Slide 1

Tracing out the Sun's Magnetic Field

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Solar REU 2013
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Slide 2

MAGNETIC FIELD

- Dipole field
  - Active region loops that are not flaring approximate a potential field
- Constant flux condition
  - $\Phi = B \cdot A$
  - *B* decreases and *A* increases as distance from the sun's surface increases
  - Loops should be thicker at the top and thinner at the footpoints
  - However, this has not been observed
- Why is this?

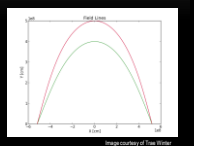
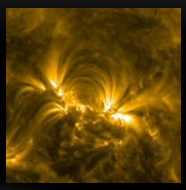


Image courtesy of Trae Winter

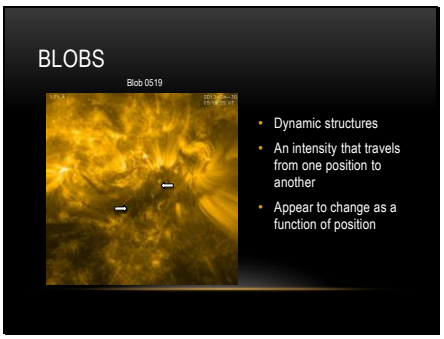
Slide 3

LOOPS

- Generally static, continuous structures with uniform brightness and width
- Thought to trace out magnetic field lines
- Mass and energy flow easily along field lines, but not across the lines

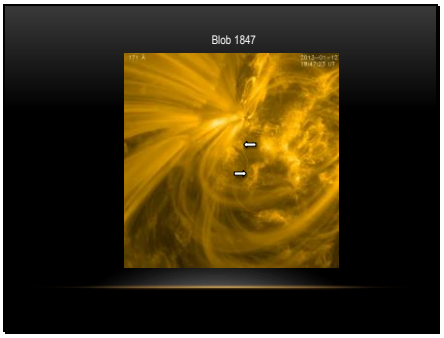


Slide 4



However, we concentrated on blobs of plasma traveling along field lines. These are dynamic and transient structures, with apparently changing brightness and width.

Slide 5



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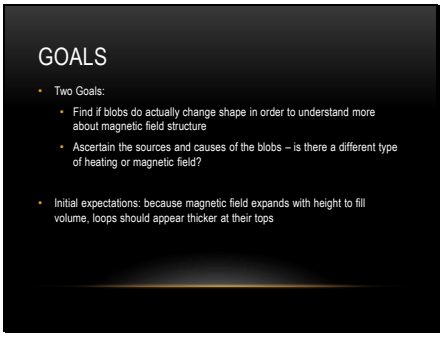
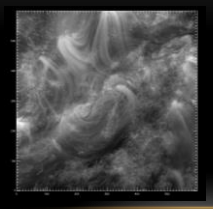


Slide 7

PREPARING DATA

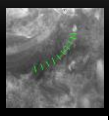


- Diffraction and scattering of light spreads light from a point source into a pattern called the point spread function (PSF)
- Deconvolution involves removing the effect of the PSF in order to create a clearer image
- Prepping involves aligning and derotating the images
- Necessary steps in order to obtain the clearest image possible for analysis

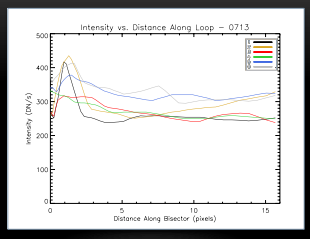
Slide 8

MEASUREMENTS

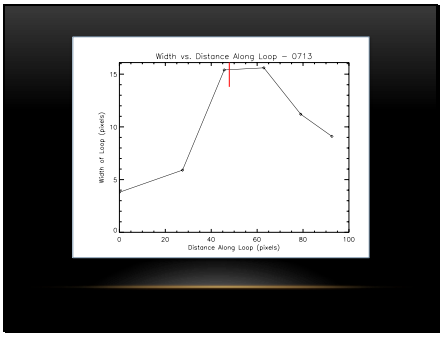
- Defined loops manually using stacks of images and movies
- Created perpendicular bisectors along each section of the loop
- Measured brightness along each bisector
- Measured full-width-at-half-maximum to determine width of loop
- Used maximum brightness as intensity
- Plotted width and intensity against distance along the loop



