A Temperature and Density Model of the Solar Corona
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**Purpose**
To create 3-d temperature, density, and magnetic field maps of active region coronae from first principles. This poster is meant to be a proof of concept for our model and a proposal for future work.

**Motivations**
The creation of this model enables a variety of scientific applications, including:

1. **Observational testing of coronal heating theories.**
   Beginning with an observed active region magnetogram, we can create a synthetic image of the region’s predicted coronal emissions, assuming a form for the coronal heating term. We can plug in different heating terms derived from various coronal heating theories. Comparing observed emission images with synthetic emission images calculated using different heating terms comprises an indirect observational test of those heating theories.

2. **Modeling of transient wave propagation events in the corona.**
   Calculated temperature, density, and magnetic field values allow predictions of wave speeds at every point on a 3-d grid representing the active region’s corona. This enables wave propagation studies using wave speed calculations that are superior to previous studies.

**Method**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Calculate coronal field from photospheric magnetogram</td>
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<tr>
<td>2</td>
<td>Assume a form for the heating mechanism (e.g., a non-constant u pace-free field model (Régnier, Anzer, and Canfield 2002))</td>
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<td>3</td>
<td>Solve a static energy equation along each loop (with some simplifying assumptions)</td>
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<td>4</td>
<td>Interpolate data along fieldlines to a regular 3-d grid</td>
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<td>5</td>
<td>Plot emissivity, integrated over line of sight and over known satellite wavelength bands</td>
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<td>6</td>
<td>Compare with observations to determine accuracy of heating function, magnetic field model, and other assumptions</td>
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1. Begin with a photospheric magnetogram, and calculate the coronal magnetic field. In this case, we use a non-constant u pace-free field model (Régnier, Anzer, and Canfield 2002).

Coronal magnetic field calculation for NOAA active region 8210:

**Assumptions**

**Present**
- Consider only static loops (with respect to all relevant time scales)
- No conductive losses through footpoints (anchored in chromosphere)
- Thin, straight loop
- Neglect gravity (loops short vs. pressure scale height)
- Uniform heating along loop
- Radiative loss function approximated with power law
- Spitzer conductivity

**Future**
- Allow area variations, while conserving flux
- Add gravity
- Heat distributed preferentially at footpoints
- Use look-up table from Chianti database

1. **Simulated Emerged Active Region**
   Here we present the predicted coronal emissions of a simulated emerged active region. The data used to reconstruct the emissions is from an MHD simulation of the emergence of a slightly twisted flux tube through a stratified model convection zone (see Abbett, Fisher and Fan 2000, run S33).

2. **Active Region 8210 (on May 1st, 1998)**
   Compare the predicted active region coronal emissions (middle), reconstructed from a vector magnetogram of the region (right), with the actual soft X-ray emissions observed by the Yohkoh Soft X-ray Telescope (left), shown at times steps close to the magnetogram data.

**Preliminary Results**

**Conclusions**
Several of the primary emission features of AR 8210’s coronal emission have been reproduced with our model. Three main sets of loop structures are visible: (1) a bright set of loops on the left connecting the strong positive polarity on the left with the primary negative polarity in the center; (2) a set of loops near the top connecting the strong negative polarity with scattered positive polarity structures near the top; (3) a larger, more diffuse area of emission that is the result of overlapping loops structures in different directions. A final reconstructed feature (4) is a dark lane of low intensity emission crossing the center of the image. (The dark lane is best viewed in the unlabeled pictures shown above.)

**Future Work**
We plan to employ this model for a study of active region coronal heating. We’ll compare observed emission structures with simulated emission pictures such as those shown here, employing a variety of heating function scaling laws predicted by different coronal heating theories, to see which heating theories predict emissions most accurately.

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