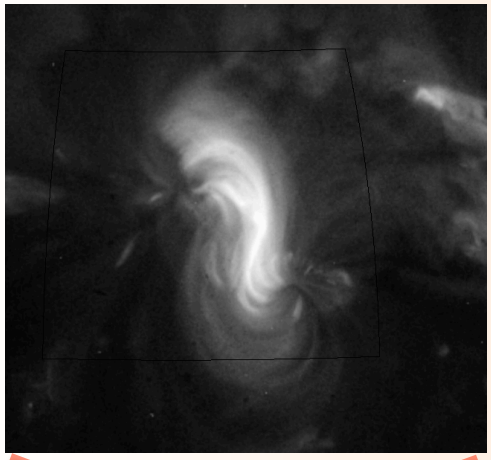
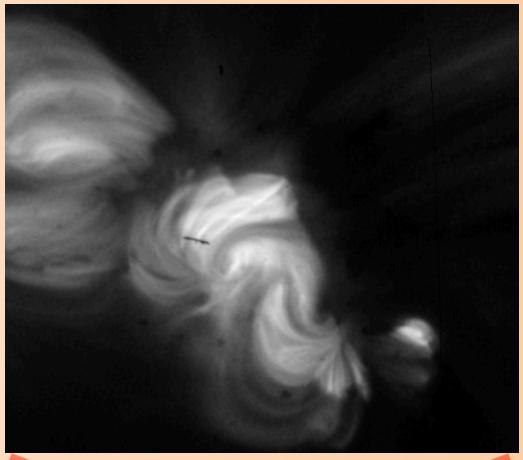
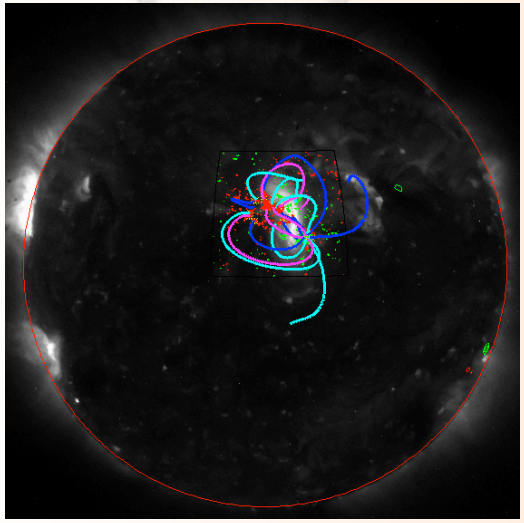
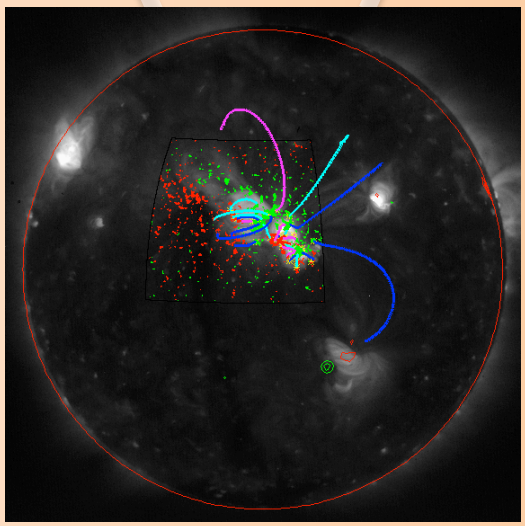




