**Problem Description**

- **Goal**: Sparse electromagnetic imaging for strong scatterers using nonlinear sparse optimization.
- **Applications**: See-through-wall imaging, molecular detection, breast imaging, hydrocarbon reservoir exploration.
- **Challenges**: Nonlinearity, ill-conditioning, noisy measurements.
- **Solution**: Newton, Born solvers, smooth and sparse regularizers, total variation.
- **Proposed solution**: Nonlinear iterative shrinkage algorithm, thresholded nonlinear Landweber iterations.

**2D electromagnetic equations**

- At receiver locations, $r_i = 1, \ldots, M$
- At source locations, $s_j = 1, \ldots, N$

**Formulation**

- **Discretization**
  \[ E^m(r) = \sum_{i=1}^{M} E(r_i) \delta(r - r_i) \]
- **Basis function**
  \[ E(r) = \sum_{i=1}^{M} E(r_i) \delta(r - r_i) \]
- **Nonlinear sparse optimization**
  \[ f = \min_{\gamma} \left\{ \frac{1}{2} \| f - E^m \|_2^2 + \gamma \| f \|_1^2 \right\} \]
  \[ f = \min_{\gamma} \left\{ \frac{1}{2} \| f - E^m \|_2^2 + \gamma \| f \|_1^2 \right\} \]

**Numerical Results**

- **Circular layered permittivity profile**
  - # Receivers: 32
  - # Transmitters: 8
  - Dimension: 7 m
  - $N_{2D}$: 2500
  - Sparseress: 9.9%
  - $N_{3D}$: 100
  - $\gamma$: 0.008

- **Square layered permittivity profile**
  - # Receivers: 32
  - # Transmitters: 8
  - Dimension: 8 m
  - $N_{2D}$: 3025
  - Sparseress: 9.92%
  - $N_{3D}$: 75
  - $\gamma$: 0.008

- **Fresnel experiment**
  - # Receivers: 40
  - # Transmitters: 12
  - Dimension: 0.2 m
  - $N_{2D}$: 2500
  - Sparseress: 9.92%
  - $N_{3D}$: 200
  - $\gamma$: 0.009

---

**References**