Dynamics and 3-dimensional structure of solar prominences

Maciej Zapiór
Astronomical Institute, University of Wroclaw

Abstract

We describe results of calculation of the true 3D trajectories of the prominence blobs observed by Wroclaw Multi-channel Subtractive Double Pass imaging spectrograph. We analyzed several blobs in two prominences observed on 1st June 2003 and 14th July 2005. Using MSDP data the trajectories of the blobs of the active and eruptive prominences can be reconstructed near the solar surface.

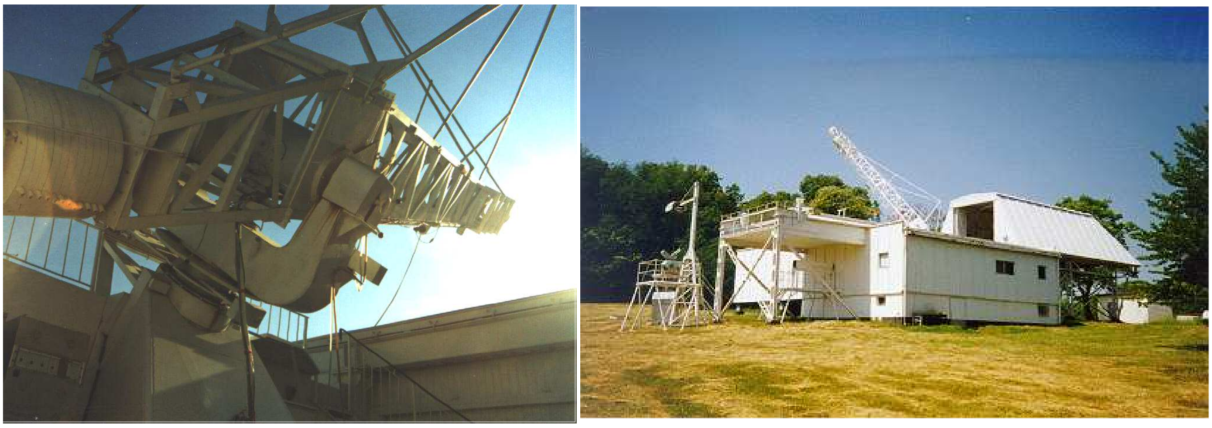

Figure 1. Bialkow Observatory. Large Coronograph.

Observations

Data were collected using Large Coronograph of University of Wroclaw installed in Bialkow Observatory (see figure 1). The instrument has 51 cm entrance aperture, nearly 14.5 m effective focal length. Its spatial resolution is limited by seeing and is about 1 arc sec. The Coronograph is equipped with Multichannel Subtractive Double Pass (MSDP) imaging spectrograph. From the huge archive of MSDP data, covering the period 1994-2005, we chose two prominences in which several well visible and separated blobs of matter were observed. There was an eruptive prominence of 1st June 2003 and an active prominence of 14th July 2005.

Analysis

Our method is based on properties of MSDP data which allow us to determine Doppler velocity as well as position on the sky plane of every structure visible in the field of view. MSDP gives us a spectral image in range +/- 1 Angstroem from H-alpha line center. Doppler velocity is calculated from the shift of the H-alpha profile. During analysis of the selected prominence we pointed position of the particular blob of matter on each image. Positions of the analyzed blobs projected onto prominence's image are presented on figures 2 and 3. We calculated its centroid (**x** and **y** value) and Doppler velocity (**v**). From this set of data we first integrated radial velocity and obtained shift in line-of-sight direction (**z**). Then we combined it with the position of the centroid on the sky plane and as a result we received 3D track (**x,y,z**) of the analyzed blob in dependence from time. Exemplary curves are presented on figures 4 and 5. Track of each blob is represented by bold curve on graphs. Projections onto perpendicular planes with thin lines are also presented. Direction toward observer is marked by arrow. Bottom plane is parallel to the solar surface. Left panels represent curves obtained by spline function interpolation and right panels by polynomial approximation respectively. Examination of tracks allows one to deduce three-dimensional structure of analyzed prominences. For example if we compare curve of blob D on figure 4 with prominence image on figure 3 we conclude that prominence's loop was bent outward to observer.

