Outstanding Results of Romanian Researchers in Solar and Solar-Terrestrial Physics (2000–2006)

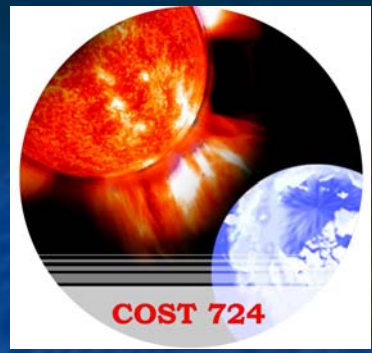
G. Maris [1], D. Besliu-Ionescu [2,3], A.-C. Donea [3], M. Mierla [2], E. Moise [4], A. Oncica [2], M. D. Popescu [5]

[1] Institute of Geodynamics, Bucharest, RO-020032, Romania
[2] Astronomical Institute of the Romanian Academy, RO-040557, Bucharest, Romania
[3] CSPA, School of Mathematical Sciences, Monash University, Clayton, Vic, Australia, 3800
[4] Institute for Astronomy, University of Hawaii, USA
[5] Armagh Observatory, Armagh, Northern Ireland

Outline

- SOFT X-RAY EMISSION IN SOLAR FLARES
- SEISMIC RADIATION OF SOLAR FLARES
- DYNAMICS OF THE INNER SOLAR CORONA AND SLOW SOLAR WIND
- FAST SOLAR WIND ORIGIN
- HIGH-SPEED STREAMS IN SOLAR WIND
- HELIOSPHERIC PLASMA DIAGNOSTIC
- NEURAL NETWORK FORECAST OF THE 24th SOLAR CYCLE

COST Action 724: *Developing the Scientific Basis for Monitoring, Modelling and Predicting Space Weather (2004 –2007)*



- **WG1 - Monitoring and predicting solar activity for Space Weather**
  - **<u>Objectives :</u>**
  - To research the use of solar observations (e.g. EUV images, X-ray observations, radio emissions) and models (e.g. magneto-hydrodynamic models of flux tubes) for predicting energetic particle events.

SOFT X-RAY EMISSION IN SOLAR FLARES

A new index, Q_x, was defined by us in order to give an evaluation of the Soft X-Ray (SXR) flare energy, similarly to the Q index for H_α flares. The Q_x indices are available on the interval 1 Jan. 1976–30 June 2006 for the whole solar disk and separately for the North and South solar hemispheres and they will be periodically up-dated (COST Action 724, WG 1).

- **Flares are better defined through importance indices, as regards the knowledge about the amount of energy released, then through frequency indices;**
- **The amount of energy emitted by SXR flares, quantified through the *Qx* index, is about the same for all SCs 21–23;**

⇒We may infer useful information about the level of the next cycle by analysing the flare activity growths during the descending & minimum phases of the SCs.

