Imaging and calibration errors

- Most data corruptions are separable

\[ V_{ij}^{\text{Obs}}(\nu, t) = G_{ij}(\nu, t) \left( \int \int P_{ij}(\nu, t) I^M(l, m, \nu) e^{2\pi i (u_{ij} l + v_{ij} m)} dl dm \right) \]

Data \rightarrow Corruptions \rightarrow Sky

\[ G_{ij} = G_i G^*_j \] where \( G_i \) is the complex antenna based gains (direction independent)

\[ P_{ij} = P_i(l,m)P_j(l,m) \] where \( P_i \) is the image plane errors (direction dependent).

- Assuming \( P_{ij} = 1 \), direction independent terms can be solved by minimizing:

\[ \sum_{ij} |V_{ij}^{\text{Obs}} - G_i G_j^* V^M|^2 \text{ w.r.t. } G_i 's \]

- Direction dependent terms remain separable in the visibility domain, but more expensive to apply (not simple division)

\[ V_{ij}^{\text{Obs}} = E_{ij} \ast V^M_{ij} \text{ where } E_{ij} = E_i \ast E_j^* ; E_i = FT[ P_i ] \]
Challenges

• Explicitly incorporate the scale information in the deconvolution algorithms.
  
  ➤ Widely separated pixels are coupled due to the sidelobes of the Point Spread Function (PSF). Fast computation of this coupling is a challenge.

  ➤ Decoupling the various scales in the image, or controlling the dimensionality of the search space is a challenge.

• Solving for direction dependent corruptions as a function of time, frequency and polarization.

• Incorporate these direction dependent effects while predicting the model visibilities.

• Modeling the sky as a function of frequency and polarization.

S. Bhatnagar/NAWG, 11May 2005
Roadmap: Wide-band imaging
(Note on “Imaging/calibration algorithm research”, Aug. 2004)

- Wide-band imaging
  - Formulate the problem
  - Simulations/tests with existing algorithms
  - Scale-sensitive decomposition as a function of frequency
  - Incorporating PB effects in deconvolution
Roadmap: PB effects

- **PB effects (pointing, squint, ionospheric/atmospheric)**
  - Formulate the problem: Done (EVLA Memo 84)
  - Test cases: Done (EVLA Memo for the solver)
  - Single pointing imaging tests: Done (in preparation)
  - Solver: Tested for basic correctness.
  - User level tool: Work in progress
    - Application of squint and pointing correction during imaging
    - Solver for pointing offsets
Roadmap: Component based Imaging

• Scale sensitive decomposition: Asp-Clean, MS-Clean
  ➔ Extend it to incorporate frequency dependence
  ➔ Simulations
  ➔ Extend the work on PB effects to work with the above during imaging
Roadmap: Inter-dependence

• Wide-band imaging needs
  ➔ The basic Asp-Clean machinery for $I(l, m, v)$
  ➔ The basic PB machinery for forward and inverse transforms $P_{ij}(l, m, v)$
  ➔ Both the above for tests/simulations/actual algorithm development

• Full beam polarimetry
  ➔ The basic PB machinery for the transforms
  ➔ More sophisticated PB modeling

• Mosaicking
  ➔ Pointing Selfcal + all the above

• Estimation of computing/Data I/O needs

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