First light and science of UCoMP at MLSO: the magnetic and thermodynamic morphology of CMEs

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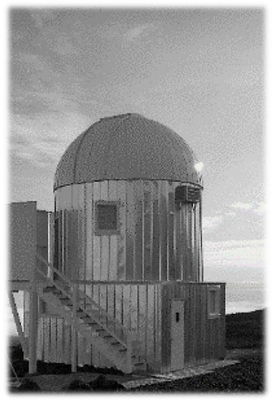
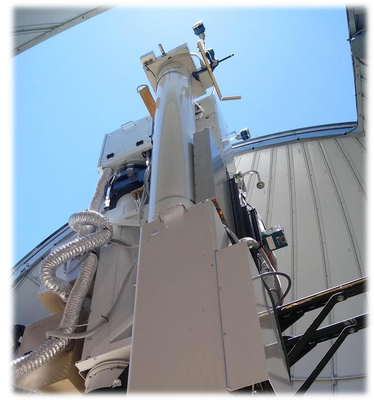




Left: Mauna Loa Solar Observatory (MLSO)
Right: UCoMP

The mechanism for the storage and release of magnetic energy in coronal mass ejections (CMEs) remains a major unsolved problem of Heliophysics. Thus, observations of the coronal magnetic field before, during, and after the eruption are important both for scientific progress and space weather predictions. We use the newly built Upgraded Coronal Multichannel Polarimeter (UCoMP) instrument from the Mauna Loa Solar Observatory (MLSO) to study the magnetic and thermodynamic morphology of CME precursors and eruptions. With this coronagraph's 20-cm aperture and field of view extending from 1.05 to 2.0 solar radii, we determine the magnetic field orientation of pre- and post-CME coronal loops using Stokes Q and U parameters as derived from the linearly polarized radiation observed from the Fe XIII 1074 nm spectral line. To ascertain the density, temperature, and ionization distribution of the hot plasma, we compare and contrast the structures seen at 1074 nm with the coronal features observed by UCoMP at the Fe X 637 nm line, the Fe XV 706 nm line, the Fe XI 789 nm line, and the Fe XIII 1079 nm line. In this study, we use several CME precursors and eruptions as examples for showcasing the unique capabilities of UCoMP, which will inform the future of ground-based coronagraph polarimeter observations that will eventually be performed with the COronal Solar Magnetism Observatory (COSMO).

(Upgraded) Coronal Multichannel Polarimeter

	CoMP	UCoMP
Aperture:	20 cm	20 cm
FOV:	1.05 – 1.38 $R_\odot$	1.04 – 1.95 $R_\odot$
Spectral Coverage:	1074 – 1083 nm	530 – 1083 nm
Spatial Resolution:	4.5 arcsec/pix	3 arcsec/pixel

Wavelength (nm)	Identification	Temperature (MK)	Lyot FWHM (nm)	Time frame
530.30	FeXIV	2.00	0.022	Removed Nov 2022
637.40	FeX	1.07	0.039	Whole mission
670.16	NiXV	2.5	0.044	Added Nov 2022
656.28	HI	0.16	0.042	Removed Nov 2022
691.80	ArXI	2.00	0.048	Removed Nov 2022
706.20	FeXV	2.19	0.051	Whole Mission
761.10	SXII	2.2	.061	Added Nov 2022
789.40	FeXI	1.26	0.068	Whole Mission
802.41	NiXV	2.5	0.069	Added Nov 2022
991.41	SVIII	0.8	0.069	Added Nov 2022
1074.62	FeXIII	1.66	0.138	Whole Mission
1079.78	FeXIII	1.66	0.141	Whole Mission
1083.00	HeI	0.19	0.142	Remove Nov 2022

Plasma Diagnostics: Temperature and Density
- via line intensity ratios & ionization equilibrium

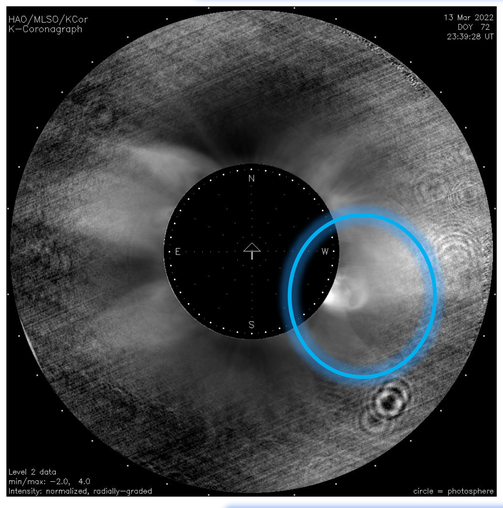
L.o.S. Velocity: Spectral Doppler Shift
- via Gaussian fit across (prefilter) bandpass