Sigmoid:
A Twisted Tale of Flux and Fields

By Tyler Behm
Mentors:
Antonia Savcheva
Dr. Ed DeLuca



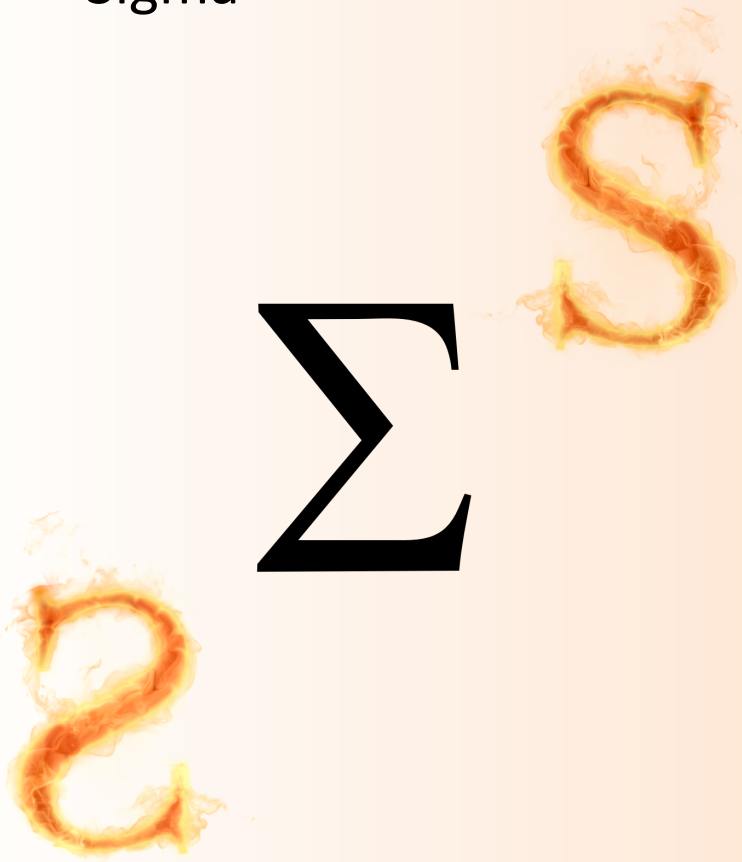


CfA

Etymology

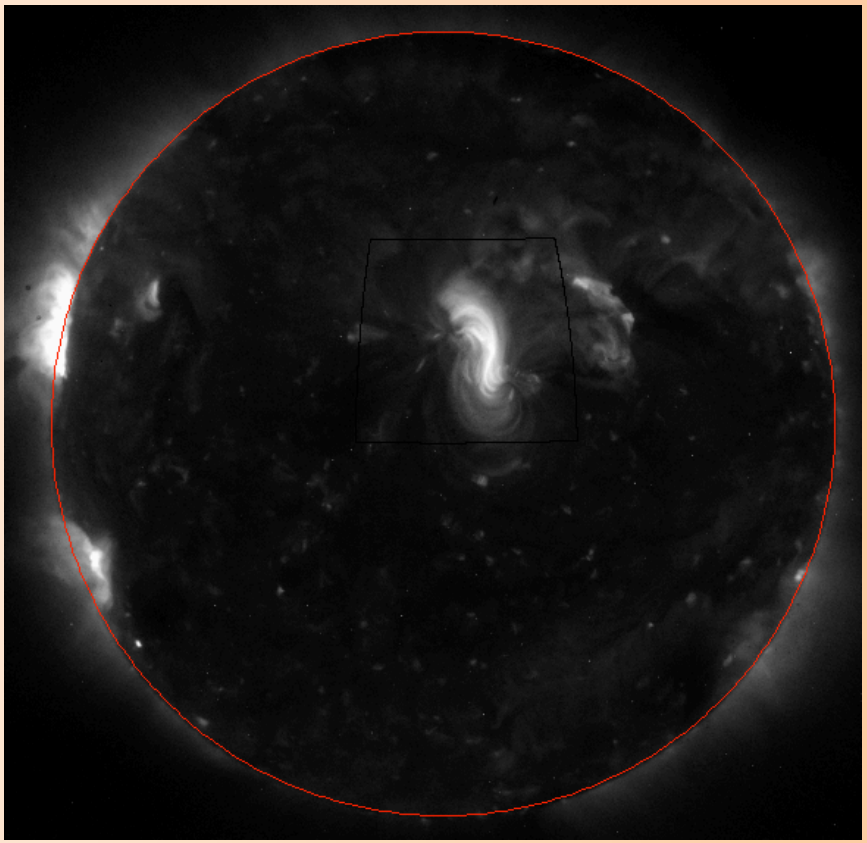
Sigm-

- Sigma



-oid

- Having the shape or form of



Talk Outline

Part 1: Background

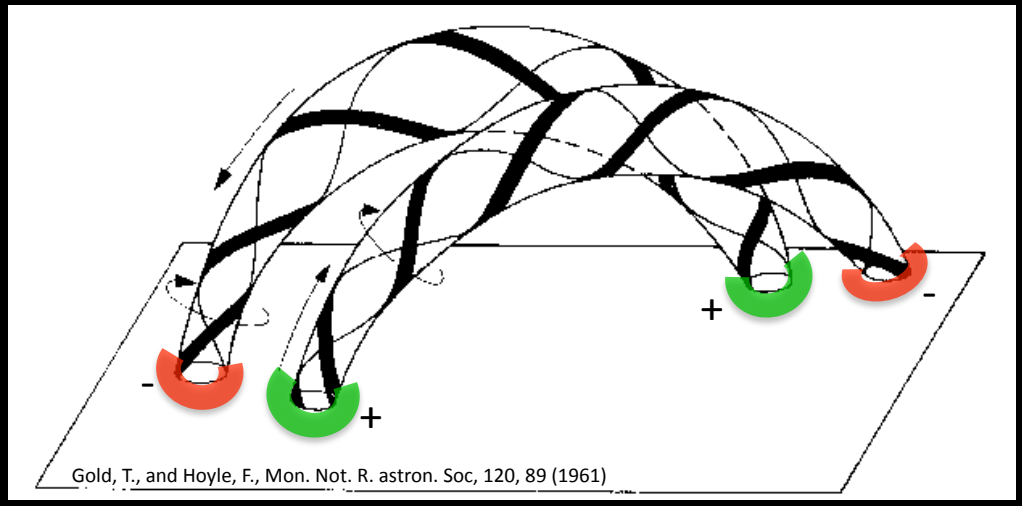
- What is the “S” made of?
- How do sigmoids evolve with time?
- How can we study sigmoids?

Part 2: REU Research

- Generate many computer models
- Find stable, best fit model

What is the “S” made of?

- Cooled plasma suspend by coiled magnetic fields



Gold, T., and Hoyle, F., Mon. Not. R. astron. Soc, 120, 89 (1961)

How do sigmoids evolve with time?

