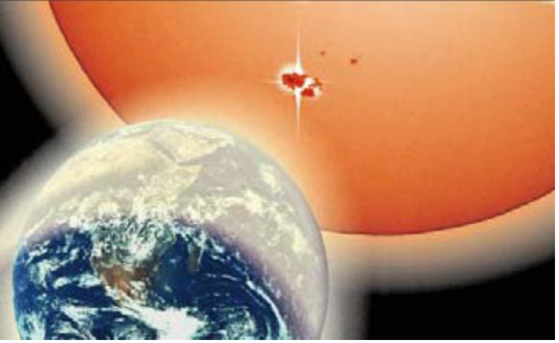


VarSITI Closing Symposium

June 10÷14, 2019, Sofia, Bulgaria

SOURCE REGIONS IDENTIFICATION AND GEOPHYSICAL EFFECTS OF STEALTH CORONAL MASS EJECTIONS

Zagainova Iu.S.[1], Fainshtein V.G.[2], Gromova L.I.[1], Gromov S.V.[1]

1 - Pushkov Institute of Terrestrial Magnetism, Ion
osphere and Radio Wave Propagation Russian
Academy of Sciences, Russian Federation

2 - Institute of solar-terrestrial physics,
Russian Federation

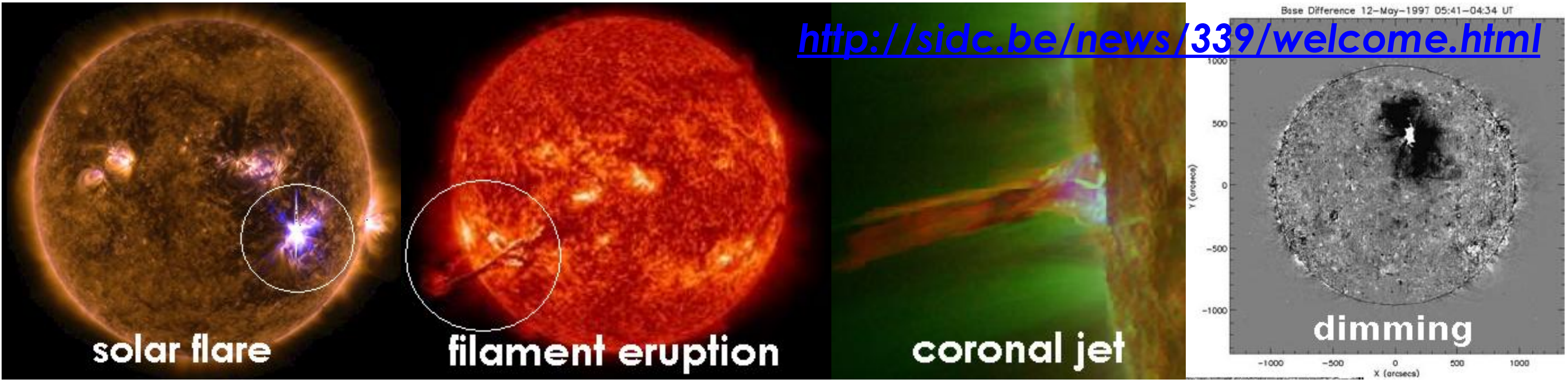
What is meant by a Stealth CMEs?

Solar Phys (2013) 285:269–280 DOI 10.1007/s11207-012-0217-0

Stealth Coronal Mass Ejections: A Perspective

Timothy A. Howard · Richard A. Harrison

The vast majority of the coronal mass ejections (CMEs) recorded in coronagraph field-of-view (FOV) is associated with various manifestations of the solar activity in emission corona (low coronal signatures - LCSs): flares, filament eruptions, coronal jets, dimming, etc.



Contrary to this, there are such CMEs, observed by coronagraphs, those are not associated with LCSs. At present, CMEs without LCSs are called stealth CMEs **(D'Huys et al., 2014)**.

And what is it really?

Stealth-CME kinematic properties

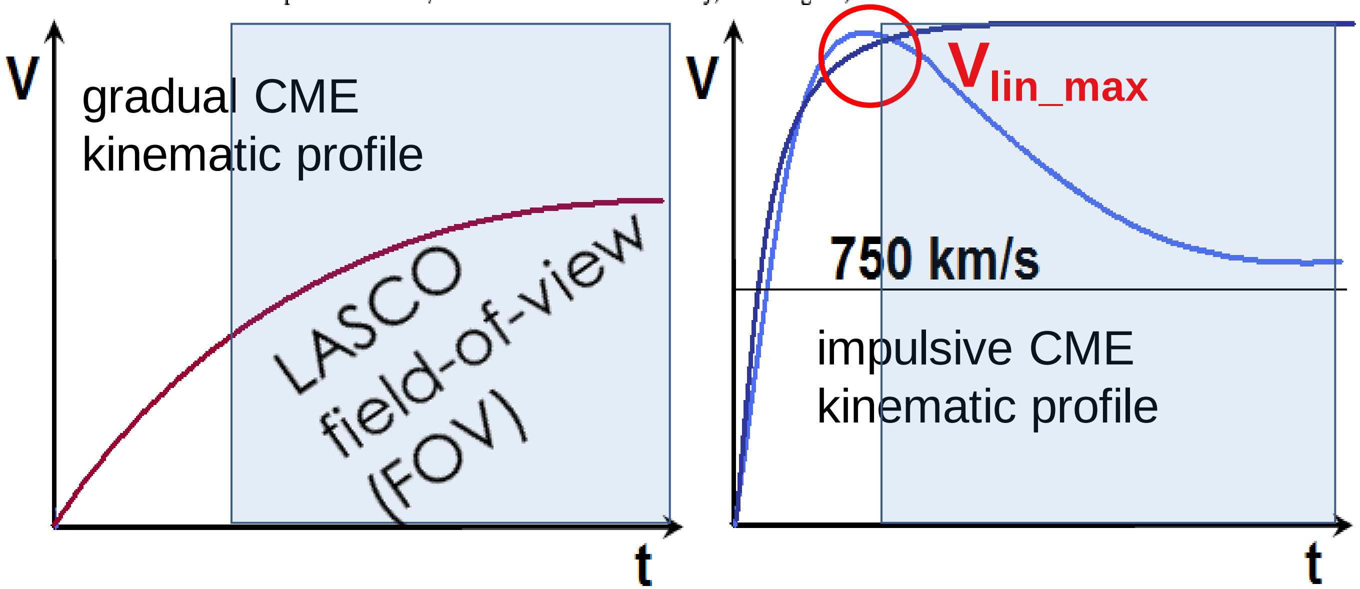
Coronal mass ejections (CMEs) are characterized by a wide range of maximum linear speed V_{lin_max} in the coronagraph field-of-view (FOV). V_{lin_max} vary greatly from N*10 to ~3000 km/sec ... (***Gopalswamy et al, 2009***). An average linear speed $<V_{lin}>$ of a stealth-CMEs is equal about 300 km/s. It is more less than $<V_{lin}>$ of CMEs with LCSs of 435 km/s.

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 104, NO. A11, PAGES 24,739–24,767, NOVEMBER 1, 1999

Continuous tracking of coronal outflows: Two kinds of coronal mass ejections

N. R. Sheeley Jr., J. H. Walters,[1] Y.-M. Wang, and R. A. Howard

E. O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, D. C.



What is the type of stealth-CME velocity profile?

Data

CMEs-list https://cdaw.gsfc.nasa.gov/CME_list/index.html

SDO AIA and HMI

http://jsoc.stanford.edu/ajax/exportdata.html

Rudenko G. V., Anfinogentov S. A. Very Fast and Accurate Azimuth Disambiguation of Vector Magnetograms // Solar Physics. V. 289. Issue 5. PP. 1499-1516. 2014.

