



Centre for Metamaterial
Research and Innovation

EPSRC Centre for
Doctoral Training
in Metamaterials

XM^2



Engineering and
Physical Sciences
Research Council

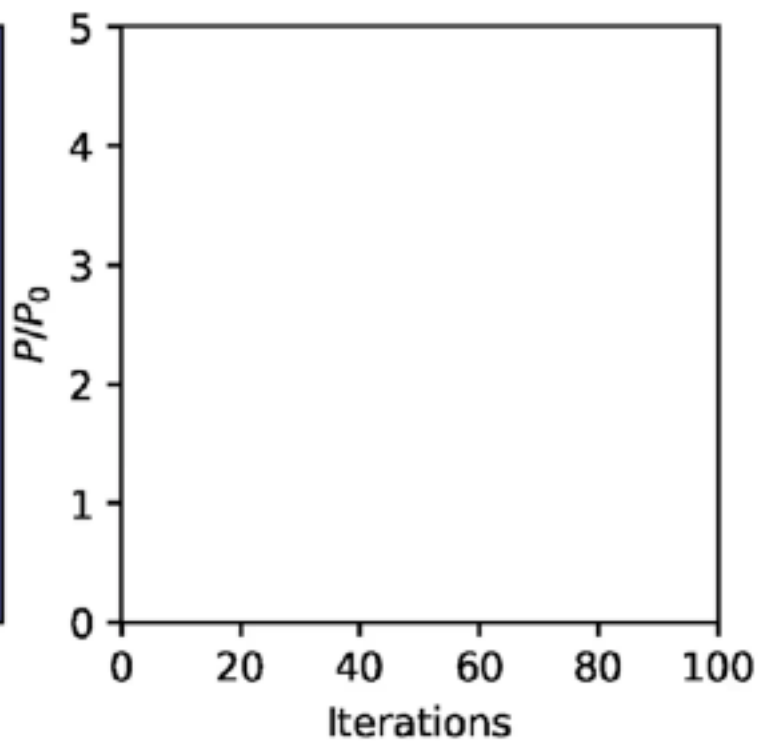
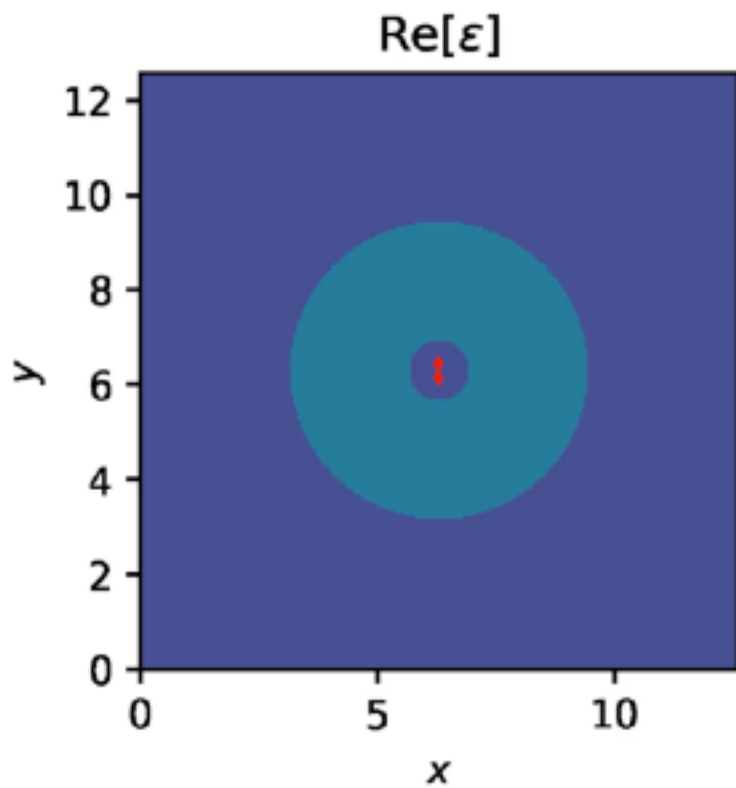
The first of these is the *Journal of the Royal Society of Medicine*, which was founded in 1849 and is the oldest medical journal in the world. It was originally published by the Royal Society of Medicine, which was founded in 1849. The journal was then transferred to the Royal Society of Medicine in 1913. The journal is now published by the Royal Society of Medicine, which is a charitable organization. The journal is published quarterly and is the leading journal in the field of medicine. It is the only journal in the field of medicine that is published by a charitable organization. The journal is the only journal in the field of medicine that is published by a charitable organization. The journal is the only journal in the field of medicine that is published by a charitable organization.

