

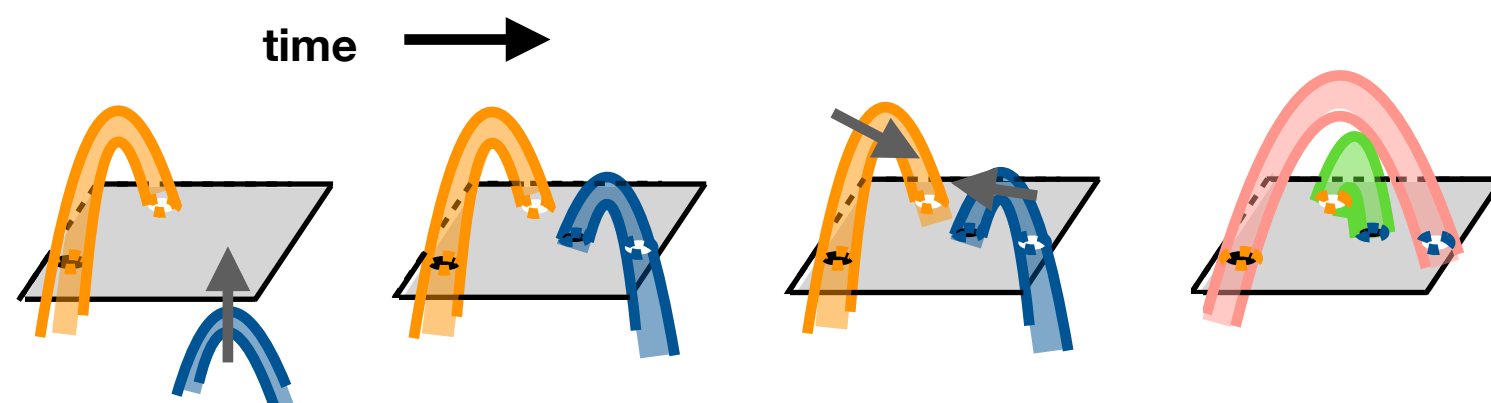
Examination of Separator Reconnection Rates in a Series of Adjacent Emerging/Existing Active Region Pairs

SH11D-3387

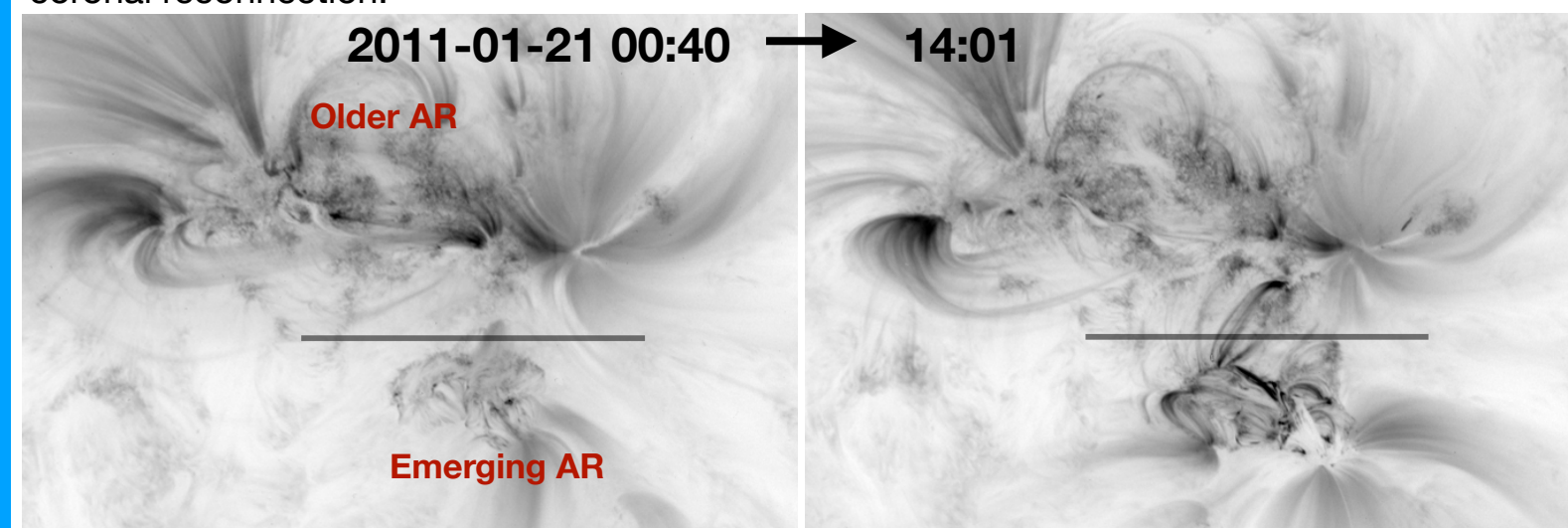
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Work thus far¹:



Using active region pairs as a laboratory for measuring reconnection: If each active region is a distinct magnetic system, any new flux linkage between two must be a result of coronal reconnection.