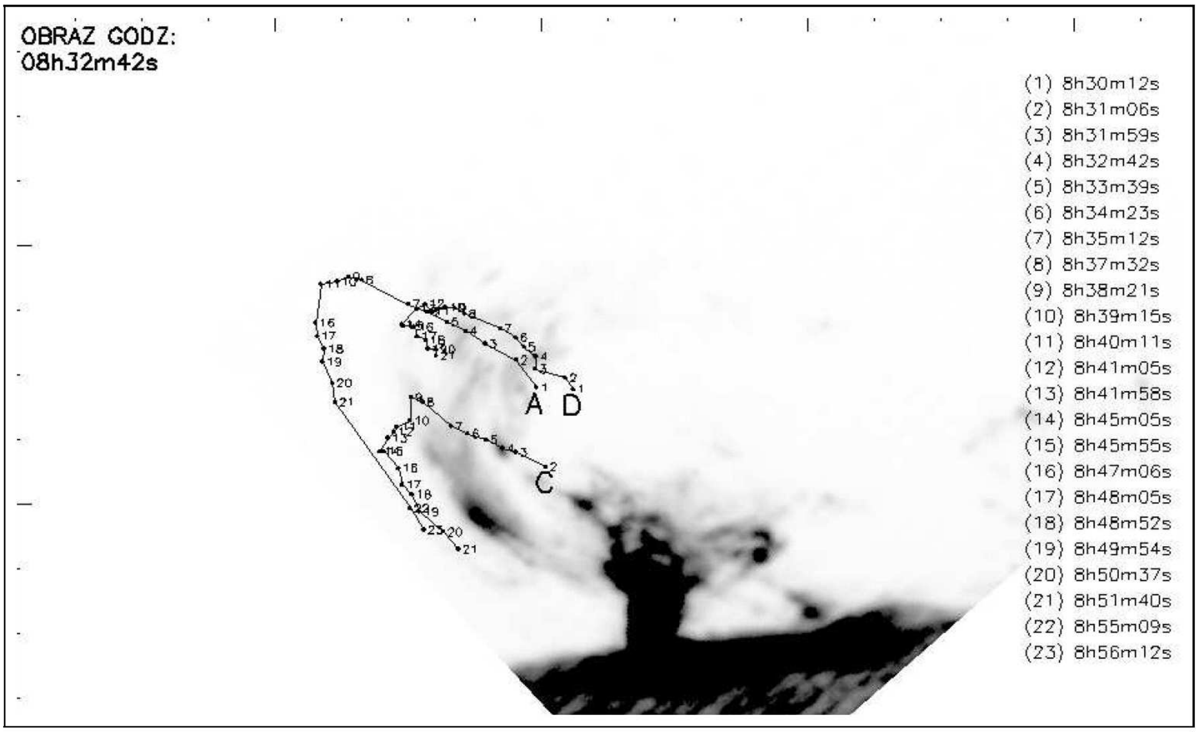

Figure 2 Image of prominence of 1st June 2003.
Trajectories of individual blobs projected onto prominence image.
Numbers indicate moments of time - listed on the right