www.nmetsmaterialscenter.com

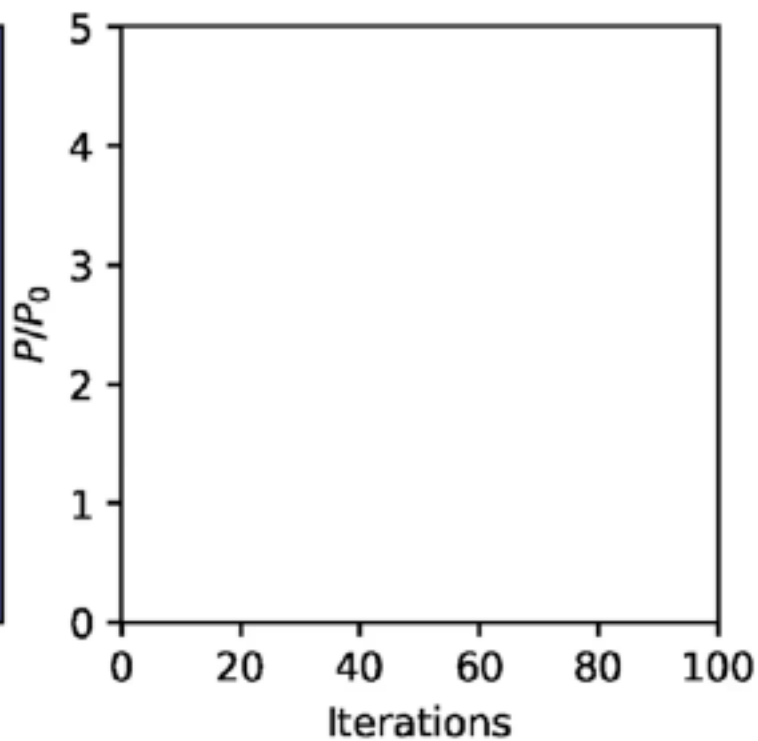
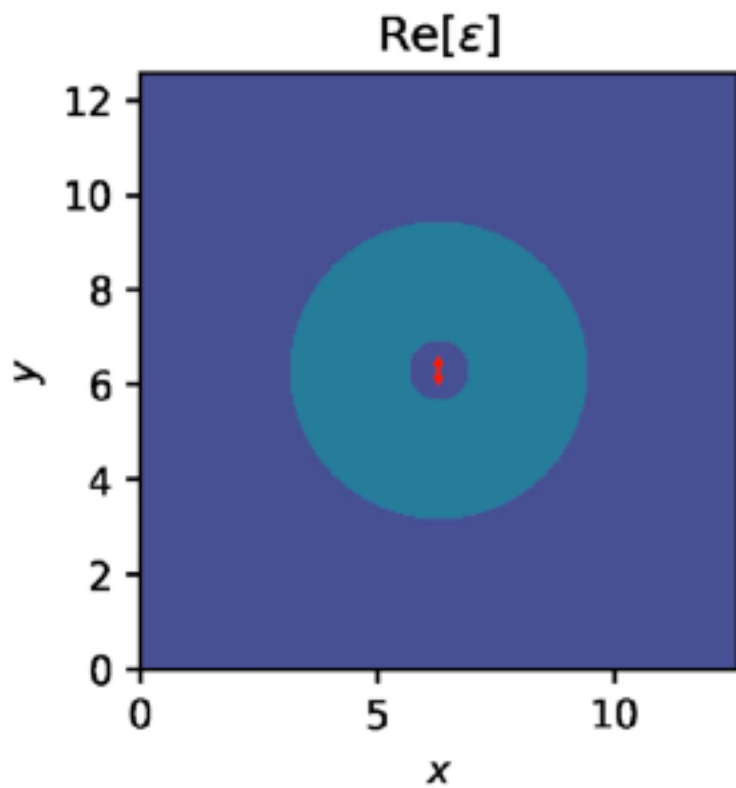
The Adjoint Method