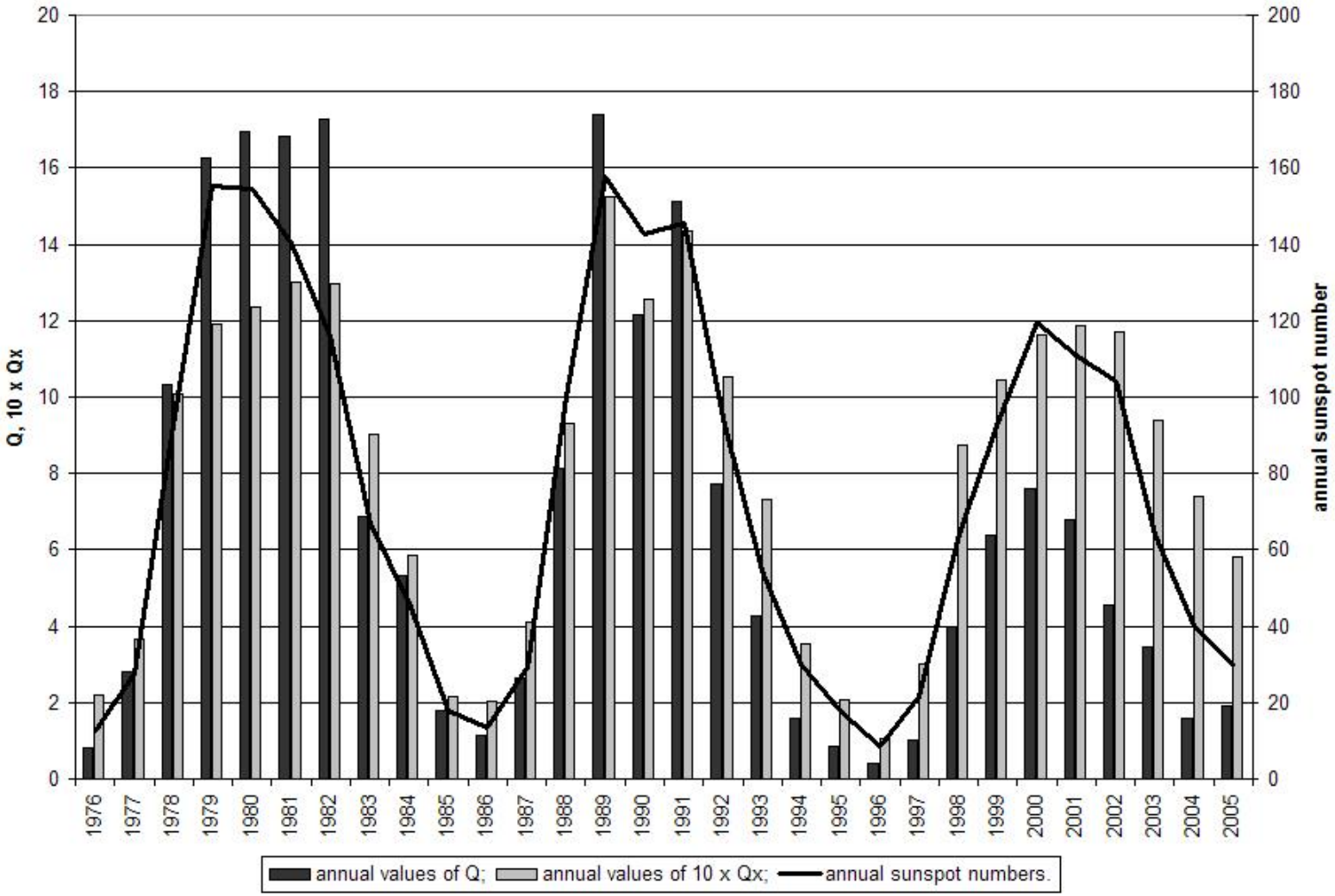
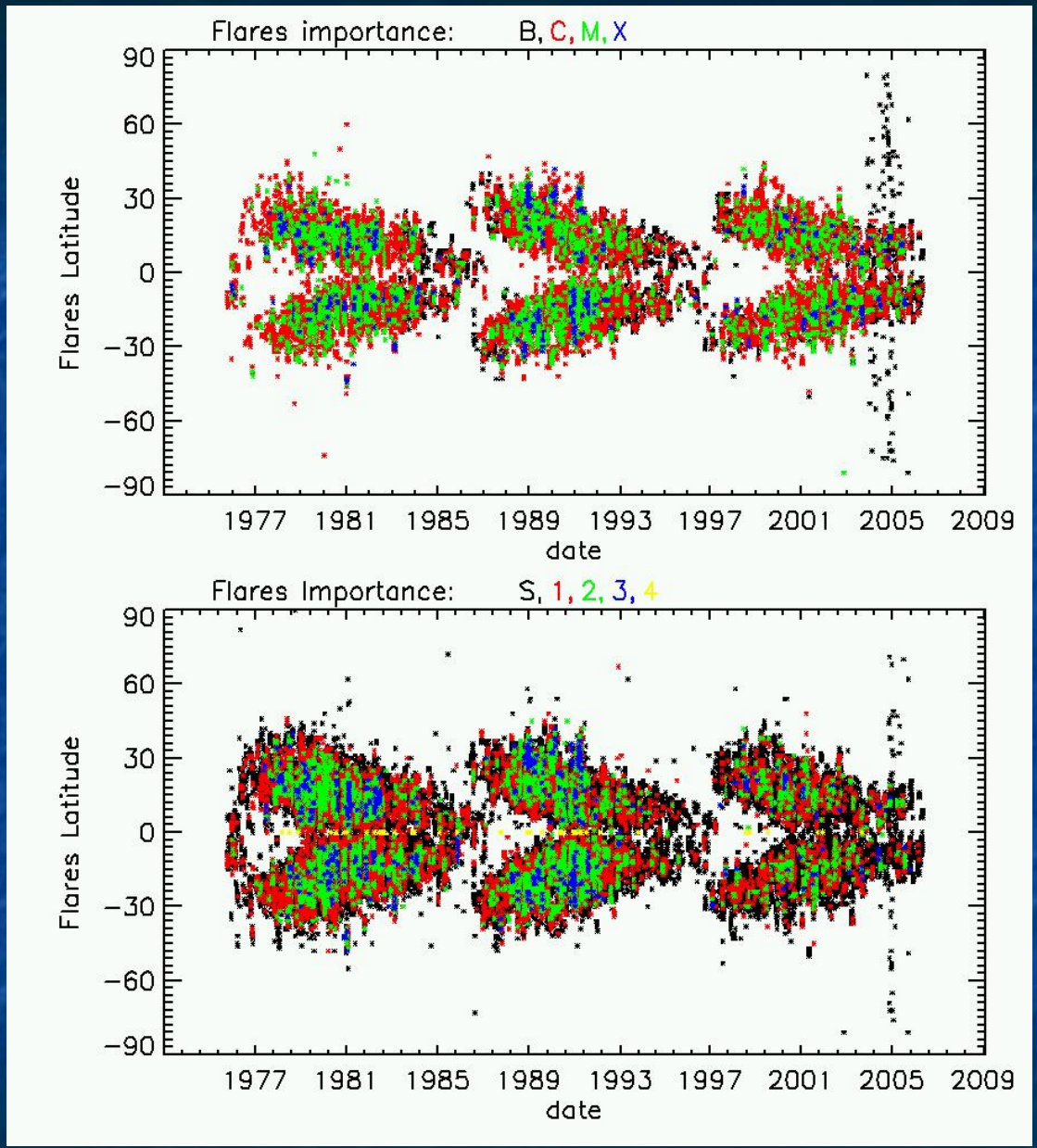


