Investigating the Relationship Between Coronal Loop Geometry and Polarized Emission

Mia Gironda, Dr. Tom Schad, Dr. Lucas Tarr, Dr. Tetsu Anan

Franklin & Marshall College, National Solar Observatory, University of Colorado Boulder

1.) Abstract

Polarimetry of spectral lines is a promising technique for studying the magnetism of the solar corona. By studying the polarization emitted from individual coronal loops, we can gain a better understanding of the sun's magnetic field in these structures, globally, and the production of solar eruptions, which impact Earth.

2.) Introduction

The data for this project is taken by the Mauna Loa Solar Observatory using the Coronal Multichannel Polarimeter instrument, which observes coronal emission lines and measures its polarization. Here, we study the Fe XIII 1074 and 1079 nm polarized emission lines. Our goal is to develop a new means of studying coronal features using this spectral line. We implemented the Rolling Hough Transform, used to calculate the angles of the coronal loop in a specified coordinate frame. We then found the angles with respect to solar vertical or the solar limb (the inclination angles). This allows us to investigate the loop's observed properties relative to the theory of polarized line formation.

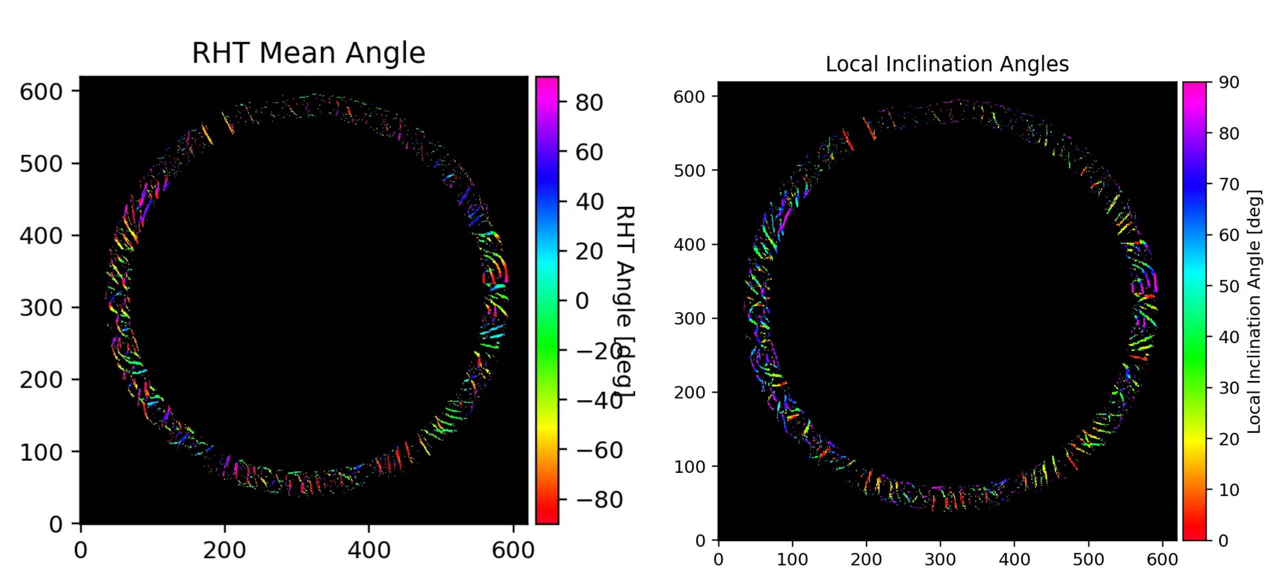

Fig. 1: The Rolling Hough Transform Angles (left) and the local inclination angles (right) for data gathered by the CoMP instrument, collected on March 14th, 2014.

3.) Methods

- ❑ To apply the Rolling Hough Transform, we had to first filter, binarize, and mask the image.
- ❑ The projected inclination angles were calculated by computing inverse cosine of the dot product between the sine and cosine of the mean angles and radial angles. We also added a parameter to make sure no angle was greater than 90 degrees.
- ❑ To calculate the inclination angles, we assumed the observed loops lie in the plane of the sky.

4.1) Results

- ❑ The azimuthal difference is the minimum angle between the RHT angles and the projected inclination angles.
- ❑ Expected polarization to change at Van-Vleck angle.

