Magnetic Structure and Evolution of CMEs:
From Their Photospheric Source Regions to the Heliosphere

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Outline

• 2007 May 19 CME
  – Summary of Source Region & In-Situ Analysis
  – Sun-to-1AU Rotation Effects ?!?!?

• MHD Simulations of CME Rotation During Eruption

• Prospects for Future:
  – More realistic 3D MHD CME Simulations
  – Continued Event/Observational Data Analysis
  – Simulation-Observation Comparisons
Many aspects of event are well-studied, e.g.

- Kilpua et al. 2009, SoPh in press
- Möstl et al. 2009, JGR in press
- Liewer et al. 2009, SoPh submitted
- and possibly more...?
2007 May 19 CME $\rightarrow$ May 22-23 ICME

[ Li et al. 2008 ]
Total magnetic flux in the region decreased by ~17% in ~48hrs before the B9.5 flare.

[ Li et al. 2008 ]
2007 May 19 CME → May 22-23 ICME

[ Li et al. 2008 ]  [ Kilpua et al. 2009 ]  [ Möstl et al. 2009 ]

[ Kilpua et al. 2009 ]  [ Möstl et al. 2009 ]  [ Liu et al. 2008 ]
2007 May 19 CME → May 22-23 ICME

[ Li et al. 2008 ]  [ Kilpua et al. 2009 ]  [ Möstl et al. 2009 ]

[ Kilpua et al. 2009 ]  [ Möstl et al. 2009 ]  [ Liu et al. 2008 ]
CME Rotation During Eruption
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\[ \hat{n} \quad \alpha \quad \hat{m} \]

Rotation Angle $\alpha$ [deg]

Radial Distance $[R_\odot]$:
- RH (Clockwise)
- LH (Counter-Clockwise)

Flux Magnitude
- $\Phi_T$
- $\Phi_P$

Time [$10^4$ sec]:
- $0.9$
- $1.0$
- $1.1$
- $1.2$
- $1.3$
Future Work - Simulations

• Data “Inspired”... 3D side-arcade (lateral) breakout

• Currently have PFSS/Magnetogram synoptic map initial conditions with outer boundary at $R_{SS}$ –

-- need solar wind outflow keep fields open for $r > R_{SS}$ (being currently tested in 2.5D coming soon to 3D)
Future Work – Data Analysis

e.g., 02 Jun 2008 CME → 06 Jun 2008 ICME
See Li et al. presentation tomorrow...
...and others!!
Future Work - Data/Model Comparison

- Block-adaptive spherical ARMS data (mass density) interpolated to uniform Cartesian grid for IDL manipulation
- Pre-eruption cavity, 3-part CME structure, shock formation & propagation in white-light/synthetic coronagraph images
- 3D Height-time profiles of running difference features
Thanks!

Looking forward to working with previous, current, and future collaborators!