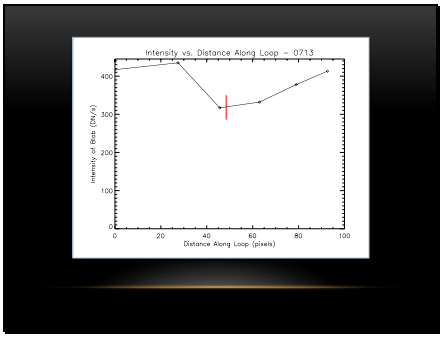
Slide 9



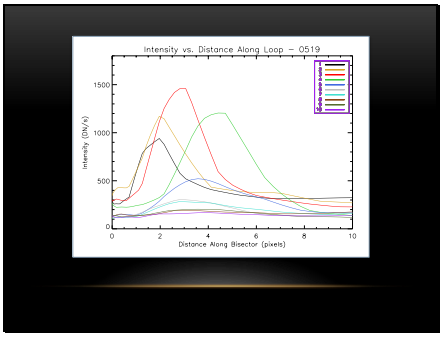
Slide 10



Slide 11



Slide 12



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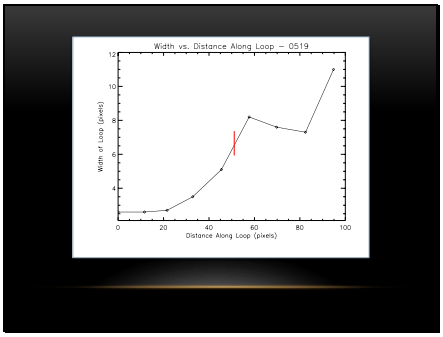
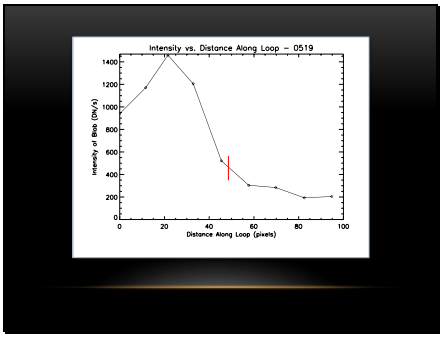
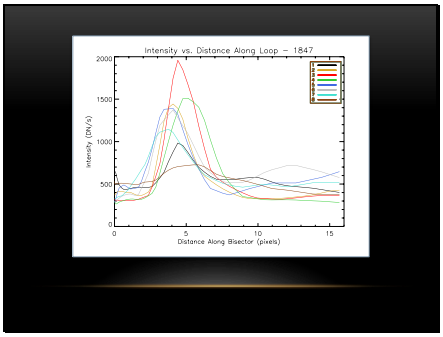


Slide 14



Slide 15



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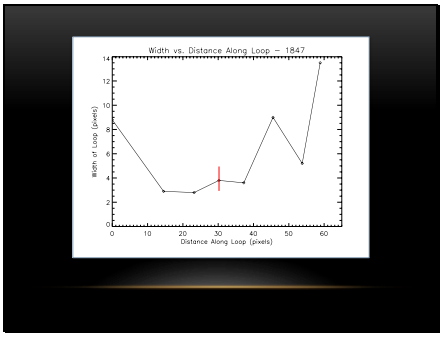
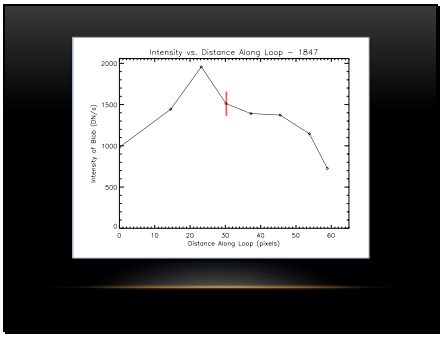
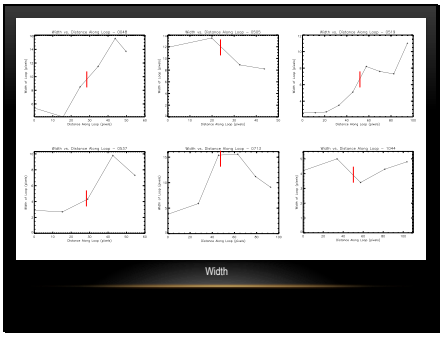


Slide 17

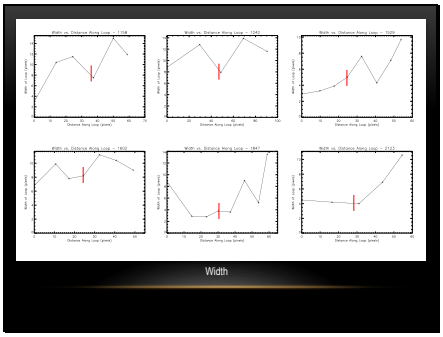


Slide 18



Twelve loops were analyzed and these data plotted for all of them.