Solar active monitor: https://solarmonitor.org/

OMNI database: https://omniweb.gsfc.nasa.gov/

IMAGE magnetometer network http://space.fmi.fi/image/

Catalogs of classification of solar wind types:

- "Near-Earth Interplanetary Coronal Mass Ejections (ICMEs**)** Since January 1996"
http://www.srl.caltech.edu/ACE/ASC/DATA/level3/icmetable2.html
- "List of ICMEs**“** http://space.ustc.edu.cn/dreams/wind_icmes.html
- catalog by Yu. I. Yermolaev’s team (Yermolaev, 2009)
ftp://ftp.iki.rssi.ru/pub/omni/catalog

For our study we selected 2 events:

Stealth-CME on 16.06.2010 and Stealth-CME on 07.07.2012.

New approach to detect the source location and initiation time of a stealth-CME formation

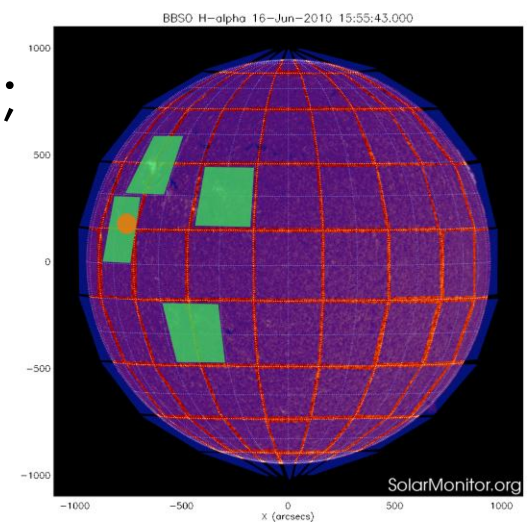
Zagainova et al., Sun and Geosphere, 2019, Volume 14, number 1.

New approach is based on a hypothesis that any forms of solar activity could be followed a stealth-CME initiation stage. It could be a short-time small-scale solar activity as EUV emission bursts in different spectral ranges (in several spectral AIA channels, i.e. on 93Å, 304 Å, 171 Å, 193Å , 211Å, and 131Å images).

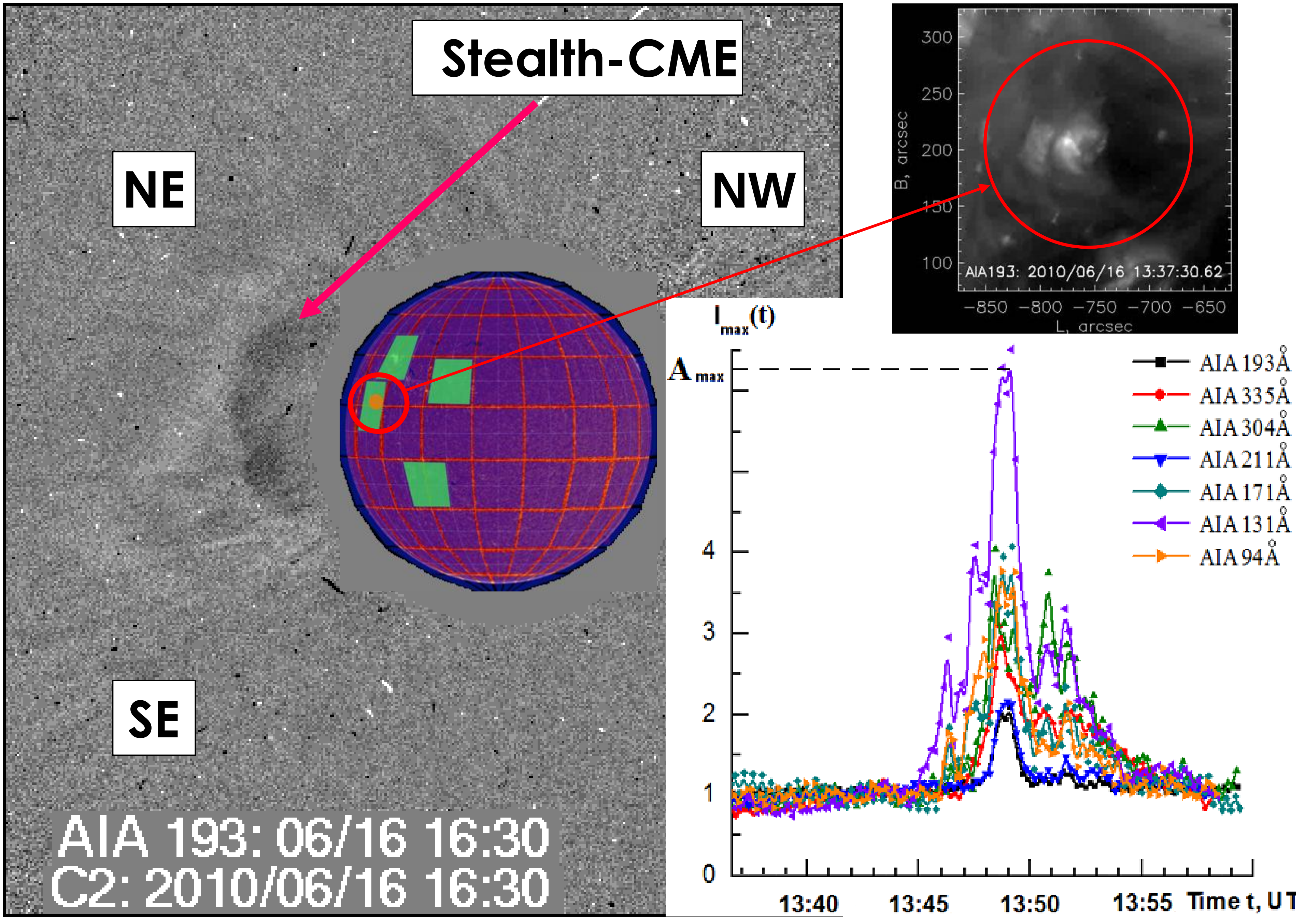
Temperature response functions for the AIA channels were listed by Boerner et al. (2012), Lemen et al. (2012), and Downs et al. (2012).

It is necessary:

- To split solar disk into [200"×200"] segments;
- To plot the time dependence of the normalized maximum emission intensity $\mathbf{I_n(t)}$ in every channels within every segment;
- To find the low-intensity bursts of EUV emission within all segments.



