THE RAILS INSIDE THE SUN AND THE BUTTERFLIES THAT RIDE THEM

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THE FOLLOWING PREVIEW HAS BEEN APPROVED FOR
APPROPRIATE AUDIENCES
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THE FILM ADVERTISED HAS BEEN RATED

GENERAL AUDIENCES

www.filmratings.com

www.mpaa.org
From the creators of

(Hathaway 2011)

(Cameron & Schüssler 2016)
Comes an action-packed psychological thriller that will change the way you see reality

(Muñoz-Jaramillo et al. in preparation)
A DEEPLY TOUCHING STORY BASED ON REAL OBSERVATIONS...
...of magnetic death*...

Poloidal \( r - \theta \)  

Differential Rotation  

Toroidal \( \phi \)

* Transformation

Credit: J. J. Love
... and rebirth

Poloidal $r\ - \ \theta$

Differential Rotation

Toroidal $\phi$

Emergence and Decay of Tilted Active Regions
For decades, our heroes have civilly debated the nature of the solar cycle. It’s deep in the interior!
For decades, our heroes have civilly debated the nature of the solar cycle. No! It’s near the surface!
For decades, our heroes have civilly debated the nature of the solar cycle. Everything can be explained by meridional flow variations... No! The convection zone is diffusive in nature!
But new ways of looking at old data may provide the clues that we are missing

- Referencing sunspot properties to the strength of the cycle at a given time (activity level; Muñoz-Jaramillo et al 2015).

- Using latitude of the toroidal belts instead of time (Hathaway 2011; Ivanov & Miletsky 2014; Cameron & Schüssler 2016; this work).
ACTIVE REGIONS AND THE TOROIDAL FIELD

Nelson et al. (2014)

Weber, Fan, & Miesch (2011)

Jouve, Brun, & Aulanier (2013)

Fan (2008)

Yeates & Muñoz-Jaramillo (2013)
A Gaussian is fitted to the latitudinal distribution of all observed groups within a 24 month window.
A Gaussian is fitted to the latitudinal distribution of all observed groups within a 24 month window.
ALL HEMISPHERIC CYCLES FOLLOW DIFFERENT PARTS OF A UNIVERSAL PATH

We use Schawbe’s, RGO and KMAS data
ALL HEMISPHERIC CYCLES FOLLOW DIFFERENT PARTS OF A UNIVERSAL PATH

And calculate the path followed by the wing centroids and the width of the wings
ALL HEMISPHERIC CYCLES FOLLOW DIFFERENT PARTS OF A UNIVERSAL PATH

All paths can be fitted by the same function with only a difference in time-shift.
ALL HEMISPHERIC CYCLES FOLLOW DIFFERENT PARTS OF A UNIVERSAL PATH

Cycle 19-North

Bell Curve Area = 19.18 mHem*Yr

Latitude (°)

Years from the belt reaching 15°
ALL HEMISPHERIC CYCLES FOLLOW DIFFERENT PARTS OF A UNIVERSAL PATH

Cycle 19-North

Bell Curve Area = 19.18 mHem*Yr
ALL HEMISPHERIC CYCLES FOLLOW DIFFERENT PARTS OF A UNIVERSAL PATH

Cycle 12-North

Bell Curve Area = 4.14 mHem*Yr

Latitude (°)

Years from the belt reaching 15°
ALL CYCLES DECAY IN THE SAME WAY (CAMERON & SCHÜSSLER 2016).
REFERENCED TO THE UNIVERSAL PATH, THE DECAYING PHASE OF ALL CYCLES ALIGNS
Latitude of centroid can be used as the independent variable instead of time.
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REFERENCED TO THE UNIVERSAL PATH, THE DECAYING PHASE OF ALL CYCLES ALIGNS
ALL CYCLES DECAY WHEN THEIR TOROIDAL BELTS TOUCH ACROSS THE EQUATOR
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[Graphs showing solar activity levels for Cycle 18 and Cycle 19, with data points for North and South hemispheres and statistical significance levels.]
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IMPLICATIONS FOR THE SOLAR DYNAMO

• The solar cycle is operating in a highly diffusive regime (in agreement with mixing-length estimates; Cameron & Schüssler 2016).