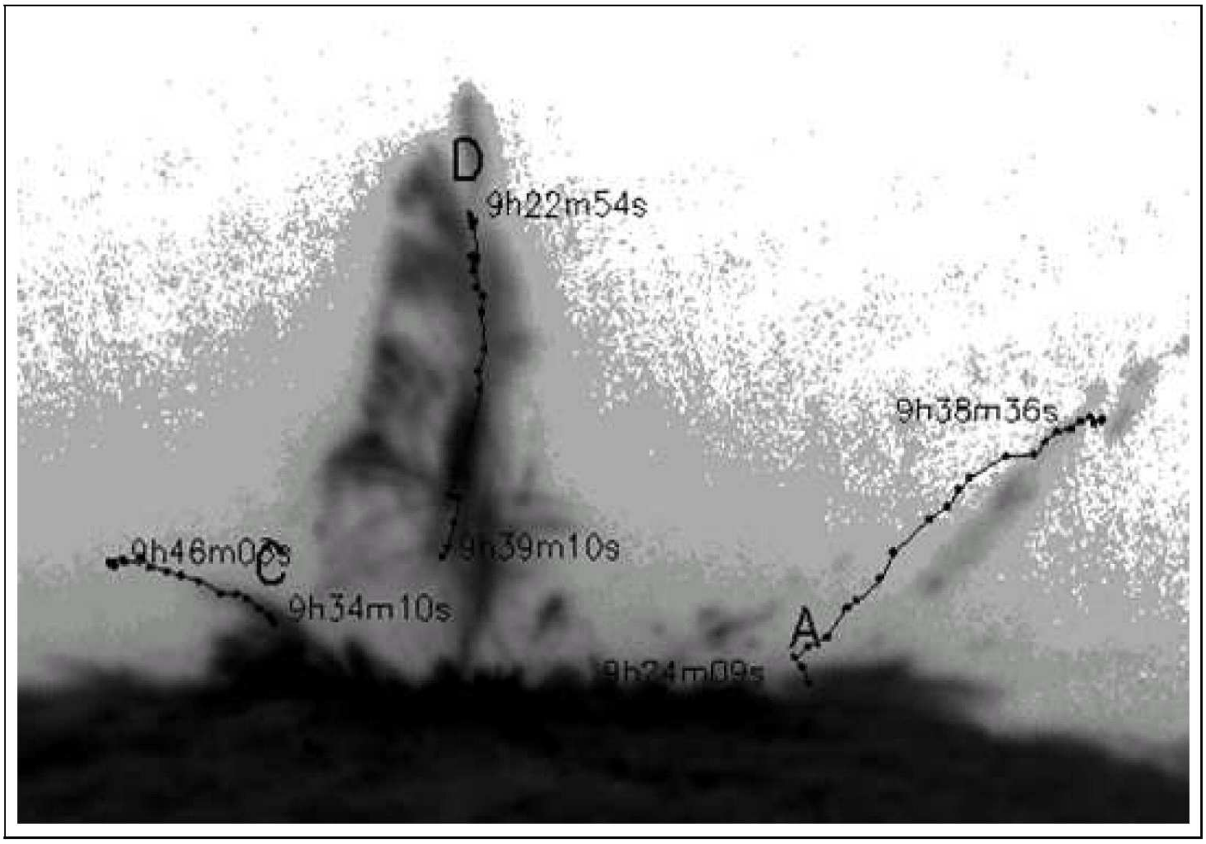

Figure 3 Image of prominence of 14th July 2005.
Trajectories of individual blobs projected onto prominence image.
Time of the start and the end of observations are shown.

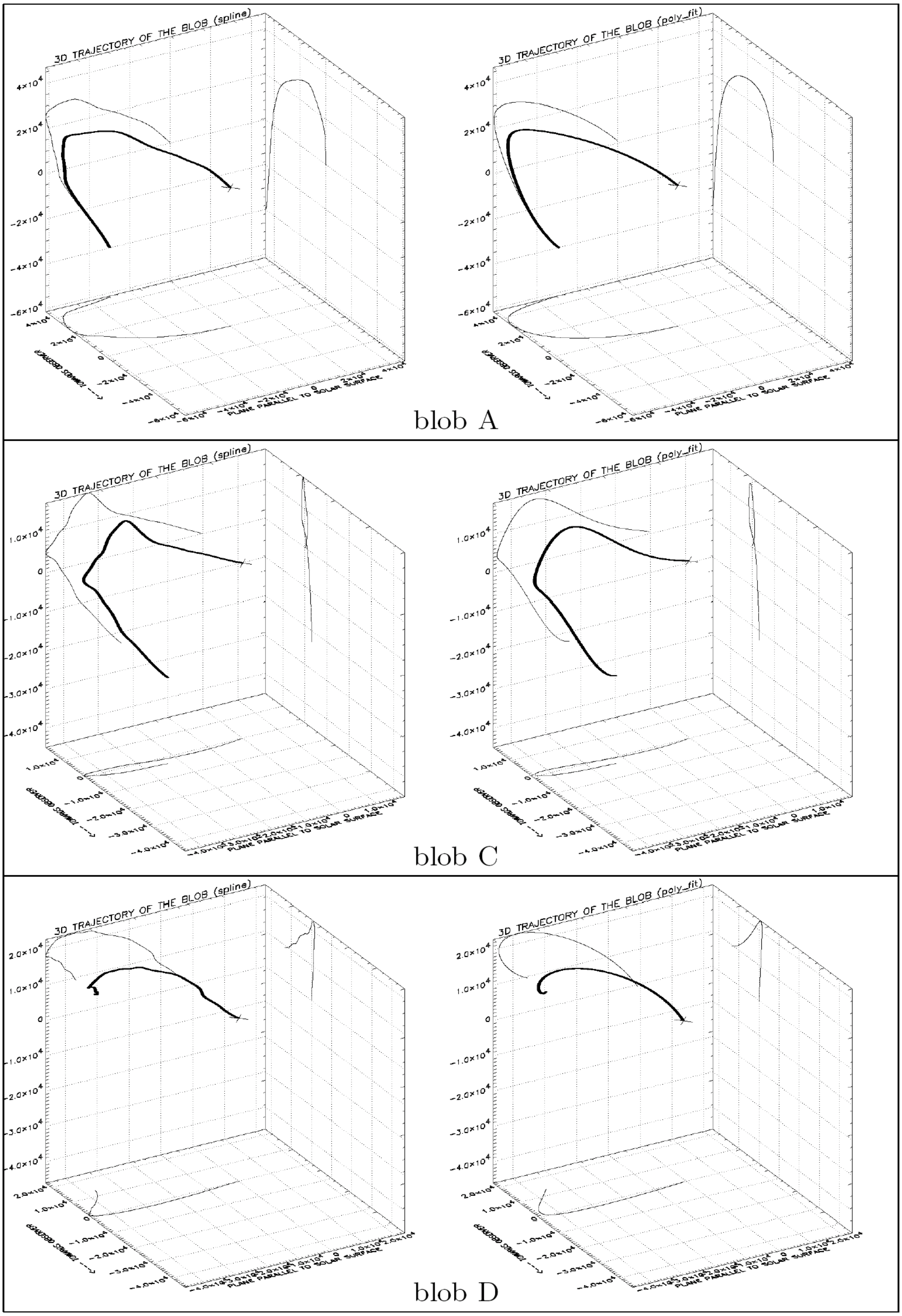

Figure 4. 3D trajectory of three blobs observed in prominence of 1st June 2003 (see text).

