Simulating Ground Plane Loss for EDGES-3

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An absorption profile centred at 78 megahertz in the sky-averaged spectrum

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 Epoch of Reionization

Brightness of redshifted 21 cm hydrogen line in early universe

Dip after galaxy formation might be the absorption profile detected by EDGES-2
• 21 cm line comes from transition between lowest two states
• In equilibrium, equal rates of emission and absorption
• Lyman-α photons excite atoms to n=2 energy level
• Atoms relax back to ground state
• Atom distribution in hyperfine states changes
• System leaves equilibrium
30 m x 16 m Ground Plane

- Reflects unwanted signals
- Shields from discontinuities in the soil and radiation created by the earth
- Will use 30 m x 16 m wire ground plane with 12.5 cm spacing
- Ground loss: fraction of gain below ground plane
- EDGES-2 used 30 m x 30m mesh
- Change in ground plane is to make deployment much cheaper and faster at the expense of a little more loss
- 2 sets of conditions:
  - Free Space
  - Dielectric soil with conductivity
    - Dielectric constant = 3.5
    - Conductivity = 0.01 S/m
Two Different Types of Ground Plane

- Meandering Connections
  - Simpler to deploy
  - More complicated resonances

- No Connections
  - More complicated to deploy
  - Simpler to model
Loss Simulations in Free Space

- Both ground planes have resonances at 10 MHz spacing
- 10 MHz $\rightarrow$ 30 m wavelength, which is length of ground plane
- Wire connections add additional resonances
Loss Simulations on Soil

- Resonances are damped out
- Connections increase magnitude of loss
- Discontinuity at 86 MHz
5 Parameter Fit around Discontinuity

- 3 pairs of matched discontinuities
- Not physical, FEKO errors
- Discontinuity near 72.5 MHz with connections, might be real
- Excluding discontinuities, variation is on order of millikelvin
Mixed Wire Spacing

- 12.5 cm spacing
- 6.25 cm spacing
- 12.5 cm spacing
Mixed Wire Spacing

- Lower Loss for mixed spacing for only slightly more wire
- Spacing transition may introduce unexpected resonances
Future Work

• Integrate loss corrections into the data calibration for EDGES-3

• Continue investigating mixed spacing ground plane and look for new resonances in loss
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