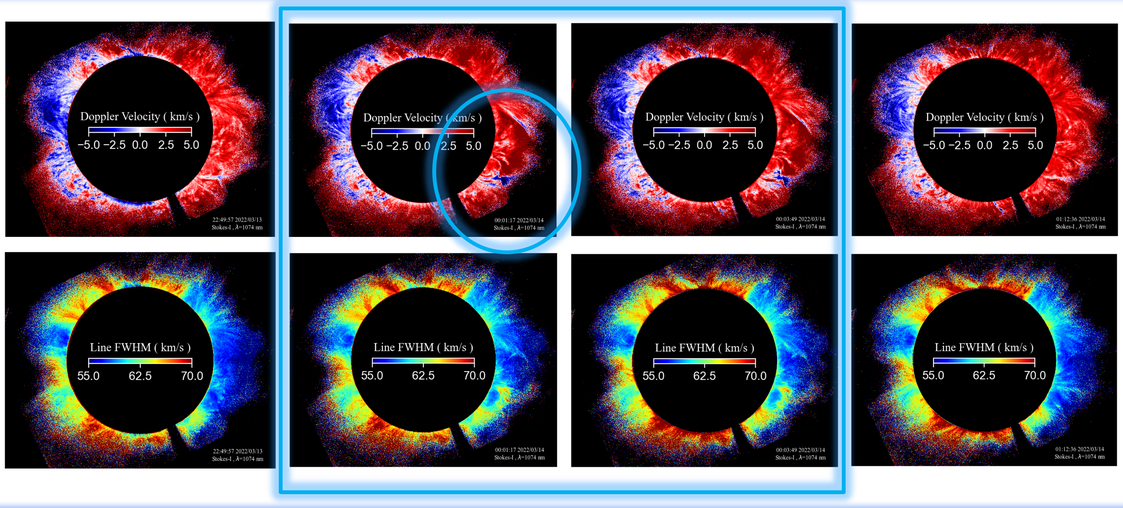
P.o.S. B-field Direction: Stokes Parameters (Q and U)
- via linear polarization from resonance scattering

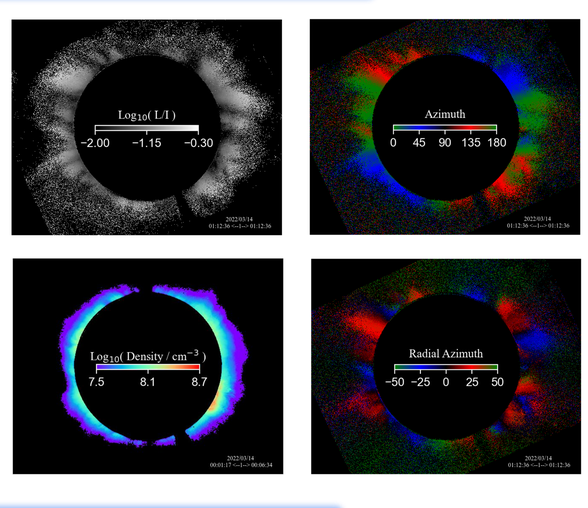
L.o.S. B-field Strength: Longitudinal Zeeman Effect
- via circular polarization (Stokes-V)

P.o.S. B-field Strength: Coronal Seismology
- via phase speed of Alfvénic waves

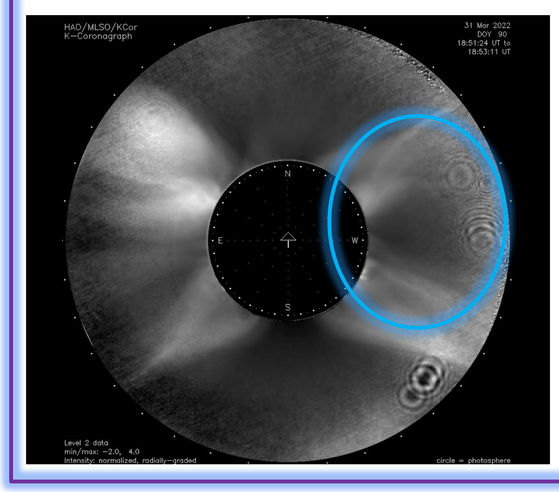
UCoMP observations of CME (March 13, 2022): Fe XIII lines, 1074 nm & 1079 nm







UCoMP observations of two CMEs? (March 31, 2022): Broad Spectral Coverage



1074 1074 1079 789 706 637