Slide 19



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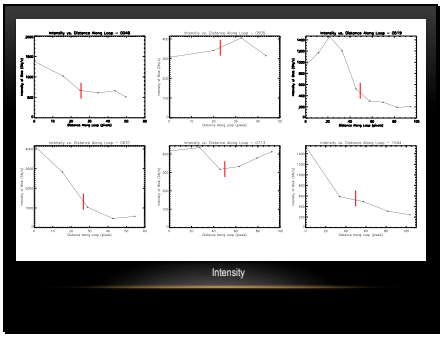

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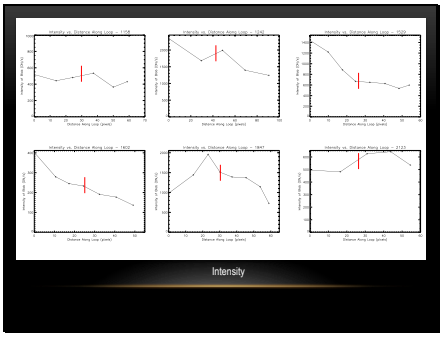
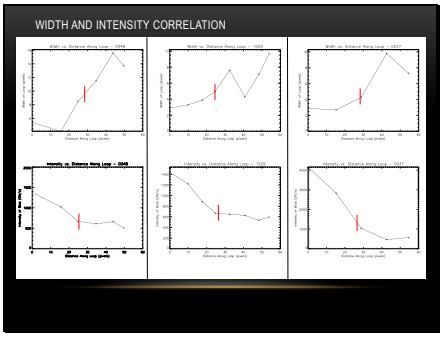


Slide 22



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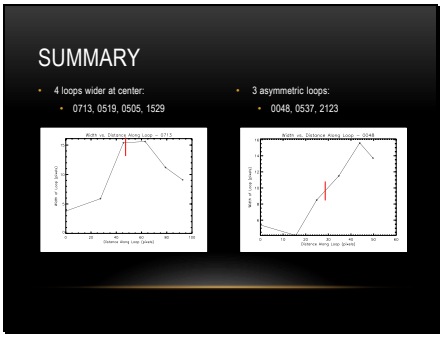

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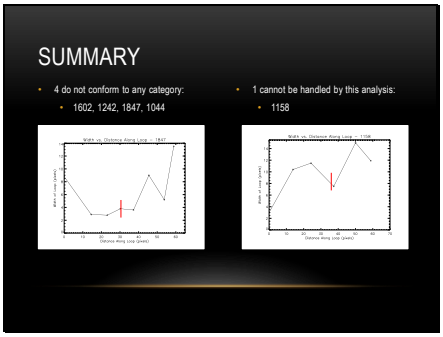

Slide 25

CONCLUSIONS

- Several loops demonstrated a greater thickness at their center
- Loops do, in fact, demonstrate a thickening near their tops, as predicted but not previously shown
- Clear correlation between intensity and width
- Several loops thicker on right side (endpoint): due to arbitrary choice of startpoint and endpoints

Slide 26

FUTURE QUESTIONS AND RESEARCH

- Measure mass and velocity of blobs to find kinetic energy
- Determine a lower bound for energy required to eject a blob from the surface of the sun
- Conduct observations in different wavelengths: is there a temperature change along the loop?
- Analyze more loops in order to confirm or refute the above results

Slide 27

ACKNOWLEDGMENTS

- Mentors Dr. Kathy Reeves and Dr. Trae Winter
- National Science Foundation (Grant AGS-1263241)
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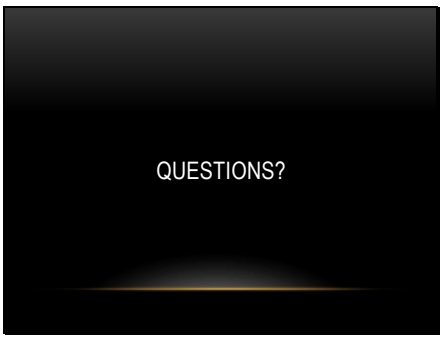
- Dr. Edward DeLuca
- Ms. Sandra Daly and SSXG Administrators
- Fellow Solar and Astronomy Interns

Slide 28



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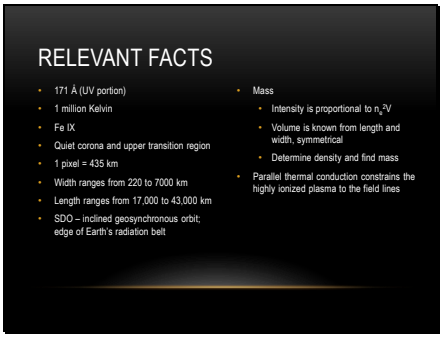

Slide 30