IDENTIFICATION of the Stealth-CME source area



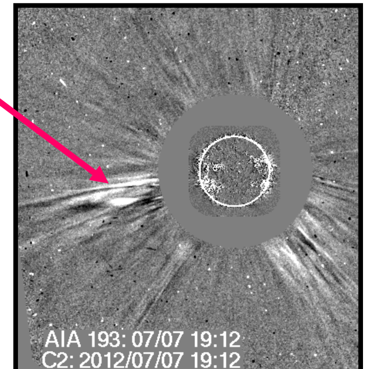
THE ASTROPHYSICAL JOURNAL, 795:49 (12pp), 2014 November 1
E. D'HUYS et al., **Observational characteristics of coronal mass ejections without low-coronal signatures**

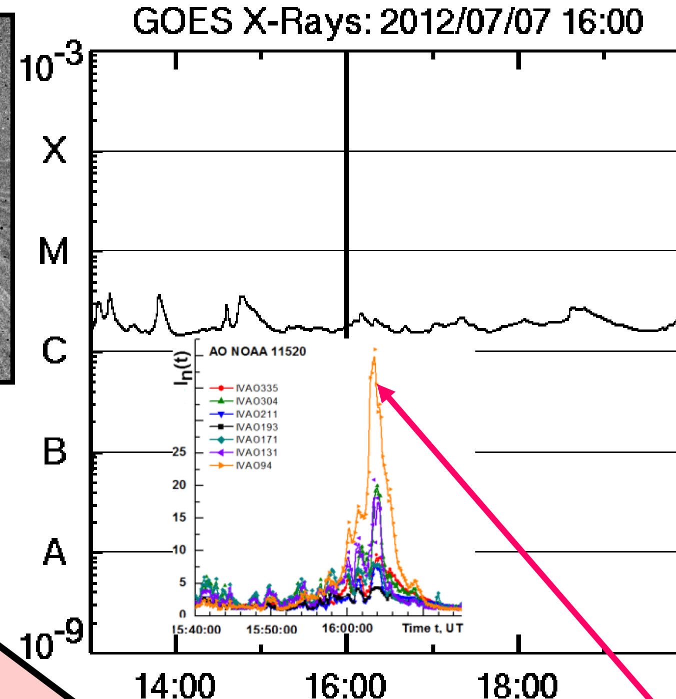
First C2 Appearance Date Time [UT]		Central PA [deg]	Angular Width [deg]	Linear Speed [km/s]	2nd-order Speed at final height [km/s]	2nd-order Speed at 20 Rs [km/s]	Accel [m/s^2]	Mass [gram]	Kinetic Energy [erg]	MPA [deg]	Movies, plots, & links	Remarks
2012/07/07	18:12:05	101	24	480	775	1714	120.0*1	1.9e+14	2.2e+29	104	C2 C3 PHTX DST Java Movie	Poor Event; Only C2

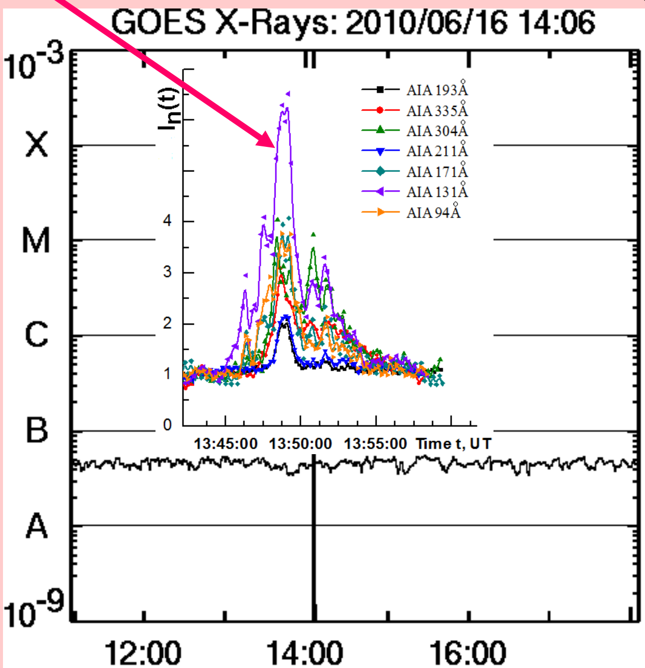
16.06.2010

EUV-micro-Burst-131Å

Stealth-CME







Stealth-CME

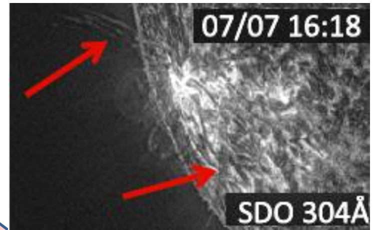
EUV-micro-burst-93Å

07.07.2012

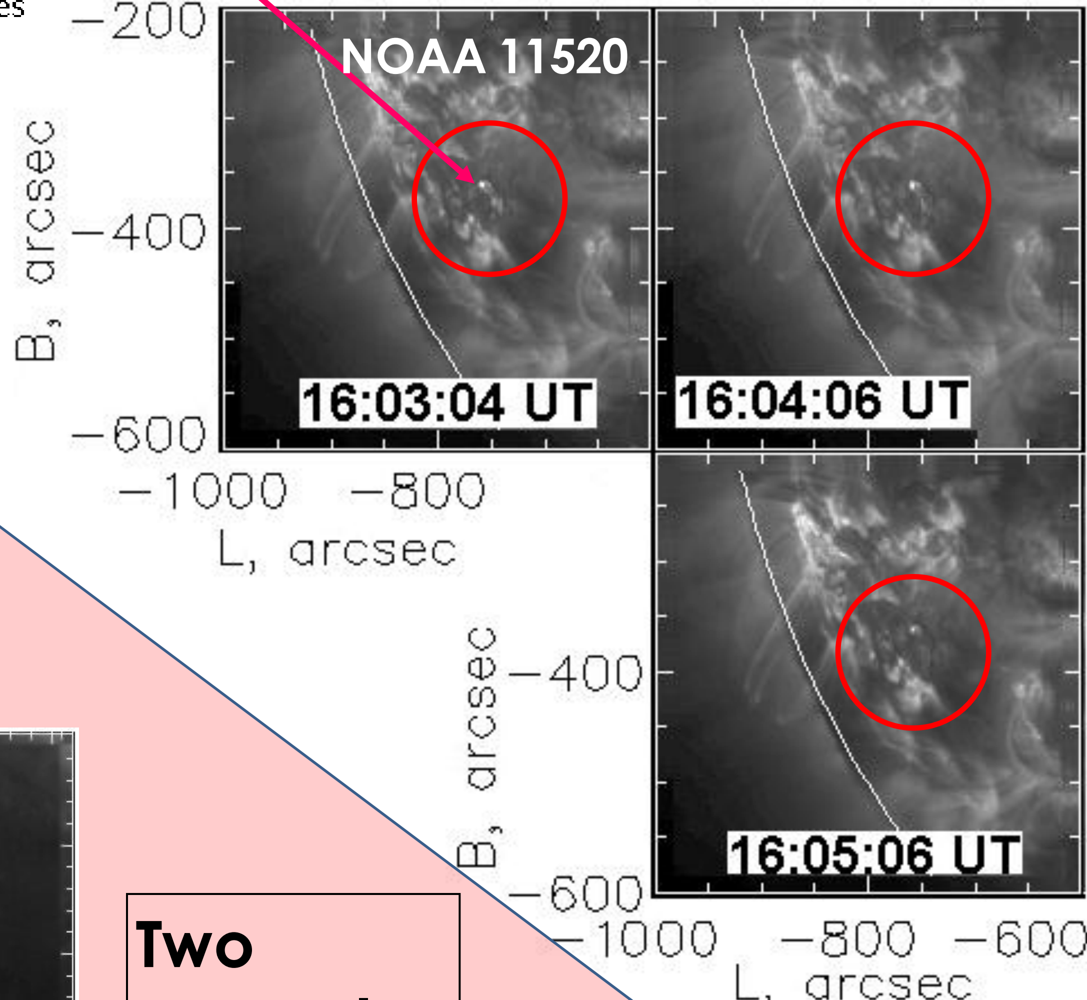
First C2 Appearance Date Time [UT]		Central PA [deg]	Angular Width [deg]	Linear Speed [km/s]	2nd-order Speed at final height [km/s]	2nd-order Speed at 20 Rs [km/s]	Accel [m/s^2]	Mass [gram]	Kinetic Energy [erg]	MPA [deg]	Movies, plots, & links	Remarks
2010/06/16	14:54:05	61	153	236	424	397	6.5*1	6.8e+14*2	1.9e+29*2	73	C2 C3 195 PHTX DST Java Movie	Poor Event; Partial Halo