Observational evidence of reconnection: During the ~14 hours time difference between these two SDO/AIA 171Å images, we see evidence of coronal reconnection in the form of loops (areas of strong emission, dark in the reverse-color scale image) between the two regions. The dark, horizontal bar indicates the slit of pixels used during the loop cataloging procedure.

Observations are supplemented with modeling of loops as a linear force-free field line²

~~Non-Linear FFF equations~~

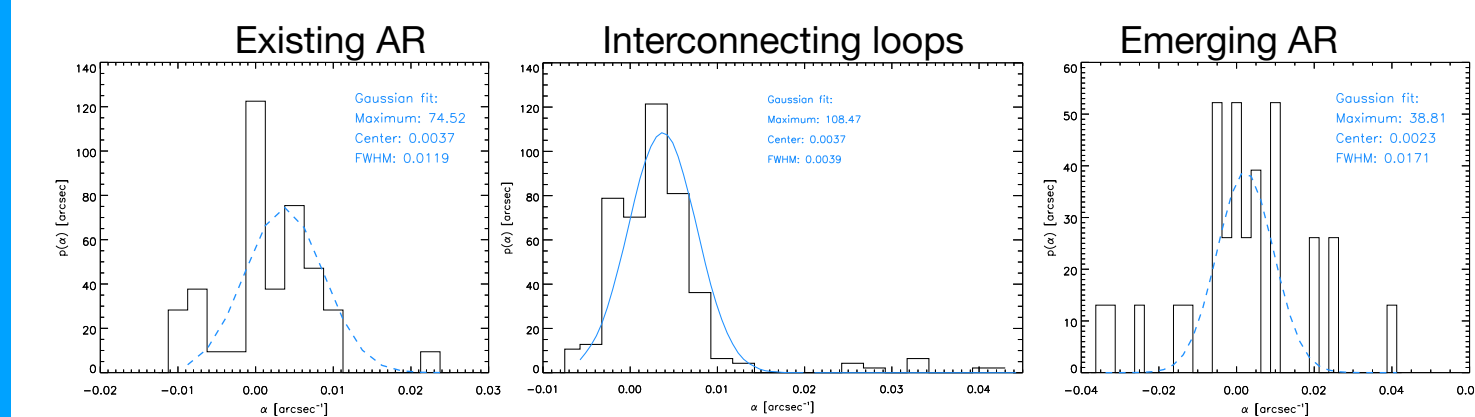
$\nabla \times \mathbf{B} = \alpha \mathbf{B} =$ field line fit

~~$\mathbf{B} \cdot \nabla \alpha = 0$~~

$\nabla \cdot \mathbf{B} = 0$ $\nabla \alpha = 0$

trace field line (LOS coronal image) + magnetic info

Obtain 3d structure of traced loops, including α :



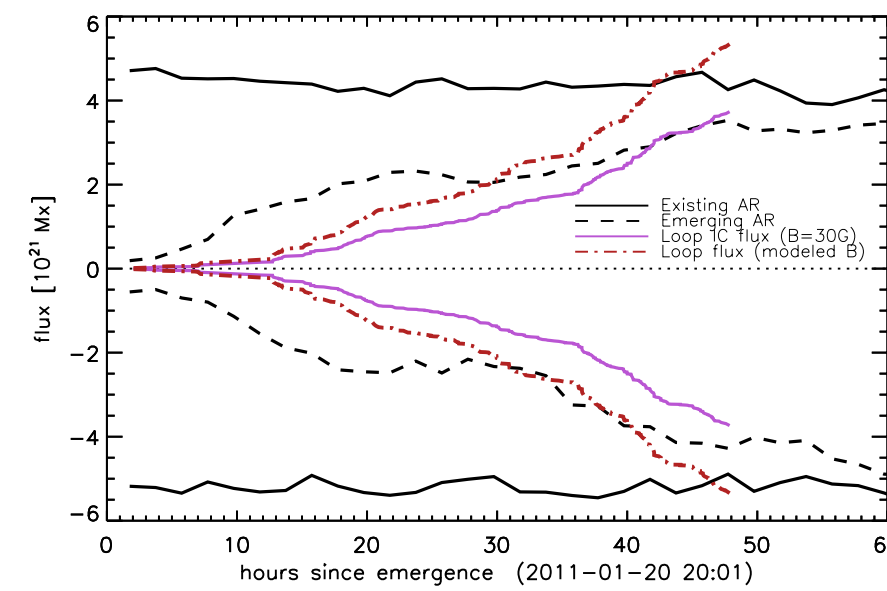
Distribution of α in various magnetic domains: The emerging and existing AR's were modeled in one snapshot. The modeled interconnecting loops [center] were modeled at multiple instances in time.

