3D kinematics of two consecutive CMEs

M. Mierla[1,2], V. Pant[3], L. Rodriguez[1]

1. Royal Observatory of Belgium, Brussels, Belgium
2. Institute of Geodynamics of the Romanian Academy, Bucharest, Romania
3. Indian Institute of Astrophysics, Bangalore, India

Abstract

The CME on December 27, 2008 was propagating into the 16N36E direction and it was a structured CME associated with the disappearance of a prominence. The CME on December 28, 2008 was directed towards 08N08E, as measured in the coronagraph images, it was a unstructured stealth CME (flow like type).
The two CMEs are followed in coronagraph and HI images on their way into the interplanetary space. We describe different pre-processing steps to isolate the CMEs from the coronal background. We also illustrate different reconstruction techniques (both in coronagraphs and heliospheric imagers) in order to derive the 3D kinematics of these dynamical events. Finally, a discussion on possible interaction of the two CMEs in the interplanetary space is carried out.

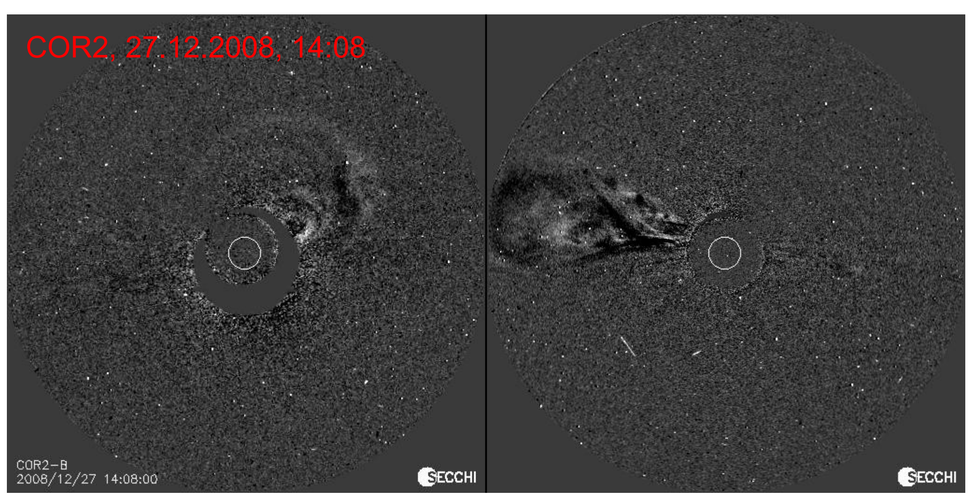
Pre-processing steps

To isolate the CMEs from the coronal background:
- running-difference images
- base difference images
- monthly background subtraction + removal of the streamers