B. Heber et al., Forbush decreases associated to Stealth CMEs, 2014

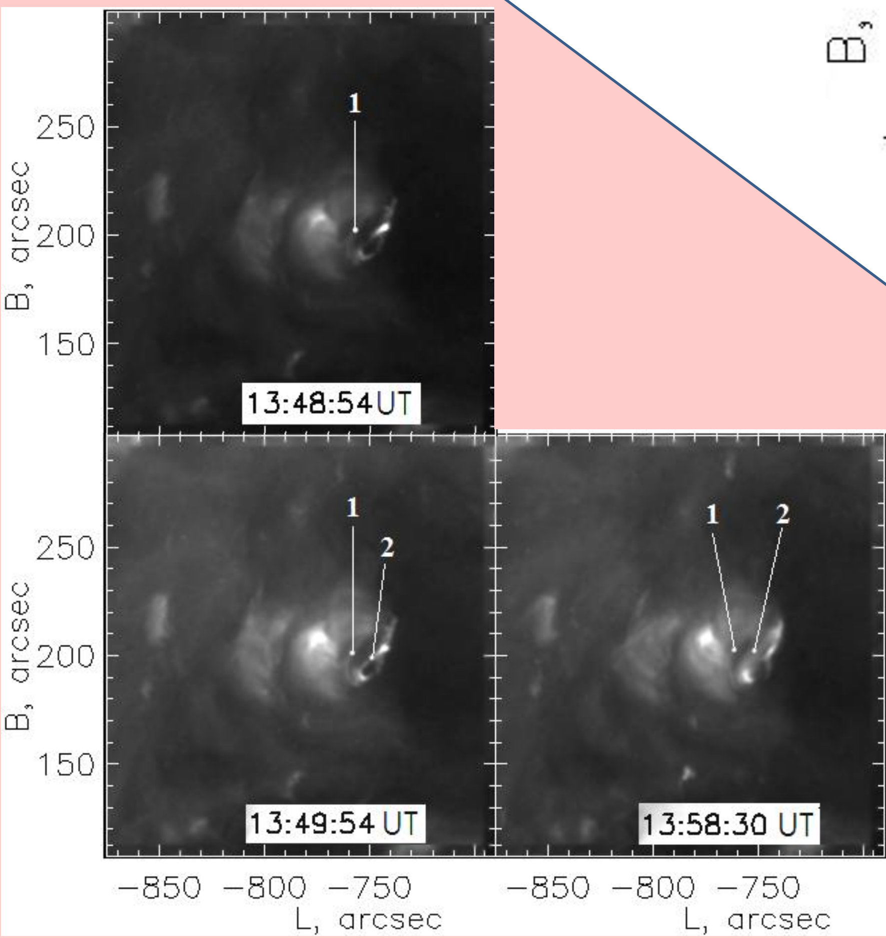
THE ASTROPHYSICAL JOURNAL, 840:103 (14pp), 2017
N. Alzate, H. Morgan. Identification of low coronal sources of "Stealth" coronal mass ejections using new image processing techniques