Improvement on methodology:

Goals:

Elucidate questions posed by previous work

- Time delays between new flux emerg. and reconnection have been shown on the order of ~24hr...³ Is this typical?
- Studies^{1,3} have both under and over counted flux interconnecting two ARs
- What about the emerging/adjacent AR system accounts for these differences?

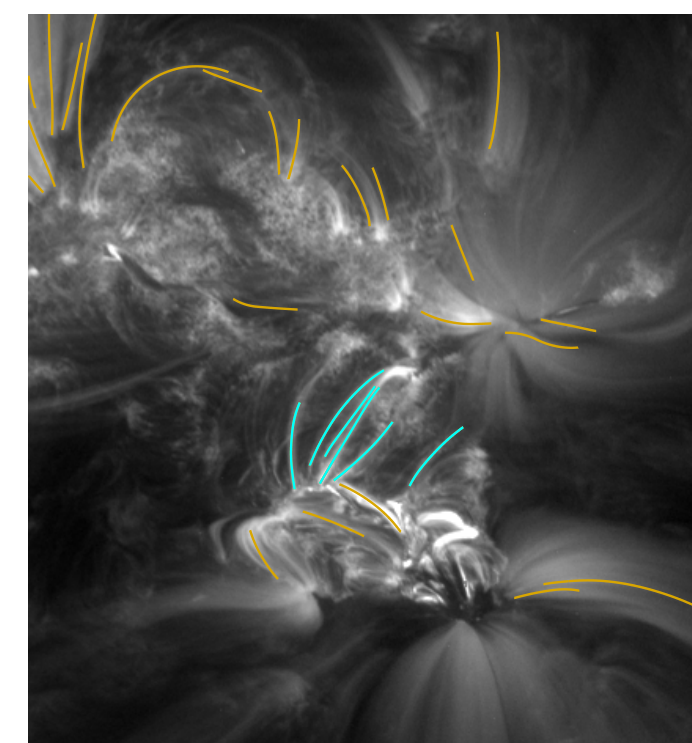
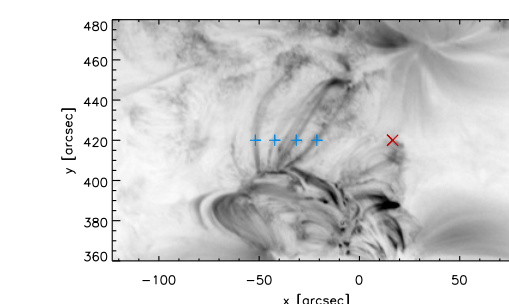
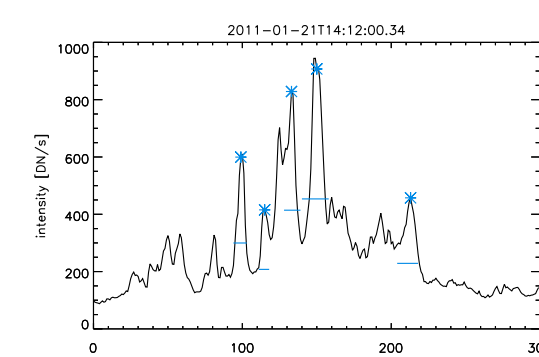


Questions for the extended study: A flux vs. time plot from McC+19 showing the overcounting of flux between two ARs (more than there is in either to begin with) and the delay between the new AR emergence and reconnection between the two.