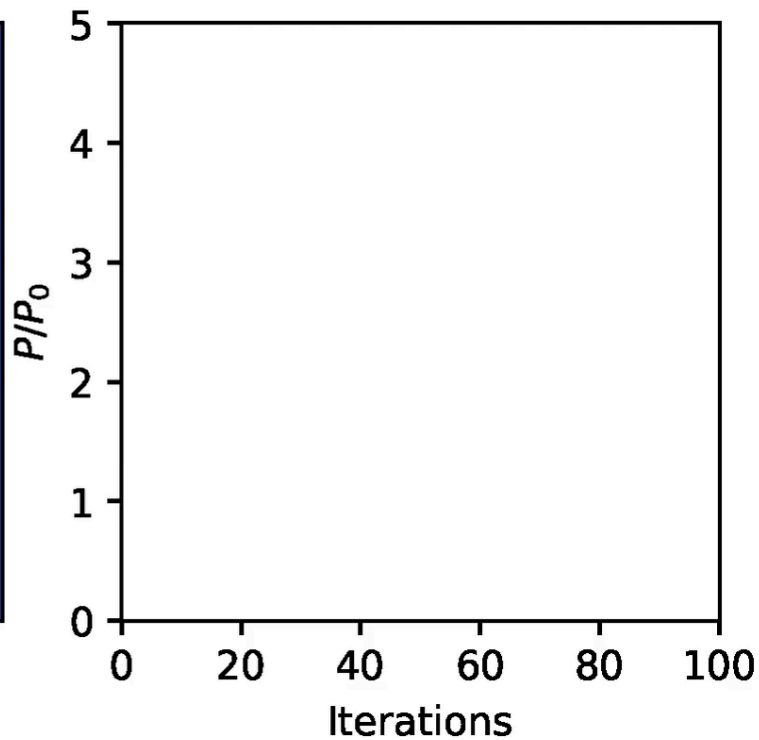
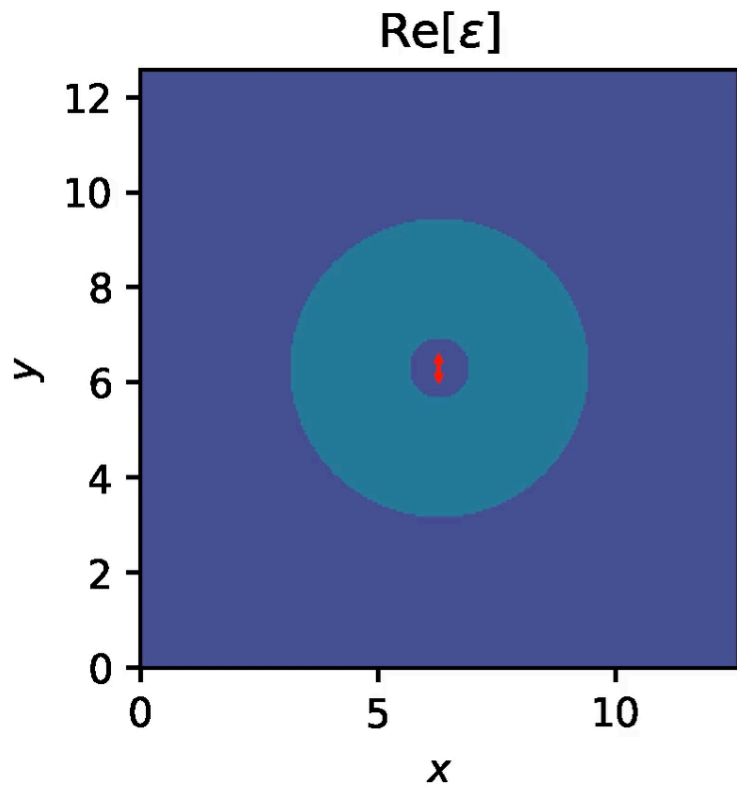


- Sandro Mignuzzi, Stefano Vezzoli, Simon A. R. Horsley, William L. Barnes, Stefan A. Maier, and Riccardo Sapienza “Nanoscale Design of the Local Density of Optical States”, Nano Lett. 19, 3, 1613–1617 (2019)
- Owen Miller, “Photonic Design: From Fundamental Solar Cell Physics to Computational Inverse Design”, PhD thesis (2012)