Coronal jet



16.06.2010



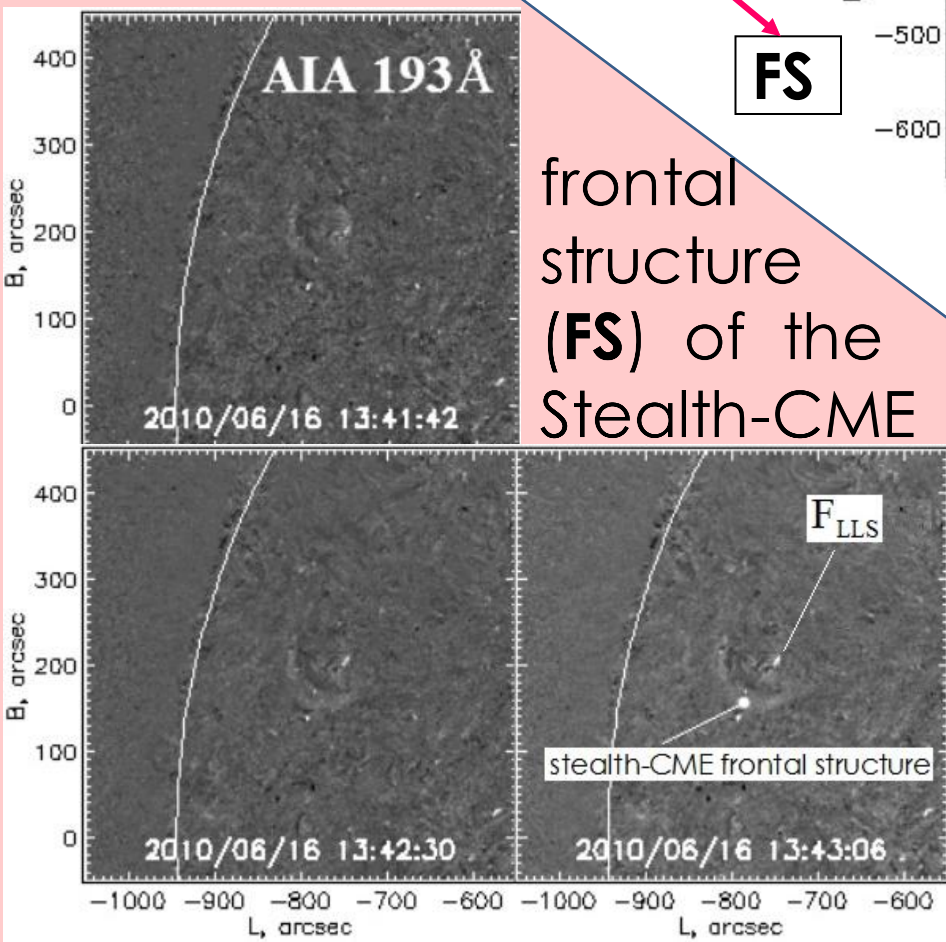
Two coronal Loop-like structures

07.07.2012

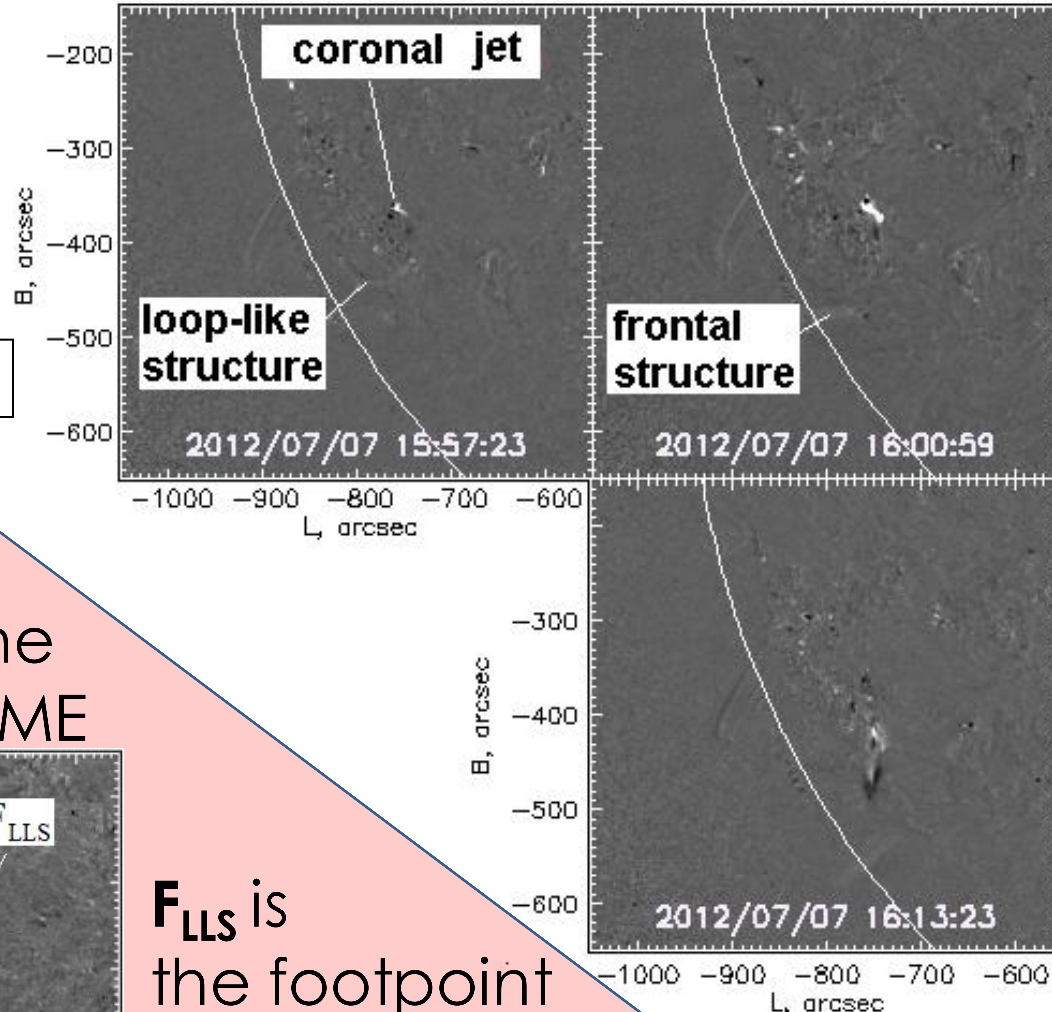
Stealth-CME on 7 July 2012

Coronal jet → Loop-like structure → **FS**

Formation of frontal structure (**FS**) of the Stealth-CME

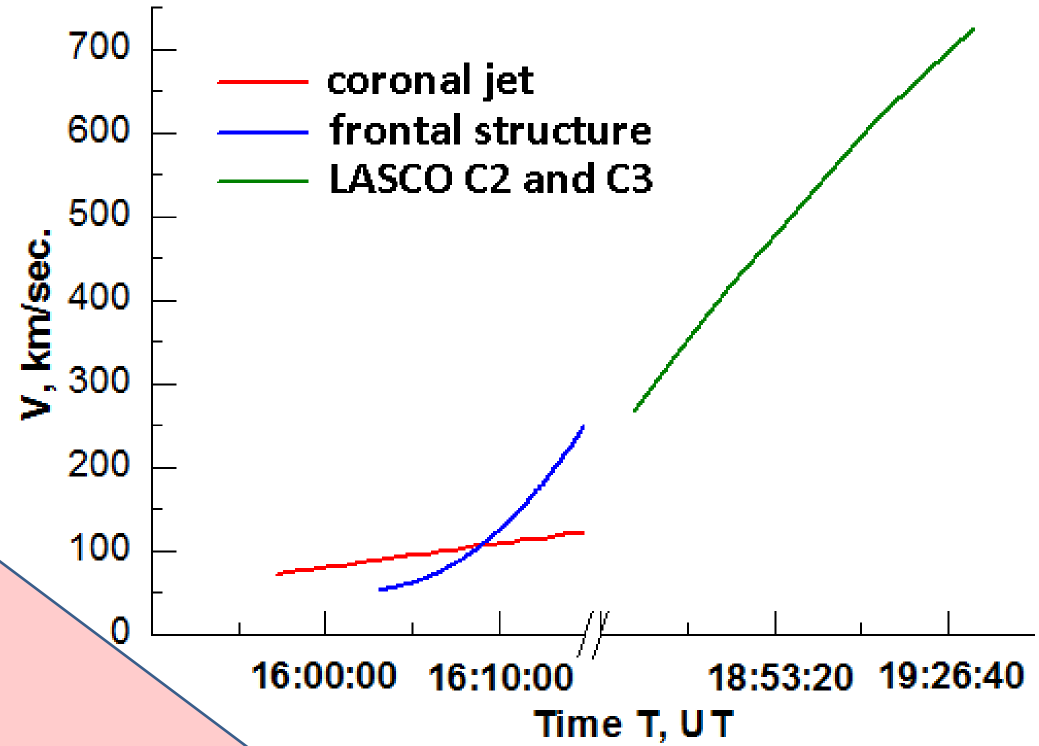


F_{LLS} is the footpoint brightening at the base of a loop - like structures



