Coronal polarization of pseudostreamers and the solar polar field reversal

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The reversal of the solar polar magnetic field is notoriously hard to pin down due to the extreme viewing angle of the pole. In Cycle 24, the southern polar field reversal can be pinpointed with high accuracy due to a large-scale pseudostreamer that formed over the pole and persisted for approximately a year. We tracked the size and shape of this structure with multiple observations and analysis techniques including PROBA2/SWAP EUV images, AIA EUV images, CoMP polarization data, and 3D tomographic reconstructions. We find that the heliospheric field reversed polarity in February 2014, whereas in the photosphere, the last vestiges of the previous polar field polarity remained until March 2015. We present here the evolution of the structure and describe its identification in the Fe XII 1074nm coronal emission line, sensitive to the Hanle effect in the corona.
Near solar maximum, the poles reverse polarity.

Red is positive magnetic flux, color scale is saturated at 15 G.
A pseudostreamer traces the polar reversal

Solar cycle 24, south pole, SWAP 174 Å images
MAGNETIC STRUCTURE EVOLUTION

Coronal hole with positive polarity surrounded by a streamer.

Circumpolar cavity (N. Karna PhD talk)

The neutral line moves south. A pseudostreamer is born.

The coronal field reverses.

The pseudostreamer shrinks.

The structure disappears leaving a negative polarity coronal hole.

The photospheric field reverses.
STREAMER TO PSEUDOSTREAMER TOPOLOGY CHANGE

Analytical model

Modeled coronal polarization

\[
\frac{L}{I} = \frac{\sqrt{Q^2 + U^2}}{I}
\]

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STREAMER TO PSEUDOSTREAMER TOPOLOGY CHANGE

A

B

C

Solar radii

-0.8

-1.0

-1.2

-1.4

-0.6

-0.2

0.2

0.6

Solar radii

-0.8

-1.0

-1.2

-1.4

-0.6

-0.2

0.2

0.6

Solar radii

-0.8

-1.0

-1.2

-1.4

-0.6

-0.2

0.2

0.6

CoMP 2014-01-27, log(L/I)

CoMP 2014-08-19, log(L/I)

CoMP 2014-11-26, log(L/I)
TRACING THE CORONAL STRUCTURE EVOLUTION

2014–06–12T01:11:22 SWAP 17.4 nm (inverted colorable)
The pseudostreamer shrinks over the course of the year.

Eruptions are common, after which the structure reforms.
➤ Pseudostreamer appears in March 2014 and shrinks in width over time.

➤ The center of the neutral line is ~5 degrees from the rotational axis.
➤ Pseudostreamer appears in March 2014 and shrinks in width over time.

➤ The center of the neutral line is ~5 degrees from the rotational axis.
The neutral line tracks well with the magnetogram data.

Neutral line moves poleward at \( \sim 4.5 \) m/s over the course of a year.
NEUTRAL LINE MOVEMENT

- Measured poleward speed of \( \sim 4.5 \text{ m/s} \).
- Consistent with meridional flow speeds at high latitudes.
- Combination of meridional flow and diffusion (\( \sim 600 \text{ km}^2/\text{s} \)).
CONCLUSIONS

➤ The south pole had a simple axisymmetric field reversal.
➤ The coronal field structure can be to trace the field reversal.
➤ The corona and heliosphere revered polarity a year before the photosphere.