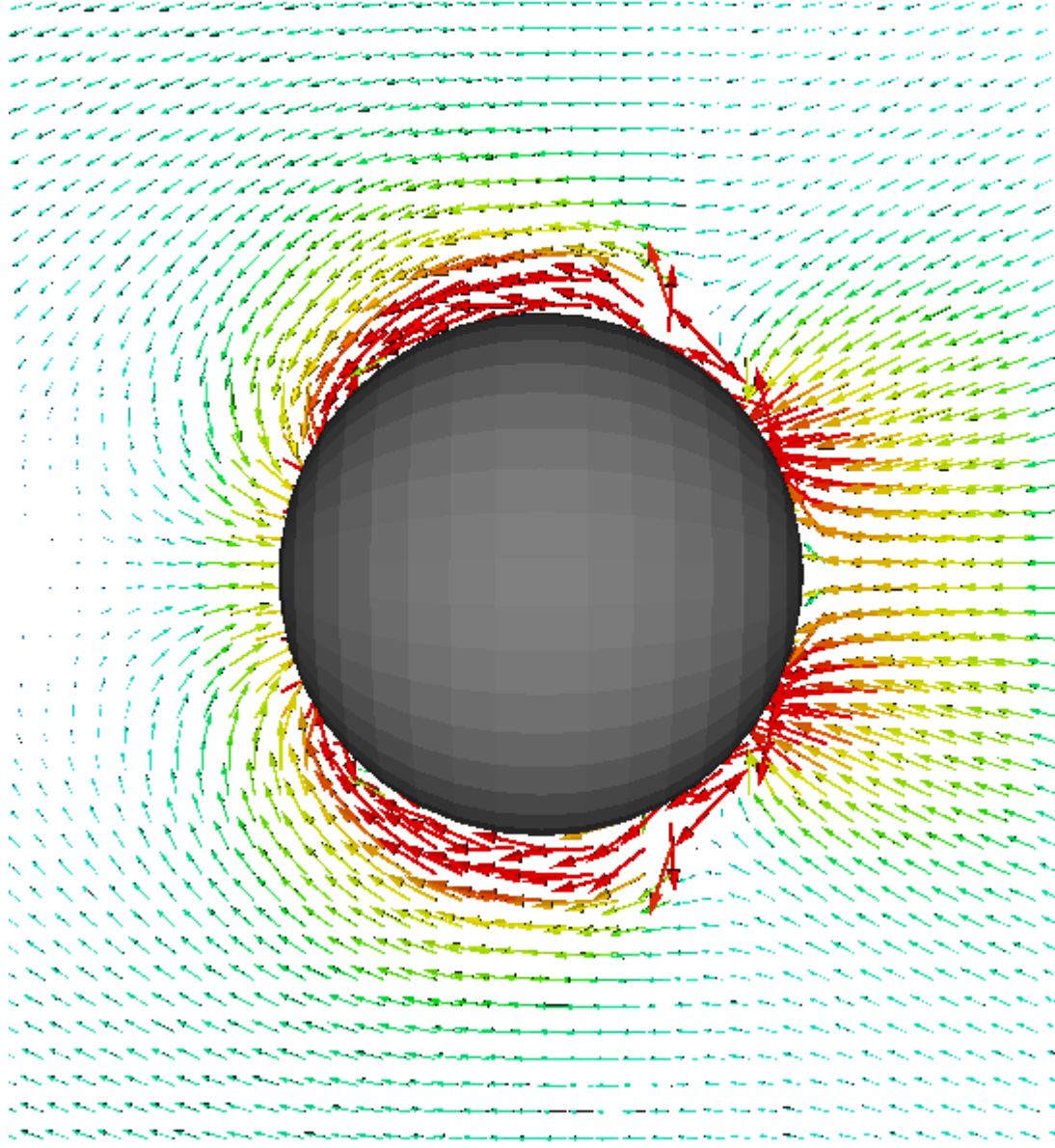
# Poynting Vector (in y-z plane)





# Poynting Vector (in x-z plane)

$\lambda = 367\text{nm}$



# Poynting Vector (in x-z plane)