Stealth-CME on 16 June 2010

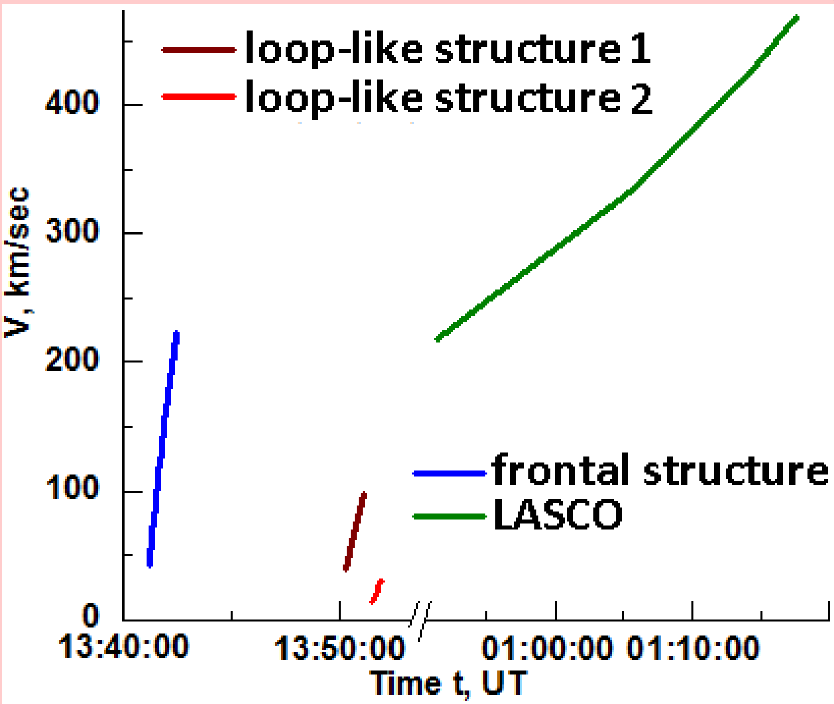
Stealth-CME on 7 July 2012



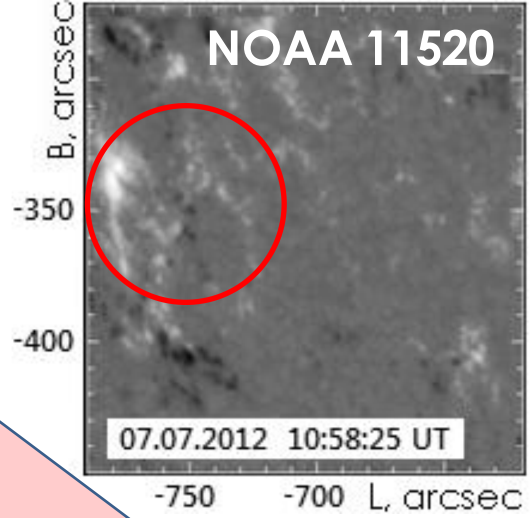
~~Gradual CME~~

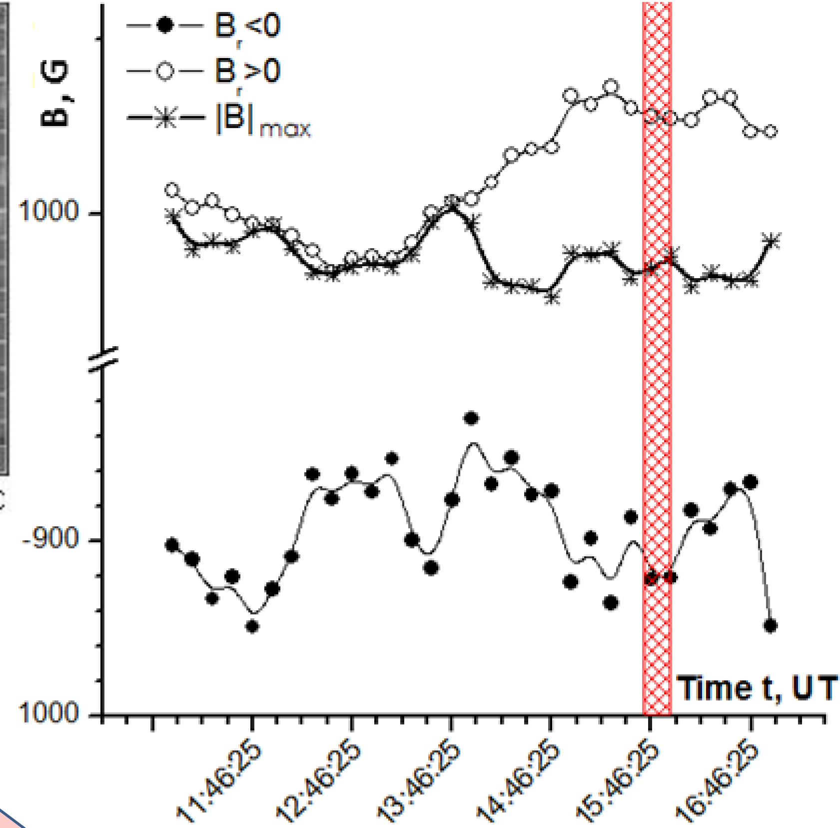
~~Impulsive CME~~

kinematic profile

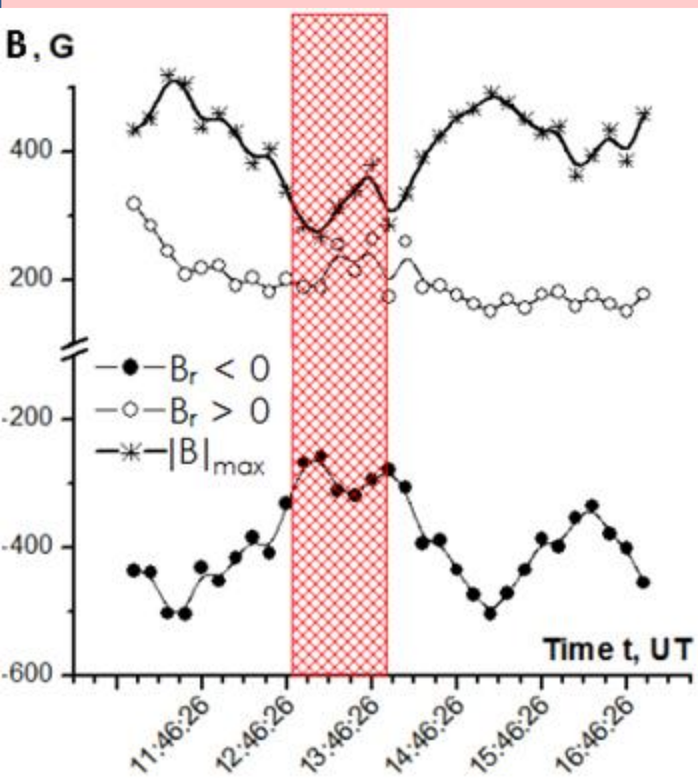


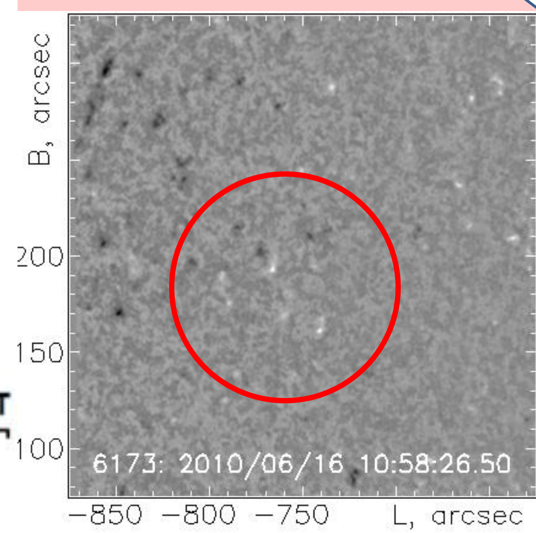
Stealth-CME on 16 June 2010



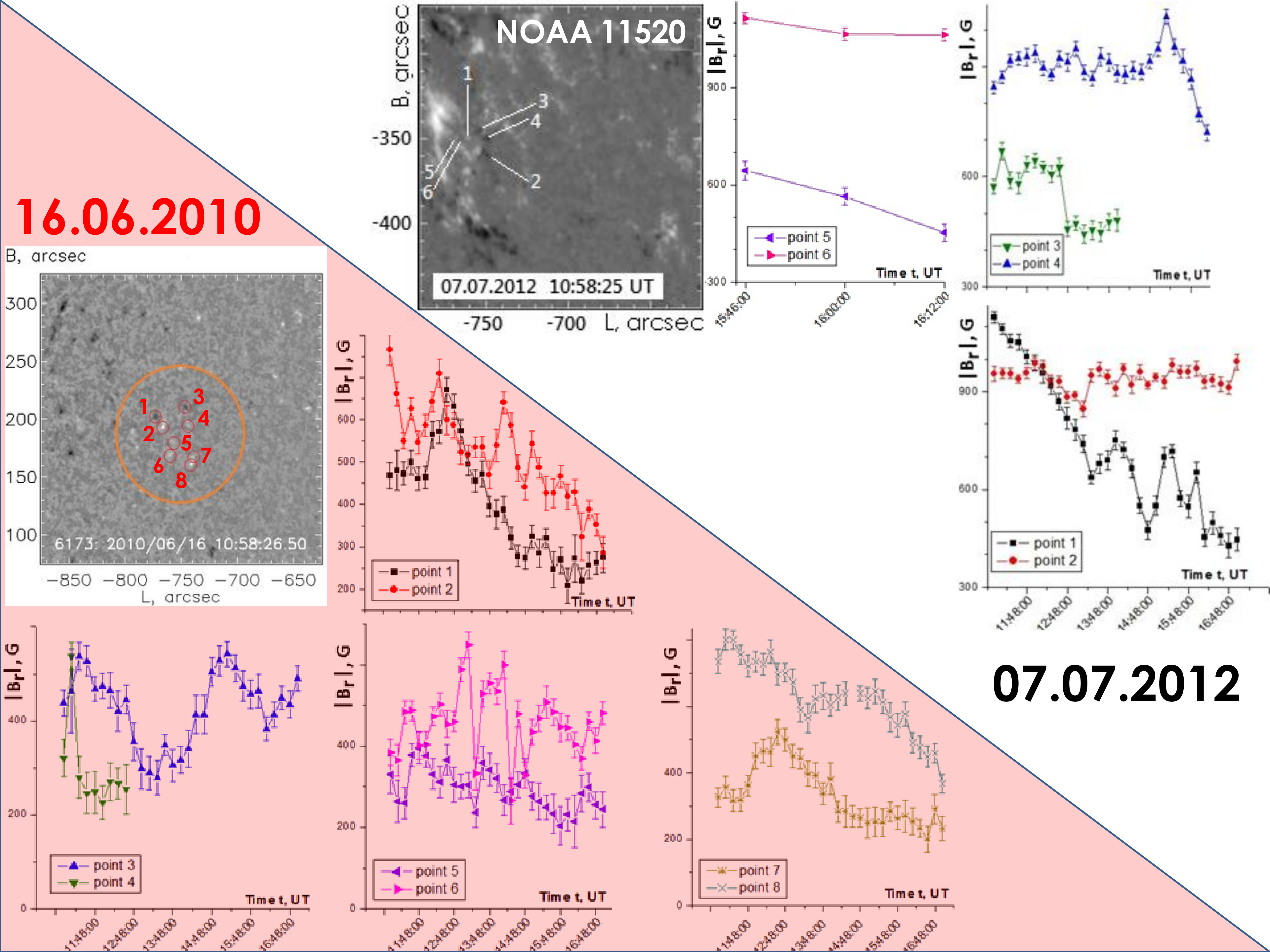


