Using Synthetic and Observed Timelags to Constrain Nanoflare Heating Properties in Active Region Cores

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Introduction

- Intro goes here

Pipeline for Forward Modeling Emission from Active Region Cores

We have developed a Python package for forward modeling emission from ARs using ensembles of field-aligned hydrodynamic models. It leverages the full power of the scientific Python stack and relies heavily on the SunPy [2] and Astropy [?] libraries.

1. Fetch observed magnetogram for the desired AR. Fig. ?? shows an HMI magnetogram of NOAA 1109.
2. Perform a field extrapolation (e.g. PFSS) to derive the three-dimensional vector field $\vec{B}$
3. Trace 1000 fieldlines through the extrapolated field, including only closed fieldlines in the range $10 < L < 1000$ Mm.
4. For each fieldline, run a field-aligned hydrodynamic model. In this case, we'll use the two-fluid EBTEL model described in Barnes et al. [1]
5. Map T_e and n_e from simulations to 3D field skeleton and calculate emissivity for each selected transition λ_{ij} of element X and charge state k,
$$\varepsilon_{ij}^{X,k} = n_j A_{ij} hc/\lambda_{ij}/n_e \quad [\mathrm{erg\,cm^3\,s^{-1}}]$$
where all atomic data comes from the CHIANTI atomic database [? ?]
6. Integrate the emissivity along the LOS for each transition,
$$I(\lambda_{ij}) = \frac{1}{4\pi}\int_{\mathrm{LOS}} \mathrm{d}h\, 0.83 \mathrm{Ab}(X) f_{X,k} \varepsilon_{ij}^{X,k} n_e^2 \quad [\mathrm{erg\,cm^{-2}\,s^{-1}\,str^{-1}}]$$
   - $f_{X,k}$ calculation includes effects due to nonequilibrium ionization [e.g. ? ?]
   - T_e, n_e functions of h, the distance along the LOS which intersects *many* loops
7. Convolve with wavelength response function of each channel of each instrument. Here, we synthesize observations from both channels of the Extreme-ultraviolet Imaging Spectrometer (EIS) on *Hinode*.

Heating Model: Impulsive Heating over a Range of Frequencies

- Describe heating model here

Forward Modeling AIA Intensities

- Details about AIA calculation
- list ions/elements
- Show equations

Simulated AIA Intensities

Computing Timelags Between AIA Channel Pairs

Simulated versus Observed Timelags

Analyzing Observed Pixels with a Random Forest Classifier

Conclusions

- The conclusions go here

References

[1] Barnes, W. T., Cargill, P. J., & Bradshaw, S. J. 2016, The Astrophysical Journal, 829, 31

[2] SunPy Community, Mumford, S. J., Christe, S., et al. 2015, Computational Science and Discovery, 8, 014009