The Squashing Factor $Q$

- An infinitesimal circle is mapped along a field line into an infinitesimal ellipse. The aspect ratio of the resulting ellipse defines the squashing factor, $Q$, of the flux tube surrounding the field line (Fig. 1).
- Magnetic null, separator, and separatrix have infinite $Q$ due to discontinuity in field line mapping. Quasi-separatrix layers (QSLs) have finite high $Q$.
- High-$Q$ regions are preferred sites for magnetic reconnection and thus play key roles in flare, CME and slow solar wind.

Uses of $Q$-Maps

- Identification of hyperbolic flux tubes as preferred sites for current sheet formation and thus flare sites (e.g., Savcheva+ 2012; Zhao+ 2014).
- Classification of streamer & pseudo-streamer as background environment which systematically affects CME speed (Liu 2007).
- Investigation of subtle magnetic linkage between remote regions that participate in sympathetic eruptions (Torok+ 2011, Titov+ 2012, Fig. 2).
- Visualization of topological changes related to eruptive/confined flares (Sun+ 2015, Fig. 3).
- Evolution of magnetic topology over days and over a solar cycle.

Synoptic Data Product: $Q$-Maps Based on HMI/PFSS

- Routine coronal hole maps and $Q$-maps calculated on 10 different radial slices based on PFSS model and HMI data.
- Inputs: synoptic maps/synchronic frames corrected for polar field. Outputs: 0.25 deg maps per CR/per day.
- Code developed at Predictive Science Inc.; has been tested and ported to HMI pipeline.
- Routine and on-request runs; data and visualization available through JSOC and VSO.

Future Work

- Computing $Q$ on routine and campaign MHD runs in comparison with the PFSS version.
- Active region $Q$ maps using HMI vector data and non-potential extrapolation (e.g. Fig. 3).
- Possible auto-classification of topological structures.
- Visualization of data products (e.g., Fig 6).