16.06.2010

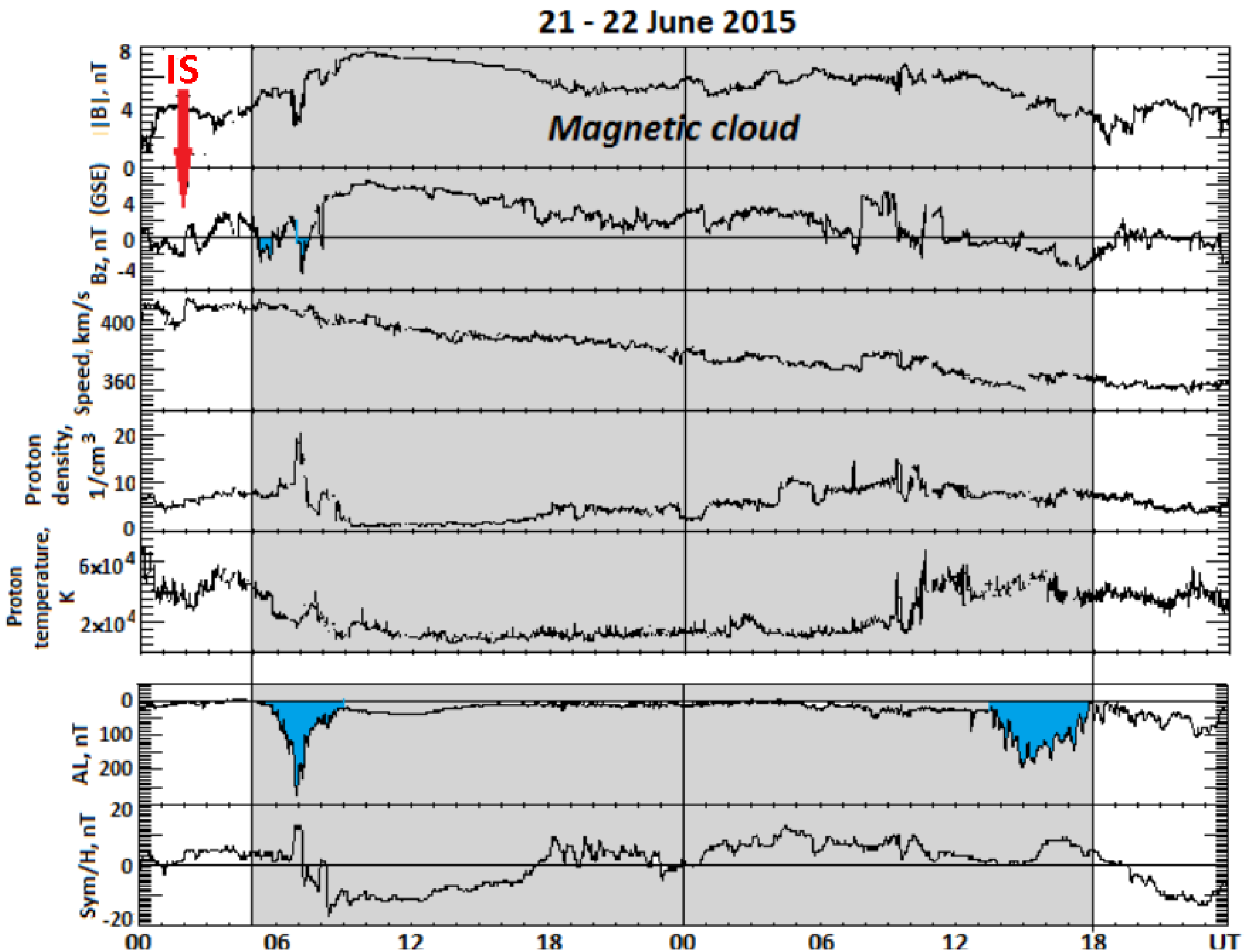




07.07.2012


16.06.2010
B, arcsec
6173: 2010/06/16 10:58:26.50
L, arcsec
1
2
3
4
5
6
7
8
point 1
point 2
point 3
point 4
point 5
point 6
point 7
point 8
|B_r|, G
Time t, UT
11:48:00
12:48:00
13:48:00
14:48:00
15:48:00
16:48:00
NOAA 11520
07.07.2012 10:58:25 UT
B, arcsec
L, arcsec
15:46:00
16:00:00
16:12:00
07.07.2012