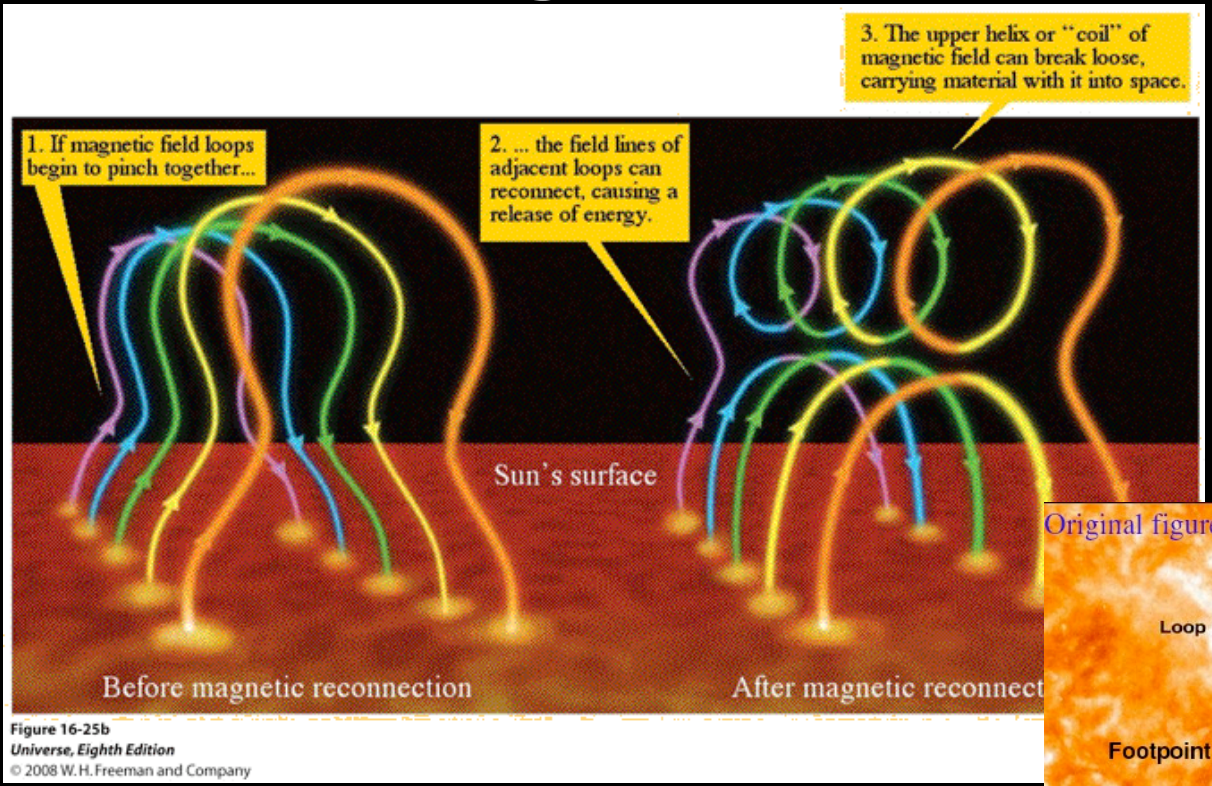
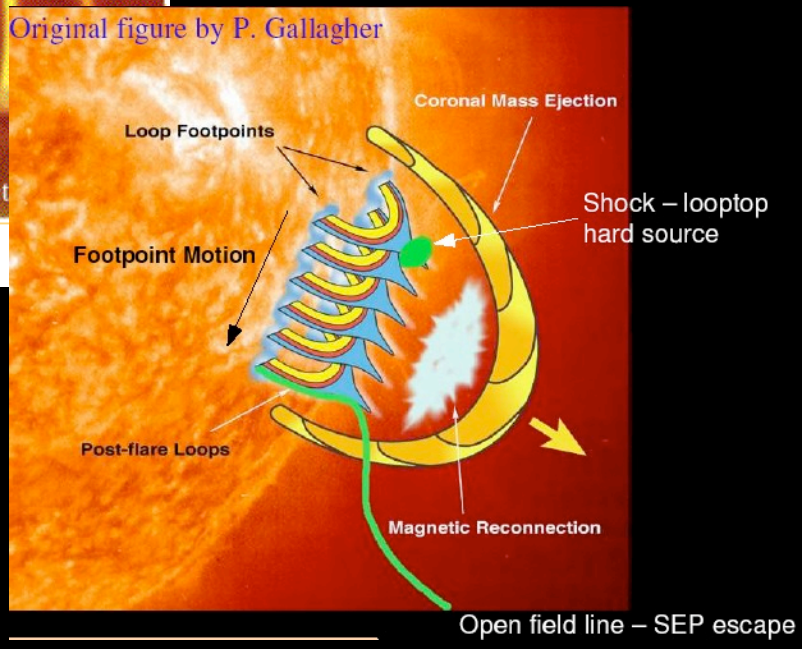


Figure 16-25b
Universe, Eighth Edition

- Magnetic reconnection

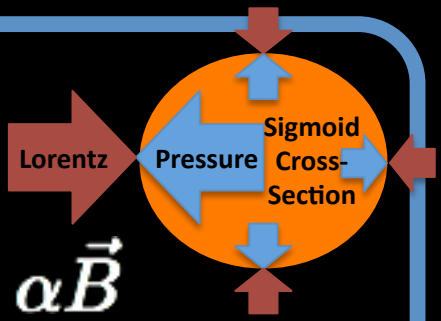


- 68% of erupting active regions are sigmoids

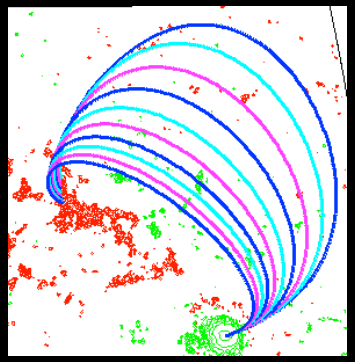
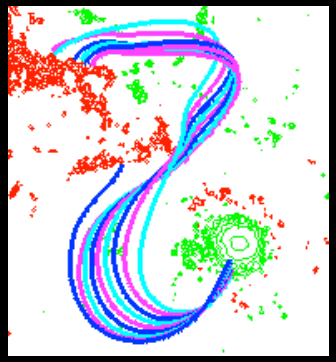
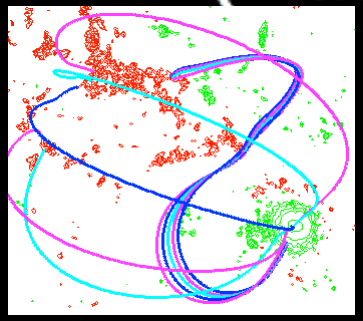
How can we study sigmoids?