Fig. 1 - Solar cycles of solar flares indices Q and Q_x



- the "butterfly" diagram of the all H_α flares shows a larger dispersion than the one of SXR flares;

- SC 23 → the small importance flares (**B** spectral class & **s** importance H_α) appeared at all the latitudes on the descendant phase (2004-2005).

SEISMIC RADIATION OF SOLAR FLARES

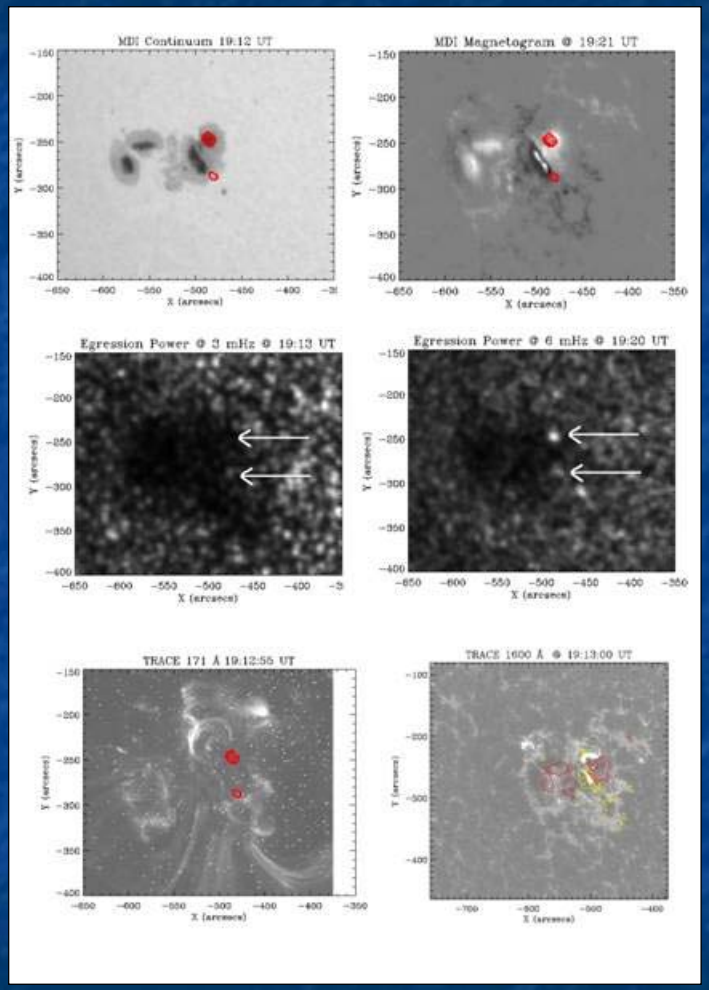


Fig. 3 – X 5.6 flare of 6 Apr. 2001

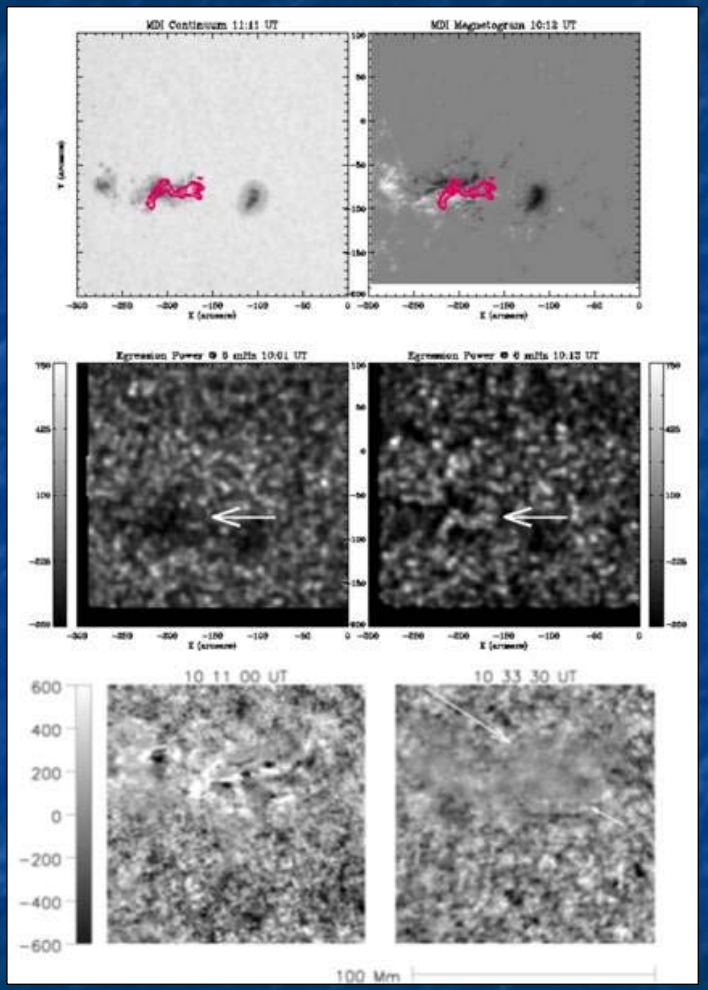
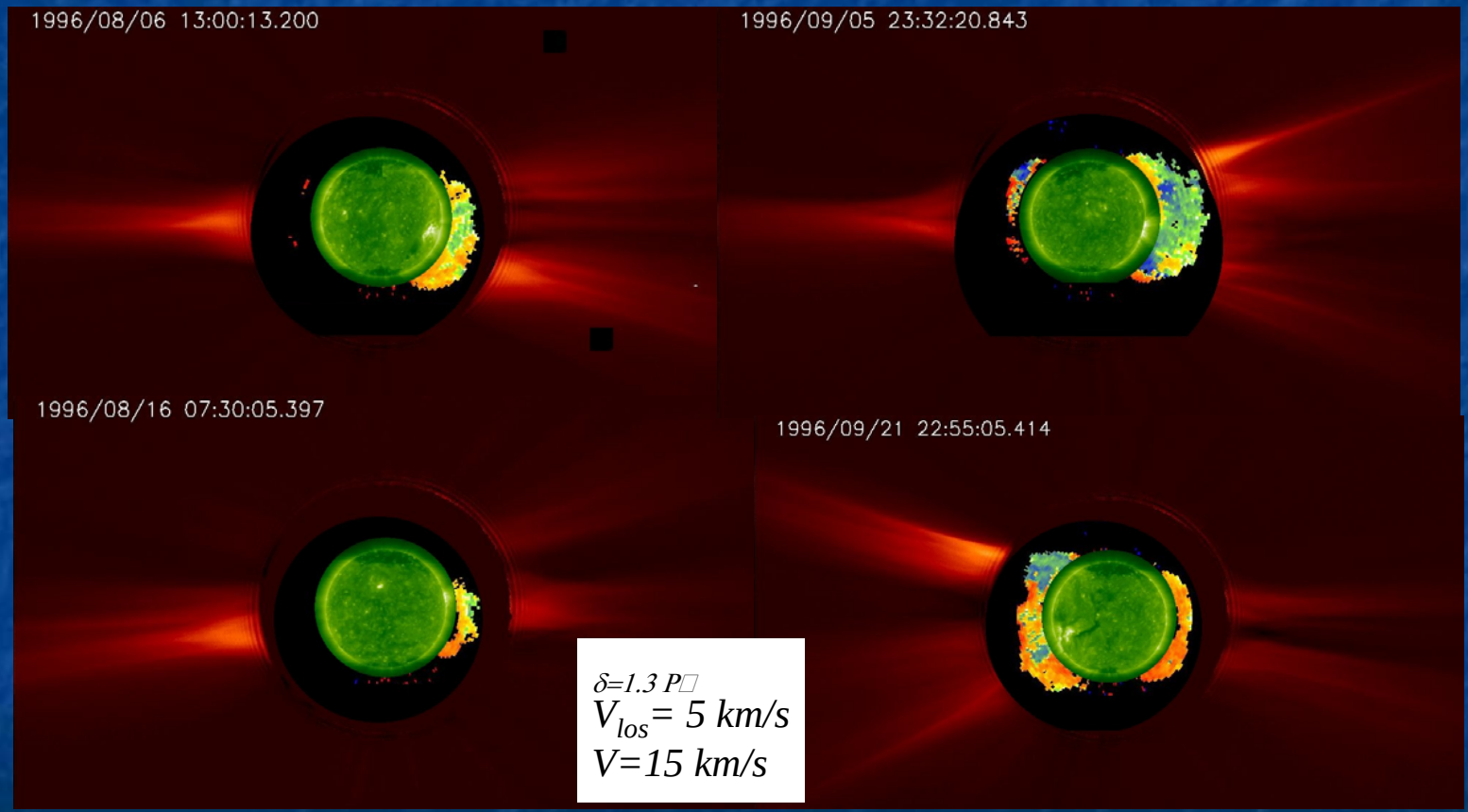