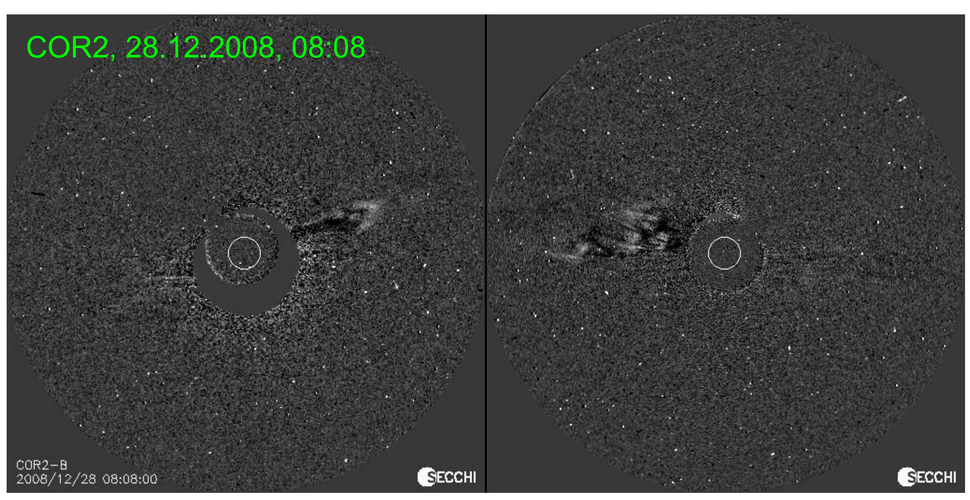
Reconstruction Techniques

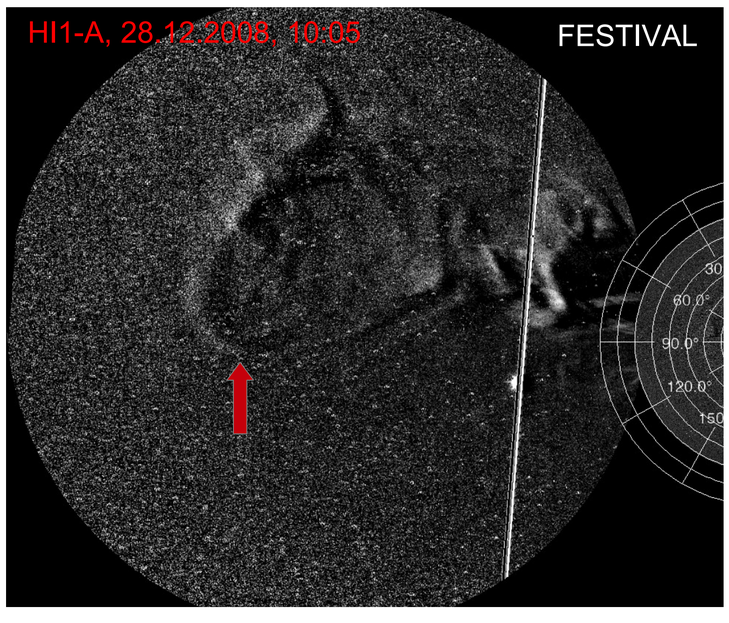
Coronagraphs:
1) Triangulation (Inhester 2006, Pizzo and Biesecker 2004, Mierla et al. 2010)
2) Forward modeling (Thernisien et al. 2006, 2009)
Imagers:
1) Point-P (Vourlidas and Howard 2006; Howard et al. 2006, 2007)
2) Fixed-Φ (Kahler and Webb, 2007)
3) Harmonic Mean (HM) (Lugaz et al. 2009)

CME on 27 December 2008 (CME1)



CME on 28 December 2008 (CME2)