NLFFF Modeling

Force-Free $\Sigma F \approx q(\vec{v} \times \vec{B}) + Pressure \approx 0$



$$\vec{j} \times \vec{B} \approx 0 \Rightarrow \begin{matrix} \vec{j} \| \vec{B} \\ \vec{j} = \nabla \times \vec{B} \end{matrix} \Rightarrow \vec{\nabla} \times \vec{B} \approx \alpha \vec{B}$$

Potential	Linear	**Nonlinear**
$\alpha \equiv 0$	$\alpha \equiv const$	$\alpha \equiv \alpha\left(\begin{matrix} Field \\ Line \end{matrix}\right)$
		

Tyler's Work
Significance and Goals

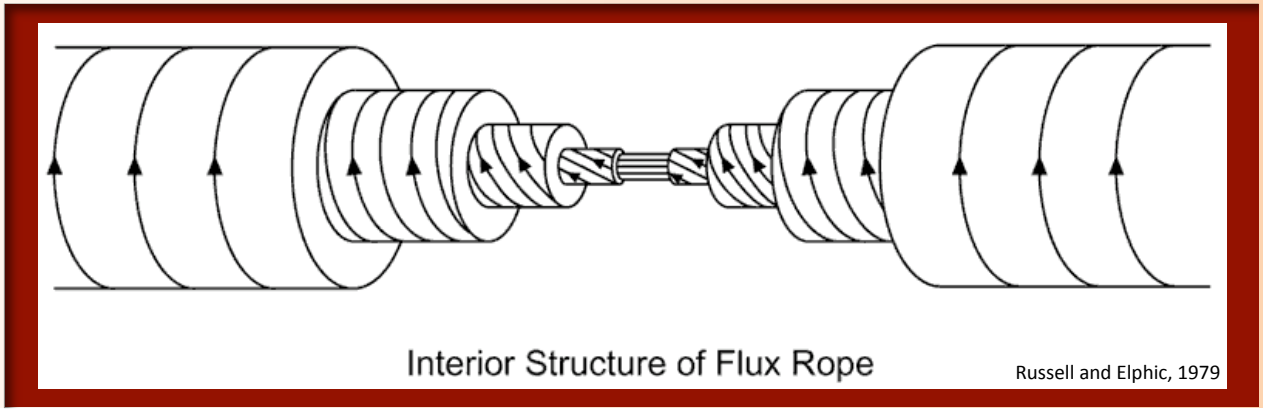
- *Goals*

  Find best fit NLFFF model in axial/poloidal flux space

- *Significance*

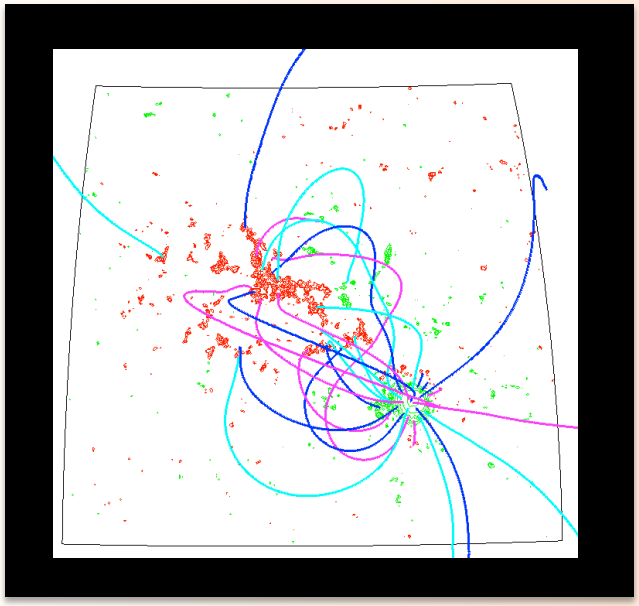
  Place boundaries on energy in field

  Predict stability of sigmoid

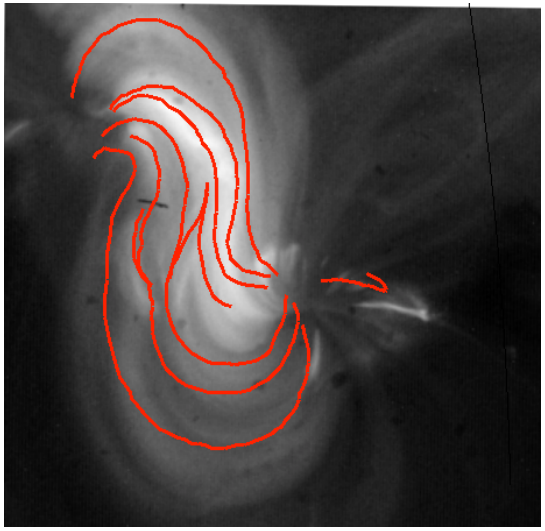


Tyler's Work
Two Sets of Data

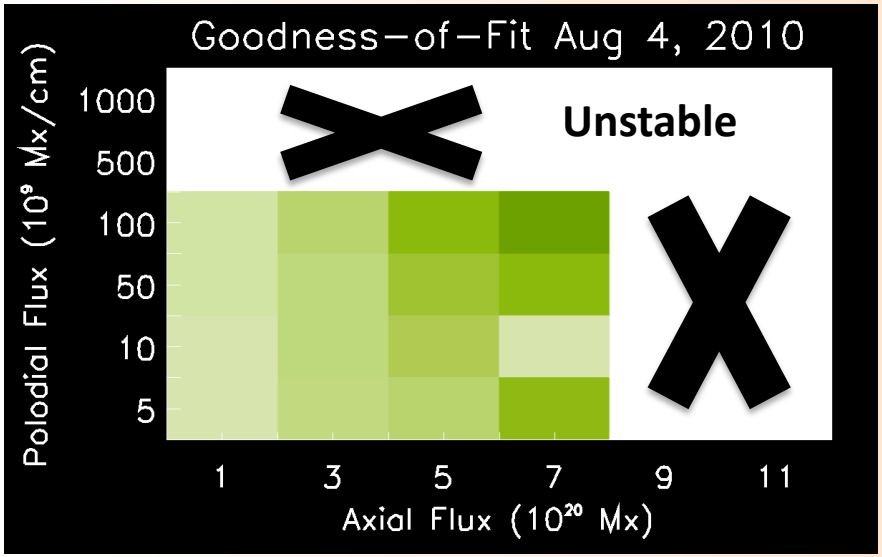
- Magnetogram → Fields
- X-Ray Images → Coronal Loops (ie Flux)
- Span axial/poloidal flux parameter space

