On the reconstruction of the electron density structures in the corona from 1.5 to 4 Rsun

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Tomography for the Solar Corona

• Problem is badly conditioned, e.g. number of unknown variables exceeds the number of equations
• Noise in the data

\[ \rightarrow \text{Regularization should be applied} \]

• Stationarity of the corona during the observations must be assumed. Coronal observations are restricted to only one-three view direction in ecliptic plane.
Scalar Field Tomography: Regularization

- Problem is badly conditioned, e.g. number of unknown variables exceeds the number of equations
- Random noise in the data

In result, there is possible no unique reconstruction. Problem is ill-conditioned.

\[
F = \sum_{i=1}^{\text{Number of Rays}} \left( I_i^{\text{sim}} - I_i^{\text{obs}} \right)^2 + \mu \cdot F_{\text{reg}} = \\
= \left| A \cdot X - Y \right|^2 + \mu \cdot \left| L \cdot X \right|^2
\]
Tomographic Reconstruction for the Solar Corona

Input:

- COR1B observations: pB images, 341x341 pixels
- Two weeks, ~ twice per day: 3 – 16 July 2007
- Monthly minimum background subtracted
- Starting point for the iterations is flat field (constant density)

Output:

- 3D Electron Density Distribution: 128x128x128 pixels
Reconstruction of the Electron Density

Isosurface: \( N_e = 3.6 \times 10^{10} \) m\(^{-3} \)

Inner spherical boundary is at 1.5 \( R_{\text{sun}} \)

White contour lines are boundary between open and closed magnetic field lines in potential field reconstruction with SS=2.5R\textsubscript{Sun}.
Spherical cross-section at $2R_{\text{sun}}$

White contour lines are boundary between open and closed magnetic field lines in potential field reconstruction with $SS=2.5R_{\text{sun}}$

Black contour line is the magnetic neutral line

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**STEREO-B EUVI 195**

$\phi_{\text{LOS}}=0.05^\circ$
$\theta_{\text{LOS}}=86.48^\circ$

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**MHD simulation**

**Reconstruction**
Reconstruction

\[ \varphi_{\text{LOS}} = 0^\circ \]
\[ \theta_{\text{LOS}} = 90^\circ \]
3D Electron Density: Streamer

3D Position of the streamer has been found by triangulation method
3D Electron Density: Streamer

Red lines on pictures below are the streamer’s positions found by triangulation method.

Cross-section by plane perpendicular to z-axis (carrington system)
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