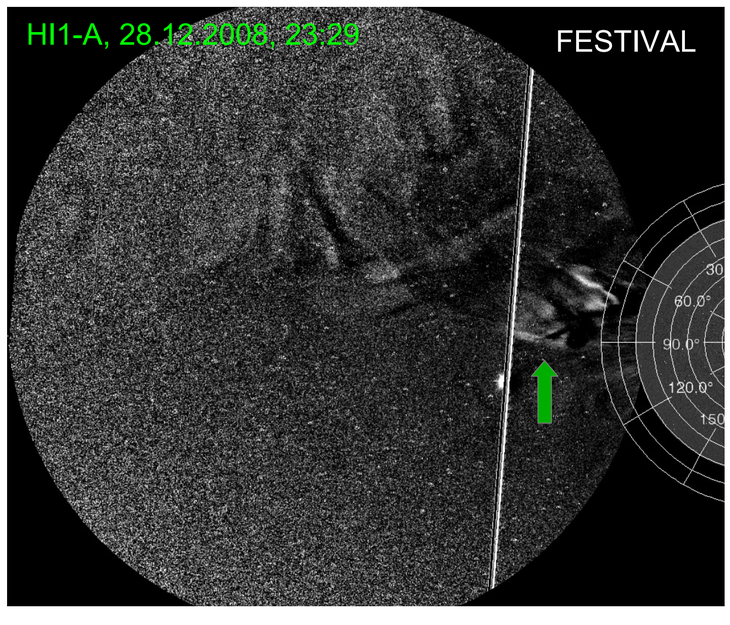


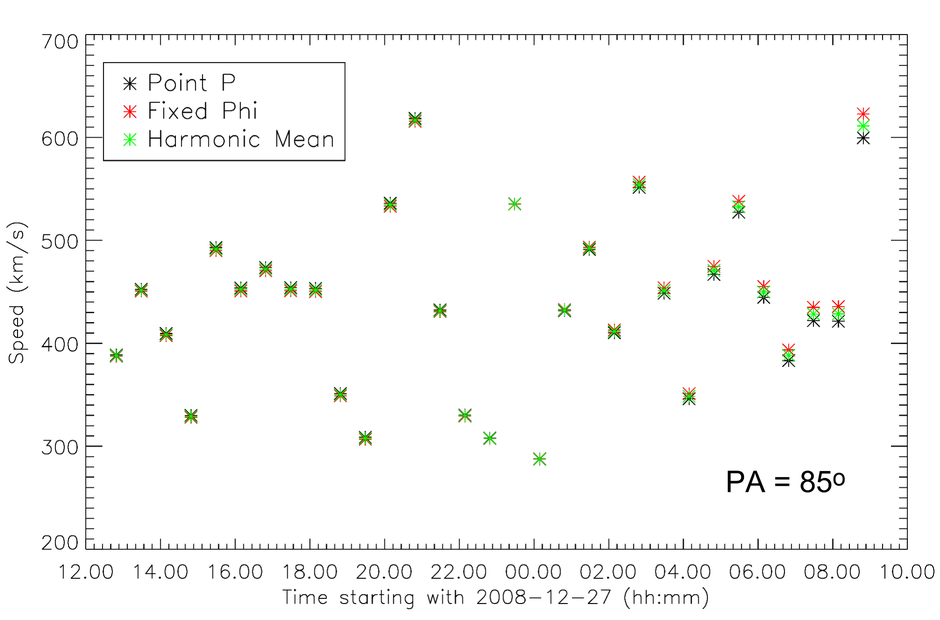


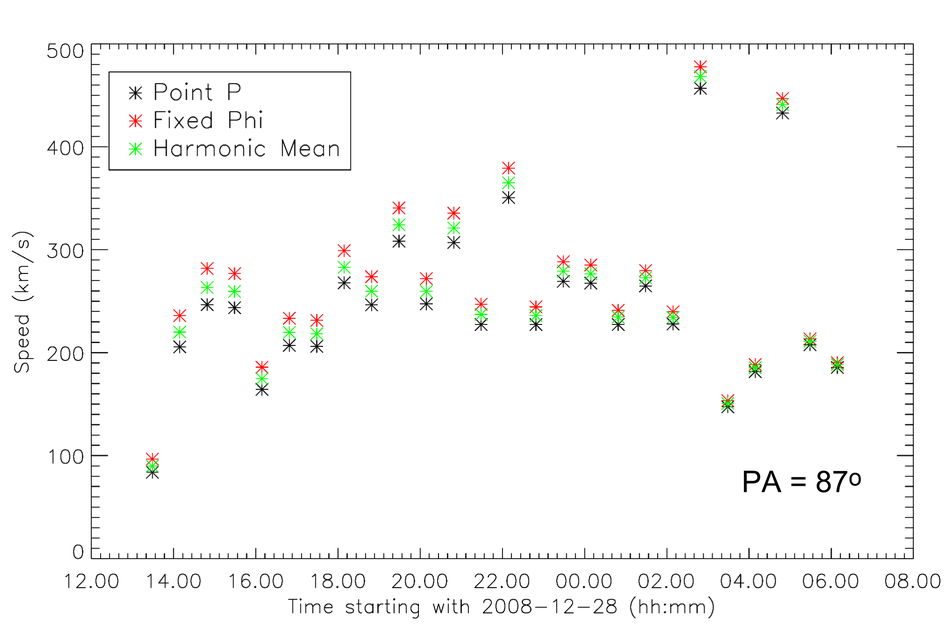
CME1
Longitudinal extent: -66° to -6°
Latitudinal extent: 1° to 31°

CME2
Longitudinal extent: -26° to 10°
Latitudinal extent: -1° to 17°

Arrival at the Earth (Kilpua et al. 2014):
- Very week ICME (Wind list).
- Starts on Jan 2, 06:00 UT
- Duration = 9 h
- B_{max} = 7 nT
- V_{max} = 400 km/s
- Flux rope ICME







Summary

Spatial interaction: in longitude: between -26° and -6°.
in latitude: between 1° and 17°.

CME1 is faster than CME2, so they may not interact, unless CME1 is strongly decelerated by the solar wind (it is not the case up to 65 Rs).

Both CMEs are in the error limits to hit the Earth.

From the timing, CME2 is most probably the one which was recorded in-situ on January 2.