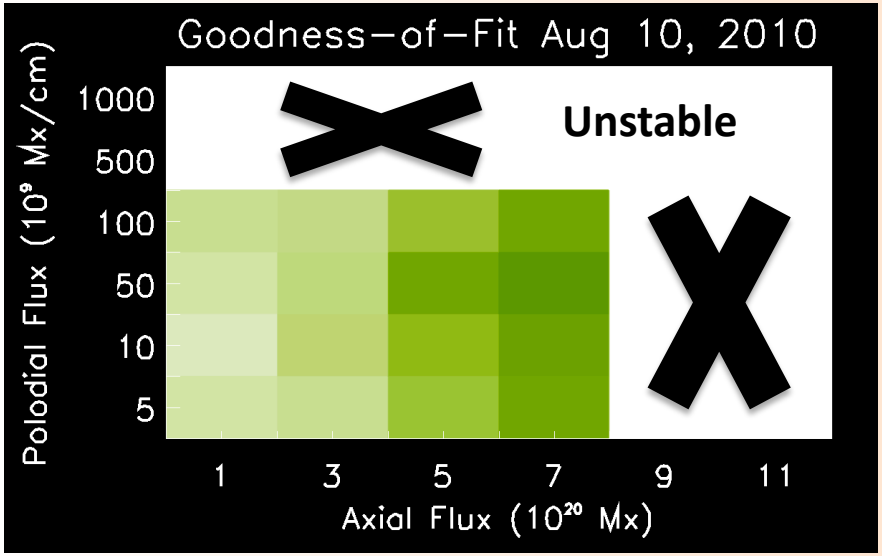


← Same Sigmoid →



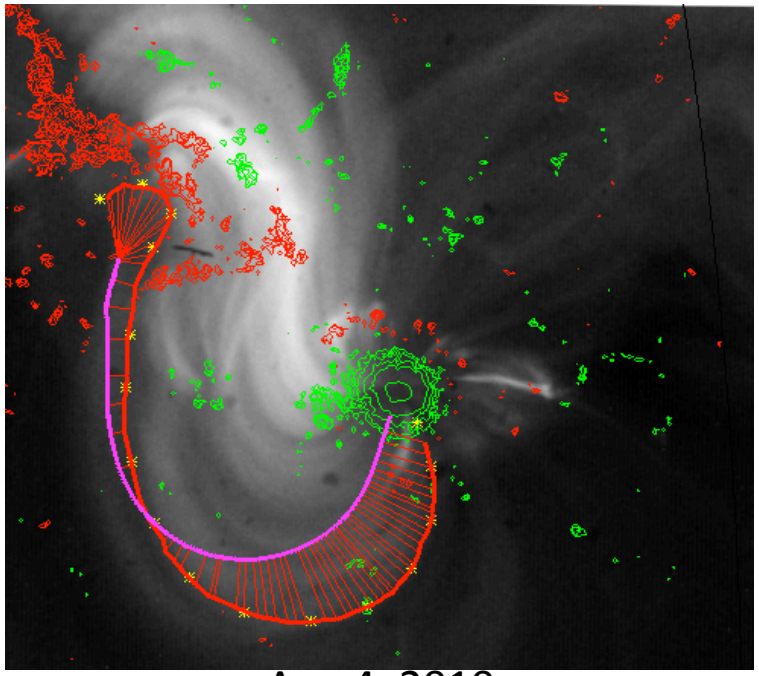
Tyler's Work
Results from Computer Models





34 models to span flux parameter space

Goodness = Less distance from field to flux
= Green *(on left charts)*



Aug 4, 2010

Conclusion

What is the “S” made of?

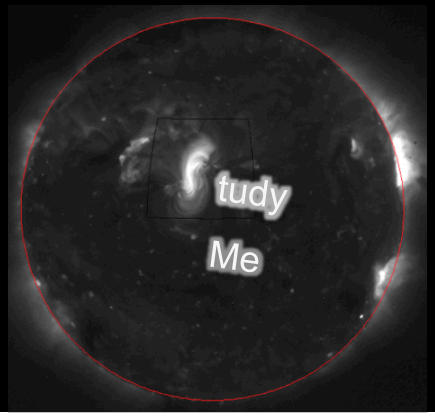
- Magnetically floated, cool coronal plasma

How do sigmoids evolve with time?

- Magnetic reconnection and eruptions

How can we study sigmoids?