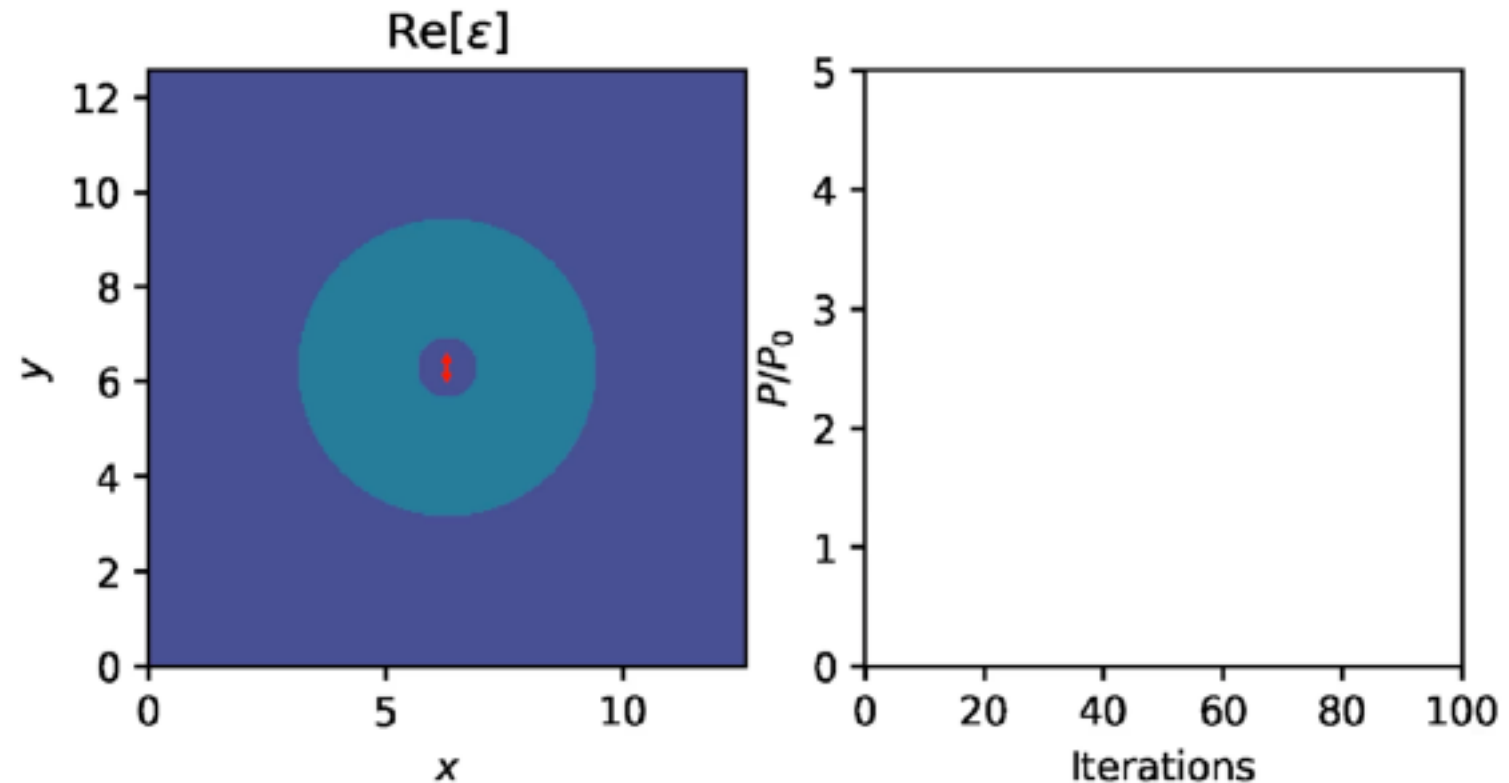
$$\delta P = \frac{1}{2} \operatorname{Im} \left[\boldsymbol{E}_*(\boldsymbol{r}) \cdot \boldsymbol{E}(\boldsymbol{r}) \right] \delta \varepsilon$$