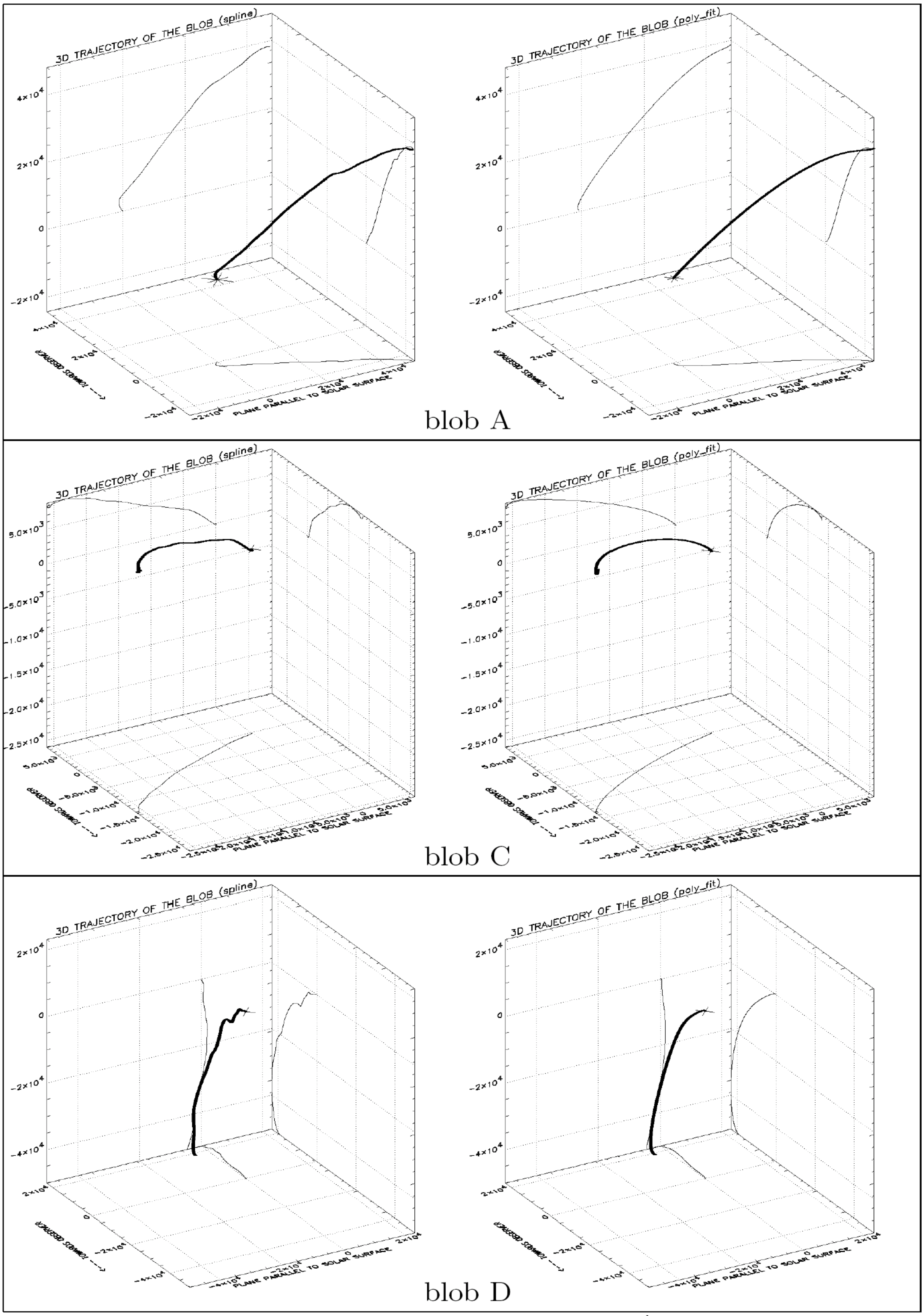

Figure 5. 3D trajectory of three blobs observed in prominence of 14th June 2003 (see text).

Conclusions

True trajectories of blobs of matter in solar prominences can be reconstructed using data collected by MSDP imaging spectrograph. Such data have great value for modelling and understanding the structure and the evolution of huge magnetic systems in solar corona and with space observations can provide us a coherent view on its evolution. Common observing campaigns with the use of various types of instruments (including classical spectrographs and space observatories) will allow ones to pursue precise investigations of the 3D structure and evolution of prominences and related phenomena.