- NLFFF Modeling + 1 intern = 2 sigmoids modeled



Special Thanks

- NSF REU solar physics program at CfA, grant number ATM-0851866 for funding
- Kathy, Marie, and all REU organizers
- Antonia and Ed for excellent mentorship
- Aad for the Coronal Modeling Software
- CfA for hospitality
- Trae, Jonathan, and Alisdair for computer help

References

Importance of Sigmoid Studies: *Canfield et al. (1999, 2007)*

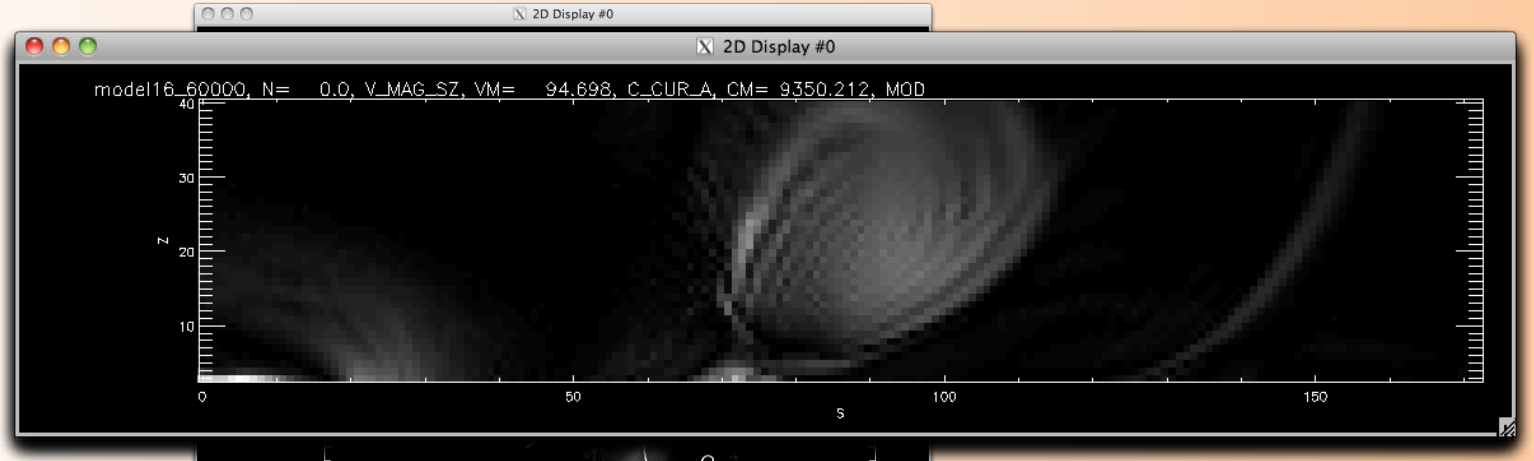
NLFFF Modeling: *Savcheva, Van Ballegooijen (2009)*

QSL's: *Domoulin, Hénoux, Priest, Mandrini (1996)*

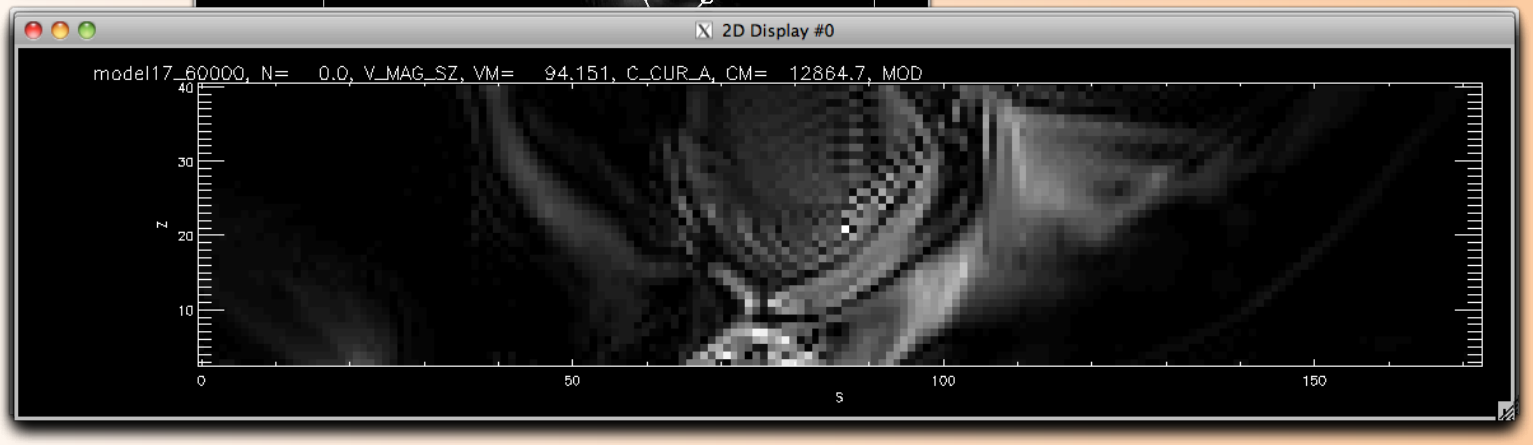
Illustrations: solarmuri.ssl.berkeley.edu/~hhudson/cartoons/