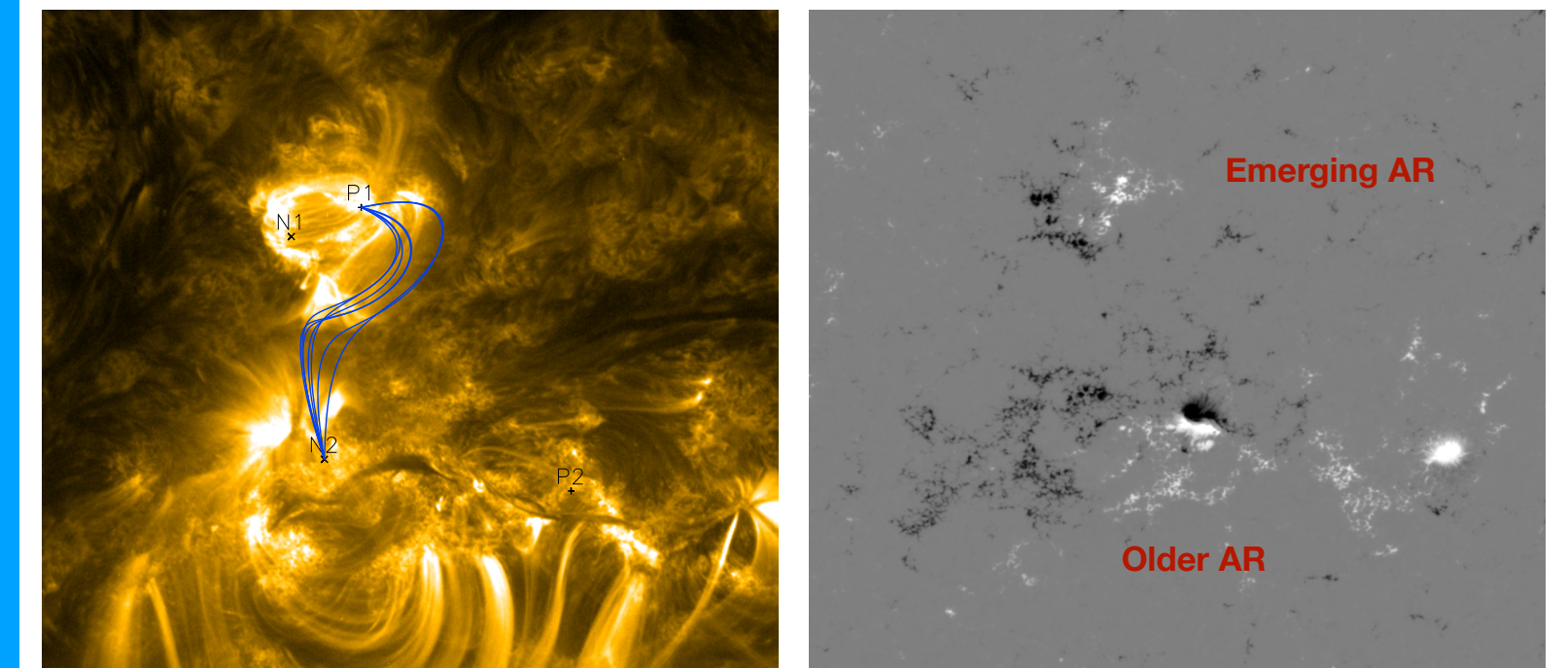
List of other adjacent active region emergences near existing ones

| # | date | ARs | # | date | ARs |
|---|------------|-----------|----|------------|-----------|
| 1 | 2011-01-20 | 1147/1149 | 10 | 2012-04-18 | 1458/1460 |
| 2 | 2011-02-17 | 1161/1162 | 11 | 2013-01-10 | 1649/1655 |
| 3 | 2011-05-15 | 1214/1217 | 12 | 2013-02-19 | 1671/1678 |
| 4 | 2011-08-29 | 1277/1282 | 13 | 2013-10-13 | 1865/1870 |
| 5 | 2011-10-12 | 1313/1320 | 14 | 2013-11-11 | 1893/1900 |
| 6 | 2011-10-29 | 1334/1335 | 15 | 2013-12-03 | 1908/1914 |
| 7 | 2011-12-05 | 1367/1370 | 16 | 2014-04-14 | 2036/2037 |
| 8 | 2011-12-18 | 1381/1382 | 17 | 2016-03-03 | 2512/2514 |
| 9 | 2012-01-14 | 1395/1398 | | | |

