THE HOW AND WHY OF BIG SOLAR FLARES

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ABSTRACT

It is generally understood that solar flares measured from an active region occur in a given line-of-sight region of magnetograms. However, it is not understood why active regions produce flares. This study is one of the first to utilize high-resolution magnetic field measurements of the active region and the path the energy takes to produce solar events. We consider a complex, active region (AR 17511) from July 9th, 2013. The region was subjected to periodic large-scale C-class flares. We divided the region into individual sub-regions in order to examine the sun-spot release process of each sub-region. We used a high-resolution solar magnetic field measurement technique to accurately measure the magnetic fields of each sub-region. We found the cusp-like structure to be the origin of the large-scale C-class flares. The cusp-like structure was found to reconnect the magnetic fields, releasing energy in the form of a C-class flare. We present our results by comparing the energy associated with the individual current systems to the magnetic fields of the flares originating from our region.

IDENTIFYING CURRENT SYSTEMS

Figure 1: Image of the sun on July 2nd, 2013 containing active region AR17511. Taken from solar monitor.

Figure 2: Image of solar current systems (AR17511), where axes are dimensional units: km.

Figure 3: Image of solar current systems (AR17511) with selected partitions for energy calculations. (Left) Table of partition numbers used for calculating currents. (Right) Negative and positive partition numbers plotted on the left.

Figure 4: Image of solar current systems (AR17511) with selected partitions for energy calculations. (Left) Table of partition numbers used for calculating currents. (Right) Negative and positive partition numbers plotted on the left.

Figure 5: Image of solar current systems (AR17511) with selected partitions for energy calculations. (Left) Table of partition numbers used for calculating currents. (Right) Negative and positive partition numbers plotted on the left.

CALCULATING THE MAGNETIC FIELD

Figure 6: Image of solar current systems (AR17511) with selected partitions for energy calculations. (Left) Table of partition numbers used for calculating currents. (Right) Negative and positive partition numbers plotted on the left.

Figure 7: Image of solar current systems (AR17511) with selected partitions for energy calculations. (Left) Table of partition numbers used for calculating currents. (Right) Negative and positive partition numbers plotted on the left.

METHODS

To estimate the energy, we:

- Identified the current of the radial current of the atmospheric model
- Calculated energy released by the photosphere
- Used the Boltzmann equation for the total energy released
- Calculated the energy from the solar integrals

RESULTS

<table>
<thead>
<tr>
<th>Partition No</th>
<th>Energy (erg)</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>9.6E+23</td>
</tr>
<tr>
<td>2</td>
<td>9.6E+23</td>
</tr>
<tr>
<td>3</td>
<td>9.6E+23</td>
</tr>
<tr>
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<td>9.6E+23</td>
</tr>
<tr>
<td>10</td>
<td>9.6E+23</td>
</tr>
</tbody>
</table>

Table 1. Current system partition numbers with calculated energy.

In Figure 1, the current was estimated using the equation:

 conversions of magnetic field B of the solar flares to the magnetic field at the photosphere can be calculated analytically using the Boltzmann law:

Where the total energy was calculated as:

\[ E = \frac{B_1}{B_2} \]

Comparisons of the active region (Active Region Analysis) of AR17511’s current systems held the energy all throughout the solar integrals, with no large amount of energy.

CONCLUSION

- The amount of the energy stored in a current system may be correlated to the size of the flare it may produce.
- The size of the flares is highly correlated to the size of the magnetic field.

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REFERENCES