Tyler's Work
Step 3: Make Sure It's Stable

Best Fit Model



Higher Flux Model



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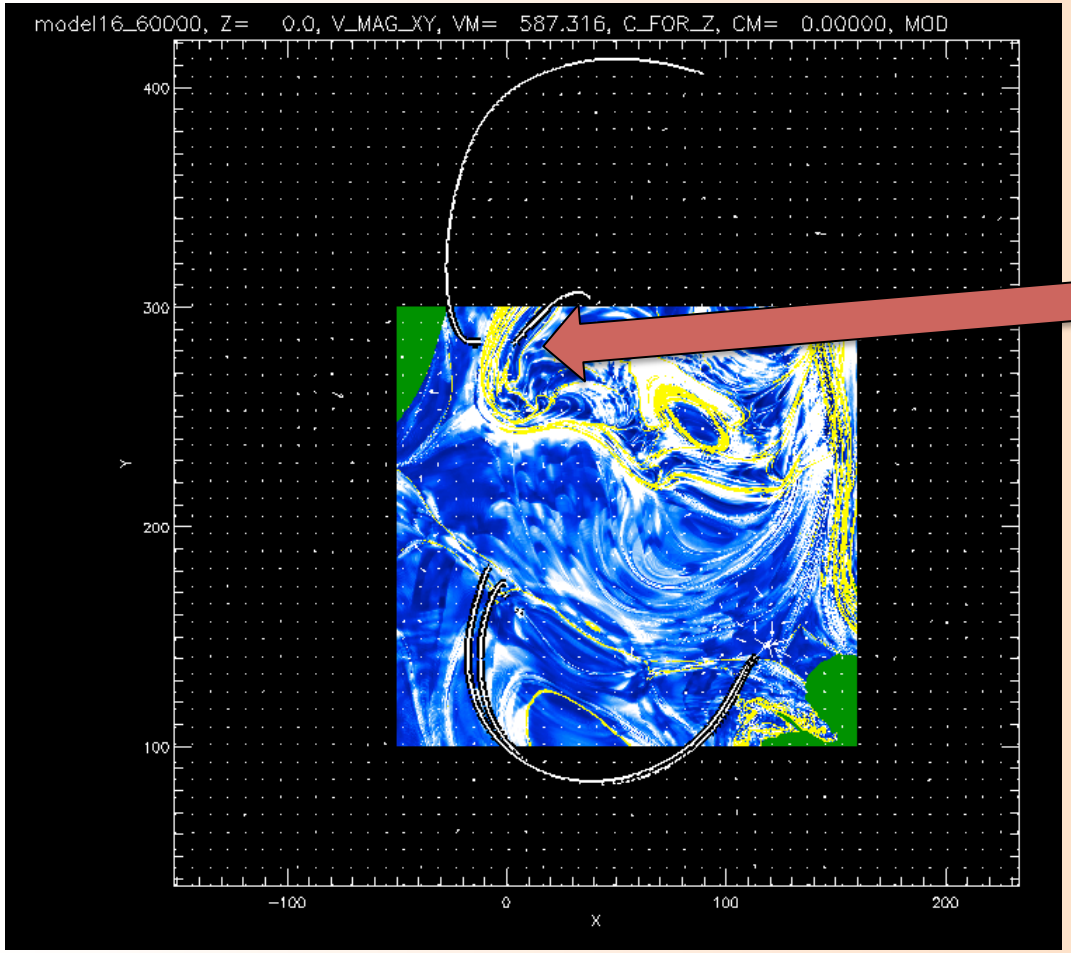
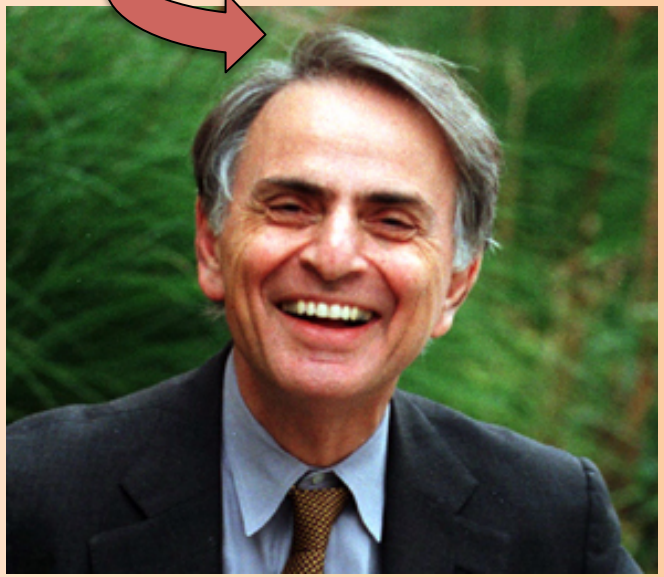
Tyler's Work
Step 4: Make Quasi-Separatrix Layers



If B-fields were heads of hair…

QSL's would be parted hairlines.

QSL



Tyler's Work
Step 4: Make Quasi-Separatrix Layers

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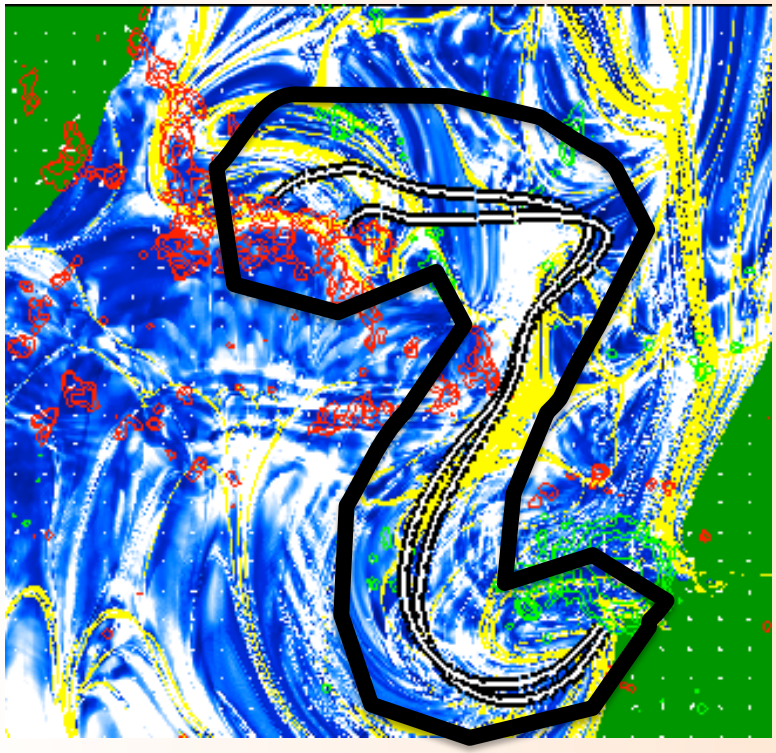