Stealth-CME on 16 June 2010

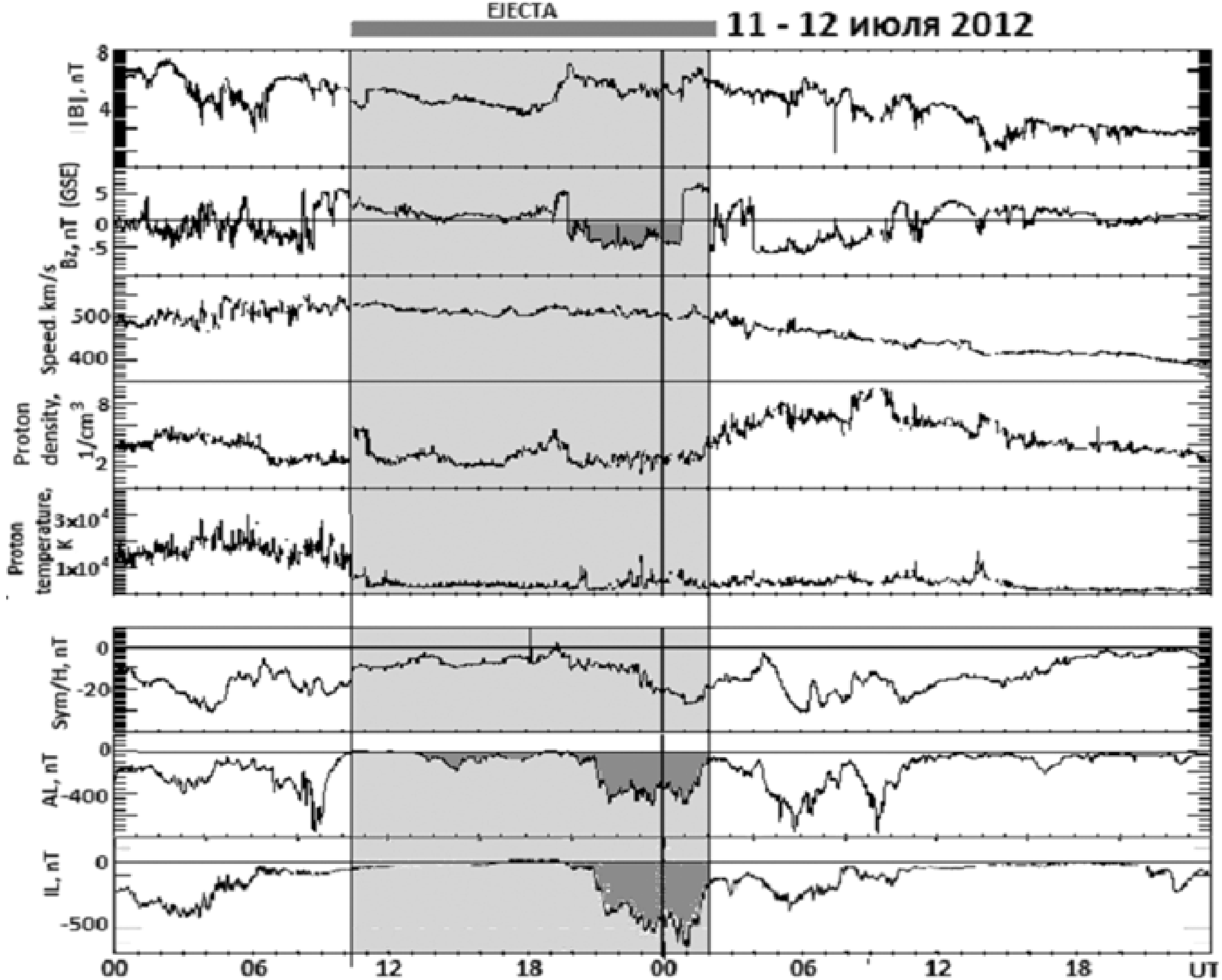


Near-Earth Interplanetary Coronal Mass Ejections Since January 1996

Compiled by Ian Richardson(1) and Hilary Cane(2),
Revised January 10, 2019

http://www.srl.caltech.edu/ACE/ASC/DATA/level3/icmetable2.htm

Stealth-CME on 7 July 2012



Yermolaev, Yu.I., Nikolaeva, N.S., Lodkina, I.G. and. Yermolaev, M.Yu. (2009) Catalogue of solar wind types for 1976-2000, Cosmic Research, 47, N2

Discus…

THE ASTROPHYSICAL JOURNAL, 795:49 (12pp), 2014 November 1

doi:10.1088/0004-637X/795/1/49
OBSERVATIONAL CHARACTERISTICS OF CORONAL MASS EJECTIONS WITHOUT LOW-CORONAL SIGNATURES
E. D'HUYS, D. B. SEATON, S. POEDTS, D. BERGHMANS

Wang Y., Wang B., Shen C. et al. // arXiv:1406.4684v1 [physics.space-ph]. 2014.

Solar Phys (2013) 285:269–280
DOI 10.1007/s11207-012-0217-0
Stealth Coronal Mass Ejections: A Perspective
Timothy A. Howard · Richard A. Harrison

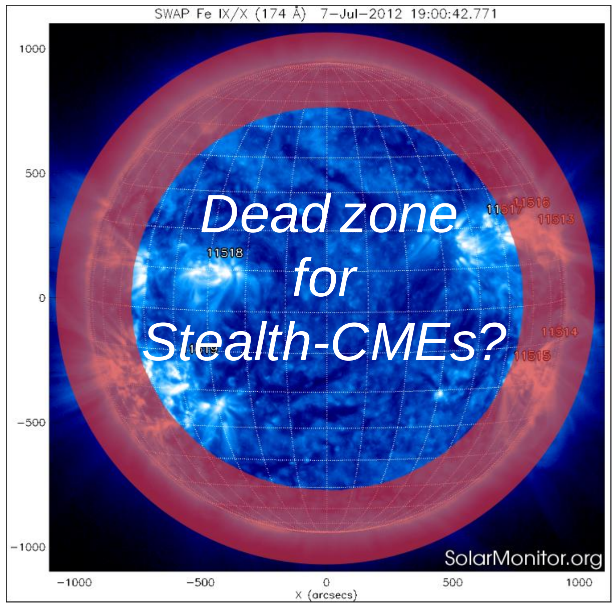
THE ASTROPHYSICAL JOURNAL, 701:283–291, 2009 August 10

doi:10.1088/0004-637X/701/1/283
NO TRACE LEFT BEHIND: *STEREO* OBSERVATION OF A CORONAL MASS EJECTION WITHOUT LOW CORONAL SIGNATURES
EVA ROBBRECHT, SPIROS PATSOURAKOS, ANGELOS VOURLIDAS

Mathematisch-Naturwissenschaftliche Fakultät | C A U Christian-Albrechts-Universität zu Kiel
Forbush decreases associated to Stealth CMEs
B. Heber, D. Galsdorf, J. Gieseler, K. Herbst, C. Wallmann (Christian-Albrechts-Universität zu Kiel)
M.Dumbović, B. Vršnak (HVAR Observatory, Zagreb)
A. Veronig. M. Temmer, and C. Moestl (IGAM, Graz)

Robbrecht et al. (2009)

List of events by Mierla et al. (2013)



THE ASTROPHYSICAL JOURNAL, 722:289–301, 2010 October 10

doi:10.1088/0004-637X/722/1/289
STATISTICAL STUDY OF CORONAL MASS EJECTIONS WITH AND WITHOUT DISTINCT LOW CORONAL SIGNATURES
S. MA, G. D. R. ATTRILL, L. GOLUB, AND J. LIN

THE ASTROPHYSICAL JOURNAL, 795:49 (12pp), 2014 November 1
© 2014. The American Astronomical Society. All rights reserved. Printed in the U.S.A.
doi:10.1088/0004-637X/795/1/49
OBSERVATIONAL CHARACTERISTICS OF CORONAL MASS EJECTIONS WITHOUT LOW-CORONAL SIGNATURES
E. D'HUYS, D. B. SEATON, S. POEDTS, D. BERGHMANS

Nieves-Chinchilla T., Vourlidas A., Stenborg G. et al. // arXiv:1311.6895v1[astro-ph.SR]. 2013.

A lot of observed Stealth-CME sources are located on the limb, on Sun's backside or on a visible solar disk next to the limb. Angular width of the Stealth-CMEs is about 25°.

It is possible that a Stealth-CME initiated from the area next to the solar disk center was occulted by coronagraph disk.

Conclusions

1. Formation stage of the stealth-CME observed by LASCO coronagraphs were associated with various manifestations of short-time small-scale solar activity, such as the EUV bursts, the activation and moving of the small-scale structures.
2. Formation of stealth-CME frontal structures was observed for the first time.
3. Stealth-CME velocity profiles were determined. It's shown that the profile neither gradual nor pulse.
4. The radial component of the magnetic field $B_r(t)$ is varied in initiation area before and after the Stealth-CME formation stage.
5. The stealth-CME arrival at the Earth did not lead to a noticeable geomagnetic field disturbance described by the Dst-index. The passage of the stealth-CME front close to the Earth was followed by a weak substorm. The stealth-CME structure on the Earth's orbit is similar to a magnetic cloud structure.

Thank you for your attention