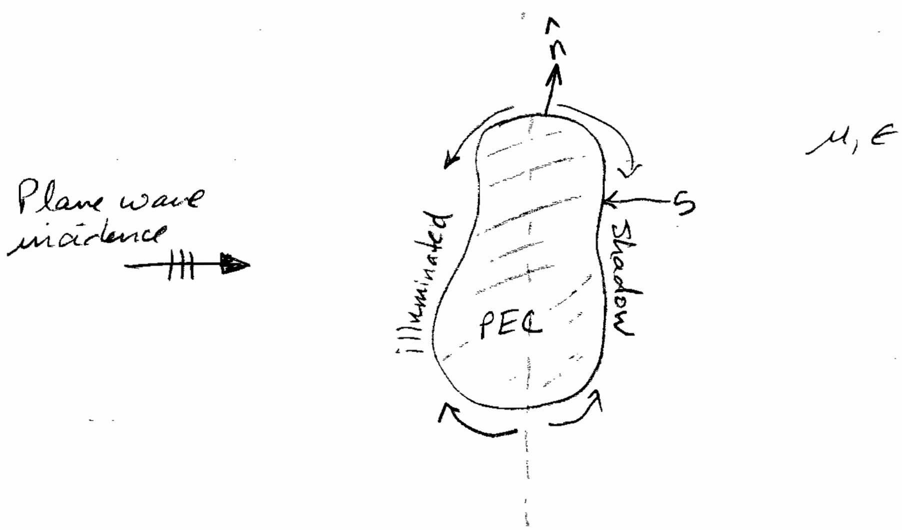
Lecture 18 – Physical Optics Approximation

We're now finished with plane wave / plane slab problems. These are probably the simplest scattering problems, and provide ample opportunities for elucidating physical understanding and insight for many types of problems.

Nevertheless, solutions to more complex scattering problems is needed. Computational EM packages are needed to solve most EM scattering problems. In some instances, though, the problem has distinguishing physical characteristics that allow an accurate approximate solution.

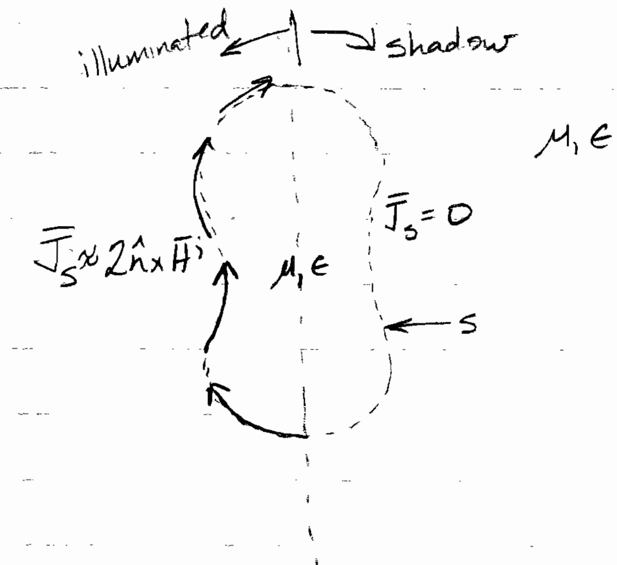
For large, smooth, PEC scatterers it is possible to obtain a rough measure of the EM scattering with suprisingly little computational effort. This technique is called the physical optics (PO) approximation.

Consider a PEC scatterer illuminated by a plane wave as shown:



In any problem of this type, the quest is to determine the unknown electric surface current density $\bar{J}_s$ that has been induced on the surface of the PEC scatterer by the incident wave. It is then a relatively simple matter to compute the scattered fields from these induced currents. The difficult part is computing $\bar{J}_s$.

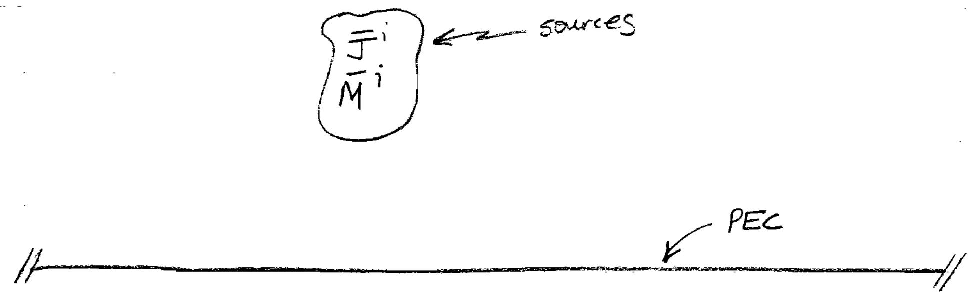
In the P.O. approximation, a known surface current density $\bar{J}_s \approx 2\,\hat{n} \times \bar{H}^i$ is assumed to reside on the illuminated surface as shown, while $\bar{J}_s = 0$ on the shadow side.



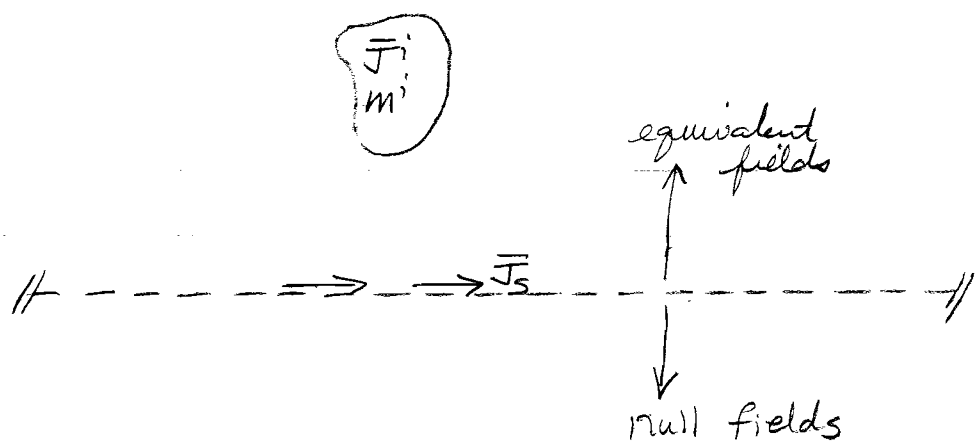
It is important to notice that $\bar{J}_s \approx 2\,\hat{n} \times \bar{H}^i$, which is known.

This P.O. approximation can be partially justified by considering each elemental piece of the scatterer as an infinite PEC plane!

In that case



can be replaced with the equivalent problem:



where $\bar{J}_s = 2\hat{n} \times \bar{H}^i$ (from image theory).