• We need to revise the role that the meridional flow as a critical ingredient of the solar dynamo.
RESEARCH SEMINARS

The Rails Inside the Sun and the Butterflies that Ride Them.

WHERE DO DATA GO WHEN THEY DIE?
Where do data go when they die?

I suppose this is a question that every man who has ever lived has thought about,
Where do data go when they die?
HOW TO ATTAIN **DATA SALVATION?**
I’m a responsible data owner, I keep them on my personal webpage!
Ah, but my webpage is institutional, that’s not going to happen to me.
REACHING ENLIGHTEMENT THANKS TO THE ApJ/AAS

• The answer is on the 6th line of the 6th section of the latest AAS LaTeX template (version 6).

  • https://github.com/AASJournals/Tutorials/tree/master/Repositories

• There are three online repositories that the AAS recommends:
  – https://zenodo.org/ (CERN)
  – https://figshare.com/ (Private)
1. They assign each database a unique DOI identifier.
2. They have contingency plans for migrating databases to another repository should their operation ends.

- There are three online repositories that the AAS recommends:
  - [https://zenodo.org/](https://zenodo.org/) (CERN)
  - [https://figshare.com/](https://figshare.com/) (Private)
  - [https://dataverse.harvard.edu/](https://dataverse.harvard.edu/) (Harvard)
THE SOLAR DYNAMO DATaverse
A century of Calibrated Polar Faculae

The most direct proxy we have for the evolution of the polar magnetic fields.

Muñoz-Jaramillo et al. (2012)
40 years of homogeneous bipolar active regions

- MDI and KPVT-512 channel done 6,885 unique objects detected and tracked. HMI is being processed.
MORE THAN JUST MY DATA
A homogeneous composite of sunspot group data

Schawbe’s, RGO and KMAS data
### 1 to 4 of 4 Results

<table>
<thead>
<tr>
<th>Title</th>
<th>Dataverse/Date</th>
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<tbody>
<tr>
<td>Bipolar magnetic regions determined from NSO synoptic carrington maps</td>
<td>Mar 30, 2016 - Magnetic Catalogs Dataverse</td>
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<tr>
<td>Anthony R. Yeates, 2016, &quot;Bipolar magnetic regions determined from NSO synoptic carrington maps&quot;.</td>
<td><a href="http://dx.doi.org/10.7910/DVNY5CXMB">http://dx.doi.org/10.7910/DVNY5CXMB</a>, Harvard Dataverse, V1</td>
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<tr>
<td>Database of bipolar magnetic regions (BMRs) determined from NSO synoptic carrington maps of the Sun’s photospheric line-of-sight magnetic flux between carrington rotations cr1911 and cr2146 inclusive. The attached plots summarize the dataset. In the data file itself, the columns a...</td>
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<td>Magnetic Catalogs Dataverse (Georgia State University)</td>
<td>Mar 30, 2016</td>
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<tr>
<td>Catalogs of solar magnetic features (i.e. bipolar magnetic regions, ephemeral regions, magnetic elements, etc.).</td>
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<td>MWO polar faculacue count calibrated to WSO polar fields and SOHO/MDI polar flux</td>
<td>Mar 22, 2016 - Solar Polar Fields Dataverse</td>
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<td>Faculacue counted by hand on the best 5 images during the periods of maximum pole coverage (August 15-September 15 for the North pole and February 15-March 15 for the South pole) and averaged. Standard deviation has been turned into standard error by dividing it by sqrt(5). Years w...</td>
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https://dataverse.harvard.edu
Search for “solar dynamo”

https://www.solardynamo.org
go to “Data” section