Free Energy = 6.0×10^{31} erg
Helicity = -5.2×10^{42} Mx^2

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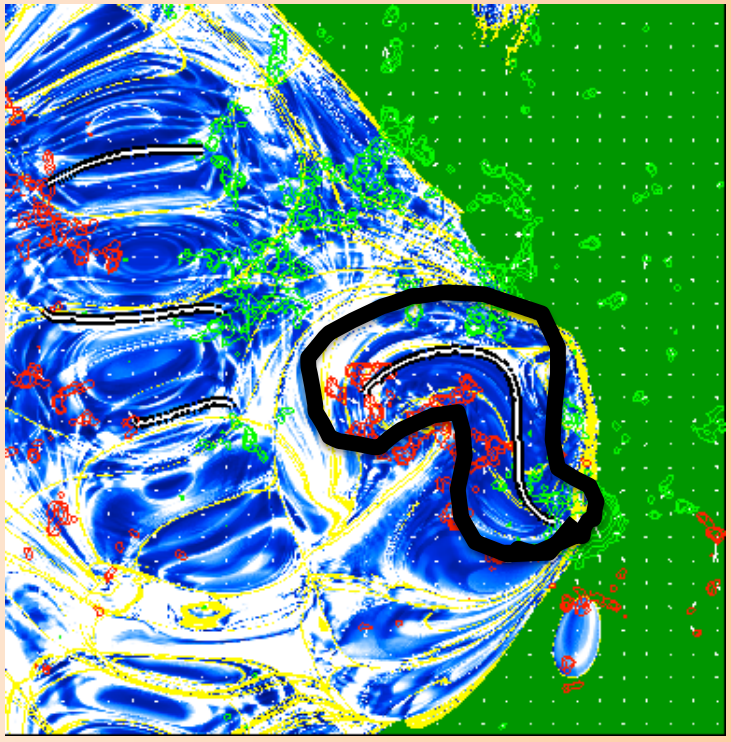

Free Energy = 3.4×10^{31} erg
Helicity = -2.3×10^{42} Mx^2

Tyler's Work
Step 4: Make Quasi-Separatrix Layers

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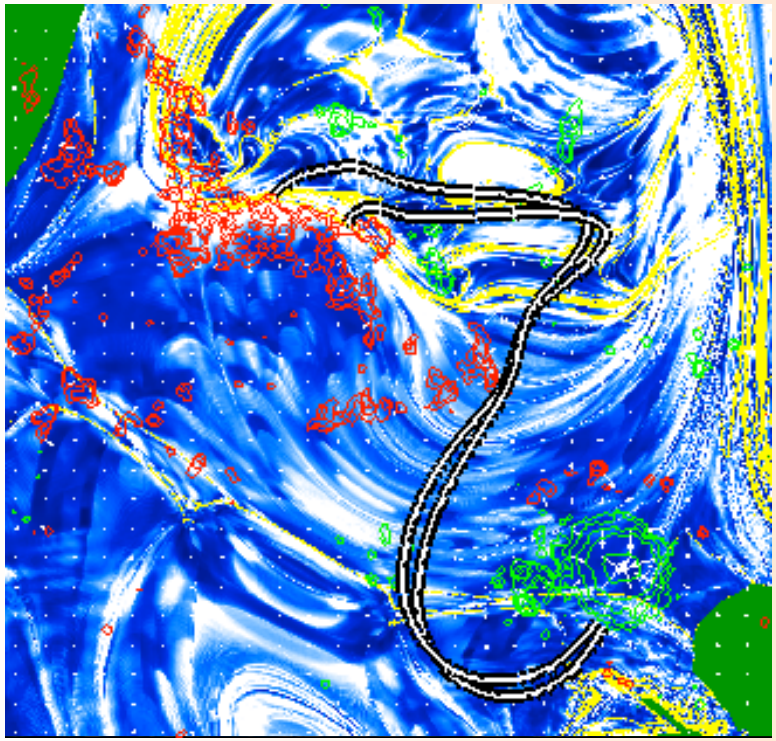

Free Energy = 6.0×10^{31} erg
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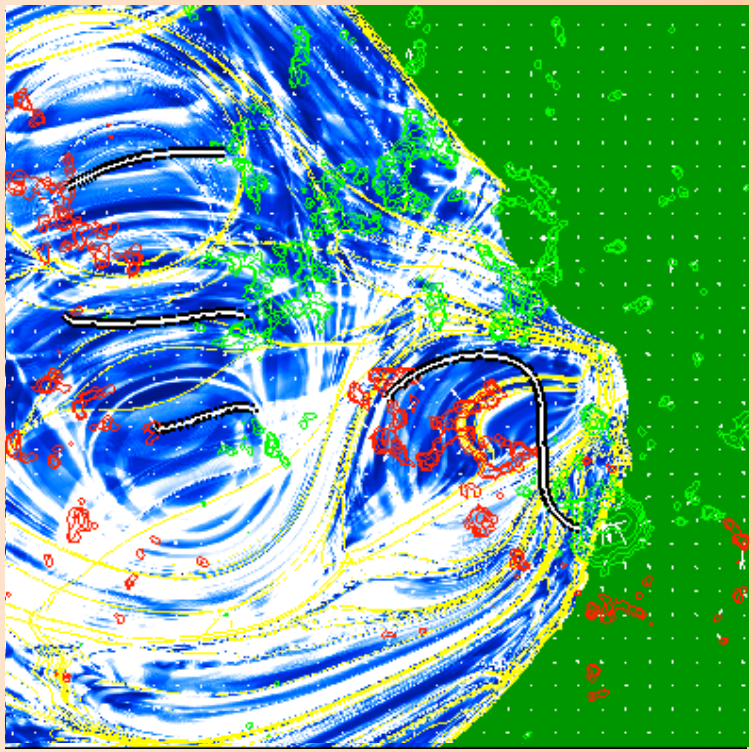
Aug 10, 2010



Free Energy = 3.4×10^{31} erg
Helicity = -2.3×10^{42} Mx^2