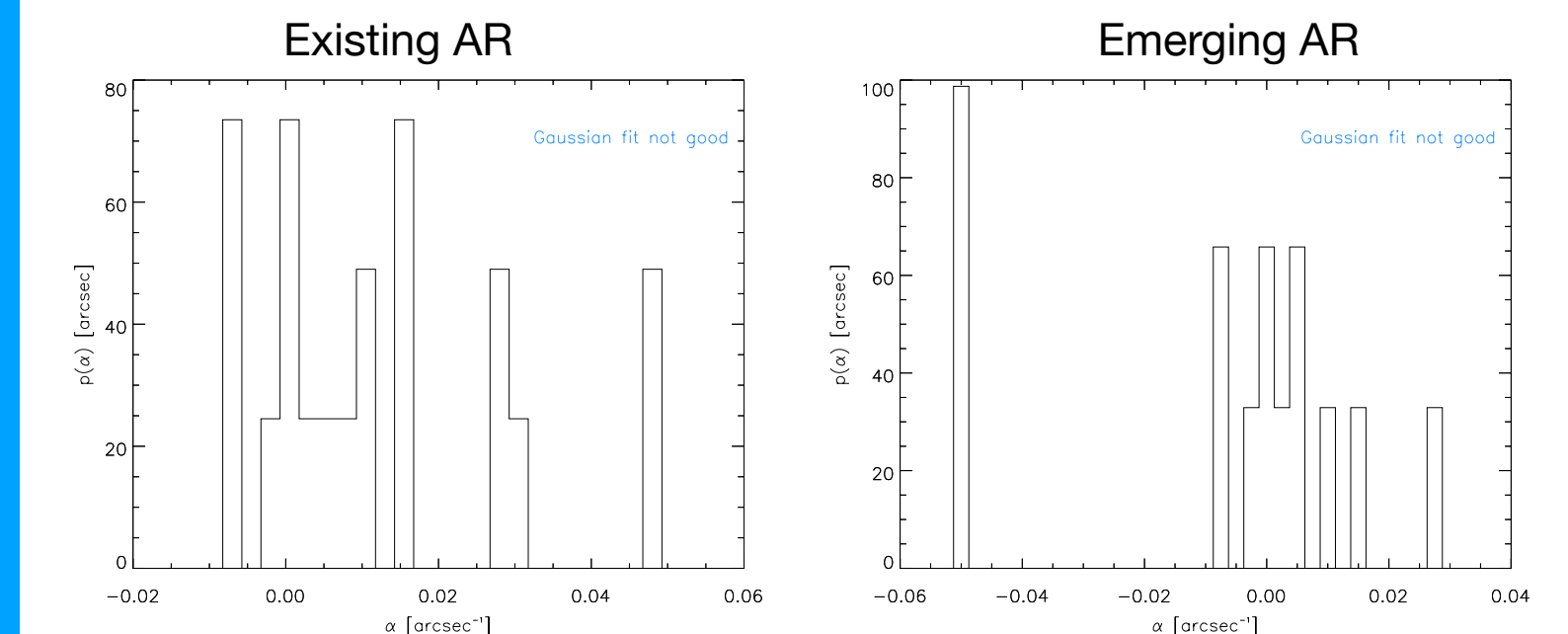
Other two-AR events for consideration: [BLUE] Case has been studied in depth in McCarthy+ 2019 (see left column). [GREEN] These pairs appear not to form coronal loops between them in excess of 24 hours post-emergence.



An interesting case: No reconnected loops?



Active regions not reconnecting: For case 13 in the list of adjacent AR emergence events, no 171Å loops seem to appear between these two active regions in excess of days. The coronal image at left has a quadrupolar MCT model overplotted for reference on where we might expect to see reconnected loops



Distribution of twist for field lines within different magnetic domains: Does the distribution of coronal alpha have an effect on how inclined the two ARs are to reconnection between them?

References:

- 1 McCarthy et al. (2019). Accepted to ApJ.
- 2 Malanushenko et al. (2019). ApJ. 707, 1044.
- 3 Longcope et al. (2005). ApJ. 630, 596.
- 4 Aschwanden et al. (2013). Entpr. 15, 3007.

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Improvement of loop selection procedure: [LEFT] In previous work¹, we used local maxima in the intensity profile to select coronal loops. [RIGHT] We make improvements to our analysis pipeline by implementing OCCULT⁴. Significant loop confirmation will be done by an REU student in summer 2020.