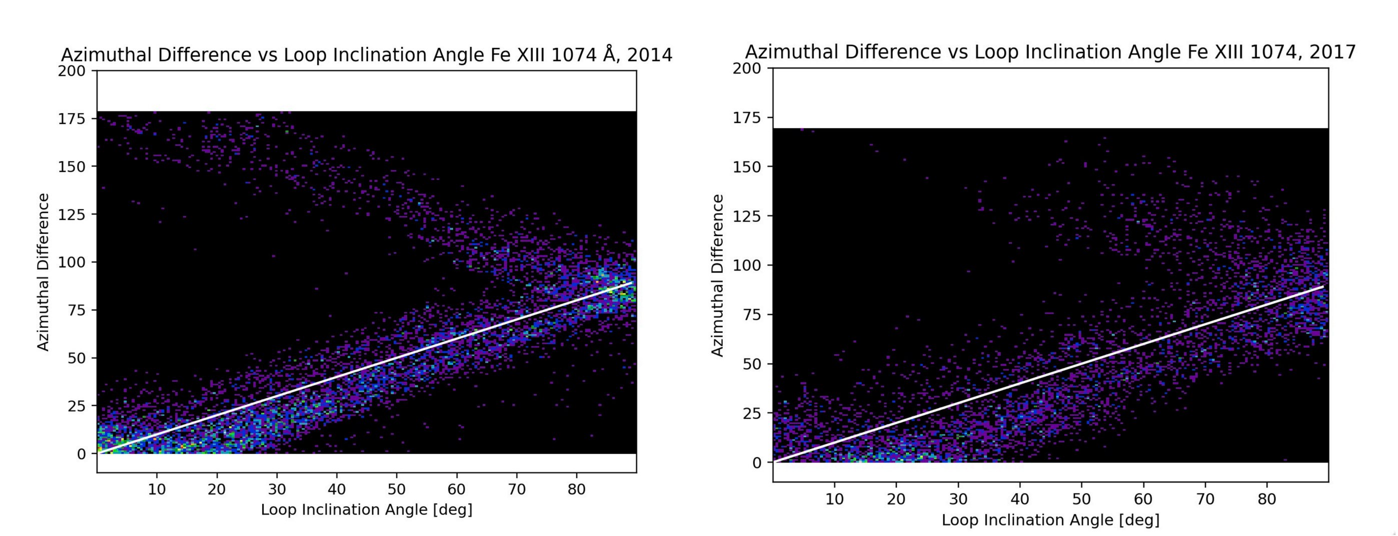

Fig. 2: Graphs plotting the relationship between the azimuthal difference and the loop inclination angles for March 14th, 2014 (left) and a large set of data spanning from January 8th to September 4th, 2017 (right).

4.2) Results

- ❑ The linear polarization fraction is the measured linear polarization divided by the measured intensity.

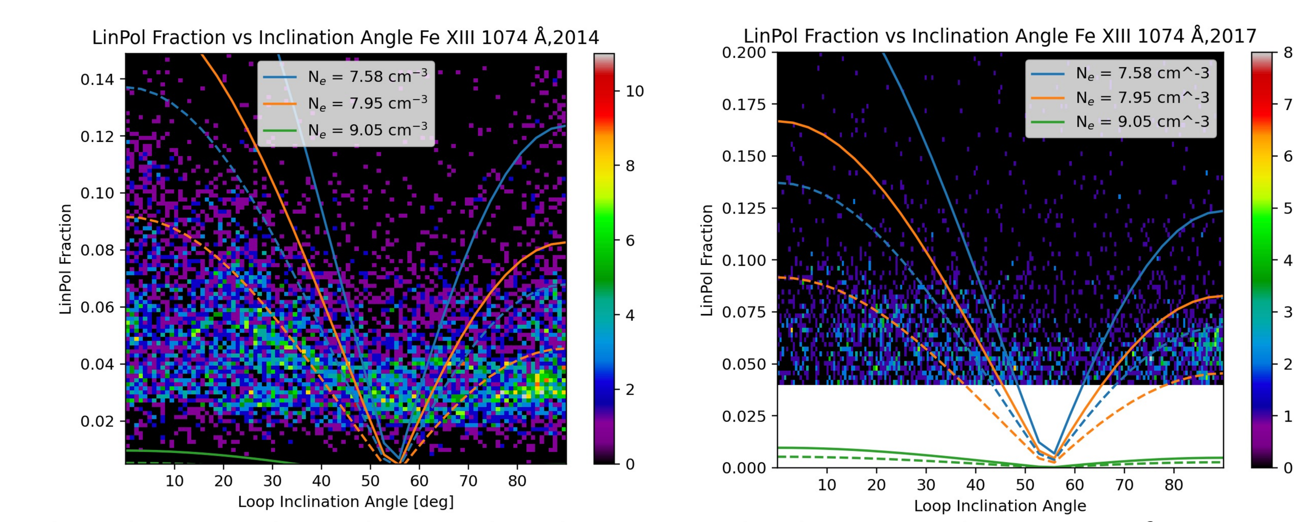

Fig. 3: Graphs plotting the relationship between the linear polarization fraction and the loop inclination angles for March 14th, 2014 (left) and a large set of data spanning from January 8th to September 4th, 2017 (right).

5.) Conclusions and Future Work

- ❑ Some evidence to support our theory that the polarization is aligned parallel/perpendicular to the loop.
- ❑ Also some evidence to show that the polarization changes at the Van-Vleck angle.
- ❑ Also can see some evidence to support that electron density is smaller at lower angles than greater angles .
- ❑ Future Plans…
  1.)Separate the loop from the background.
  2.) Try and apply the same techniques to a higher-resolution image.
  3.) Observe the line ratios of both spectral lines.

6.) References and Acknowledgements

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