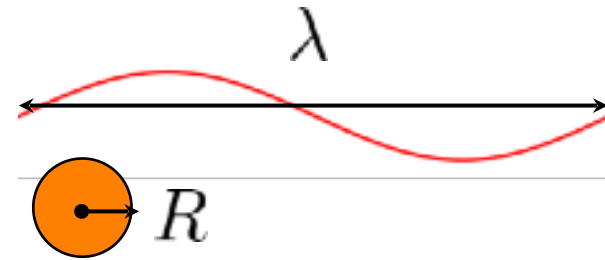
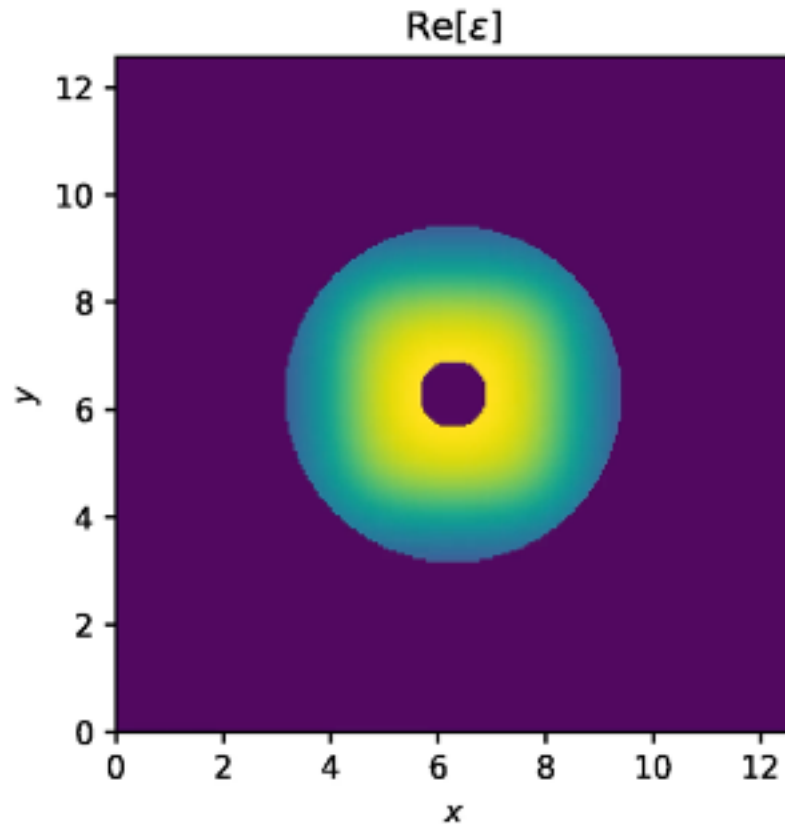
The Adjoint Method

$$\delta P = \frac{1}{2} \text{Im} [\mathbf{E}_*(\mathbf{r}) \cdot \mathbf{E}(\mathbf{r})] \delta \epsilon$$

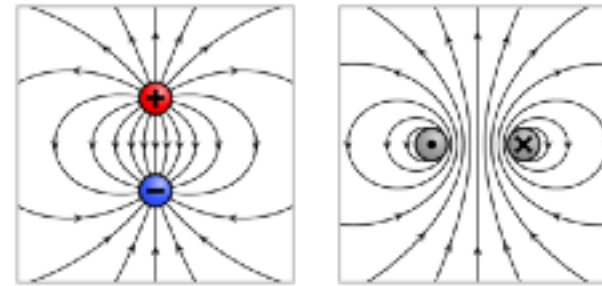


- Sandro Mignuzzi, Stefano Vezzoli, Simon A. R. Horsley, William L. Barnes, Stefan A. Maier, and Riccardo Sapienza "Nanoscale Design of the Local Density of Optical States", Nano Lett. 19, 3, 1613–1617 (2019)
- Owen Miller, "Photonic Design: From Fundamental Solar Cell Physics to Computational Inverse Design", PhD thesis (2012)

Continuous \rightarrow Discrete



$$kR \leq 1$$



$$\begin{pmatrix} p \\ m \end{pmatrix} = \begin{pmatrix} \alpha_E & 0 \\ 0 & \alpha_H \end{pmatrix} \begin{pmatrix} E \\ H \end{pmatrix}$$

$$\begin{pmatrix} E(r) \\ H(r) \end{pmatrix} = \begin{pmatrix} E_s(r) \\ H_s(r) \end{pmatrix} + \sum_n \begin{pmatrix} \xi^2 G(r, r_n) \alpha_E & i \xi \nabla \times G(r, r_n) \alpha_H \\ -i \xi \nabla \times G(r, r_n) \alpha_E & \xi^2 G(r, r_n) \alpha_H \end{pmatrix} \begin{pmatrix} E(r_n) \\ H(r_n) \end{pmatrix}$$

$$\text{Total} = \text{Source} + \text{Scattered}$$

$$\delta E(r) = - \left[\xi^2 G(r, r_n) \alpha_E \nabla E(r_n) + i \xi \nabla \times G(r, r_n) \alpha_H \nabla H(r_n) \right] \delta r_n$$

- Purcell, E. M. and Pennypacker, C. R., "Scattering and absorption of light by nonspherical dielectric grains" *Astrophysical Journal* 186 705 (1973)