Fig. 4 - M 7.8 flare of 2 Dec. 20

- The sun quake manifested itself by producing acoustic waves that propagated thousands of km from the location of the flare into the solar interior and back to the surface.
- A systematic survey covering a large number of X-class and some M-class solar flares observed by SOHO/MDI during 1996–2006 have undertaken and we have created an easily accessible database of all active regions that have been searched for sun quakes.
  - **The analysis of the acoustic activity of these solar flares, including time series of the 3 and 6 mHz egression power and the acoustic power of the active regions, and the comparison with other observations (from another five solar observatories/satellites) of the active regions, can be found at the sites:**

    http://www.maths.monash.edu.au/~dionescu/sunquakes/sunquakes.html
    and its mirror: http://www.maths.monash.edu.au/~adonea

DYNAMICS OF THE INNER SOLAR CORONA AND SLOW SOLAR WIND



- The solar wind comes in two states: **slow (~ 400 km/s)** and **fast (~ 700 km/s)**:
  - The **coronal holes** ("open" magnetic field structures) were identified as the **main source regions** of the fast, mostly uniform, solar wind.
  - Conversely, **the slow solar wind**, which shows large excursions in speed and elemental abundances, is believed to originate in **streamers** (closed magnetic tructures).
- There are still **open questions** regarding the slow solar wind origine:
  - at the level of streamer cusp?
  - in the regions surrounding the streamer, close to the streamer boundary?
  - from both streamer cusp and streamer legs?
- From the data analysed we have deduced:
  - the slow solar wind is associated with streamers;
  - the flows associated with the streamers, in both data of 1996 and 1998, are clearly associated with the interior of the streamer;
  - the flows from data taken at the minimum of activity seems to come from regions at the boundaries of open and closed magnetic structures;

FAST SOLAR WIND ORIGIN

The results have been derived due to an innovative way of extracting information from the spectral data offered by the highest resolution SUMER/SoHO detector. The “secret” of our technique stays into understanding plasma properties from the signature it leaves in the shape and widths of the spectral lines.

- The evidence that **the fast wind** does not start steadily in the transition region was found;
- It might originate from “explosive event” sites located in coronal holes, with an initial outflow of more than 100 km/s.
- Although the expelled jets extend high in the Sun's atmosphere, they are not seen on the disk in the intensity, but might appear as macro-spicules at the Sun's edge. These jets have a lifetime of about 5 min, and are often seen reoccurring over intervals of 1 hour .

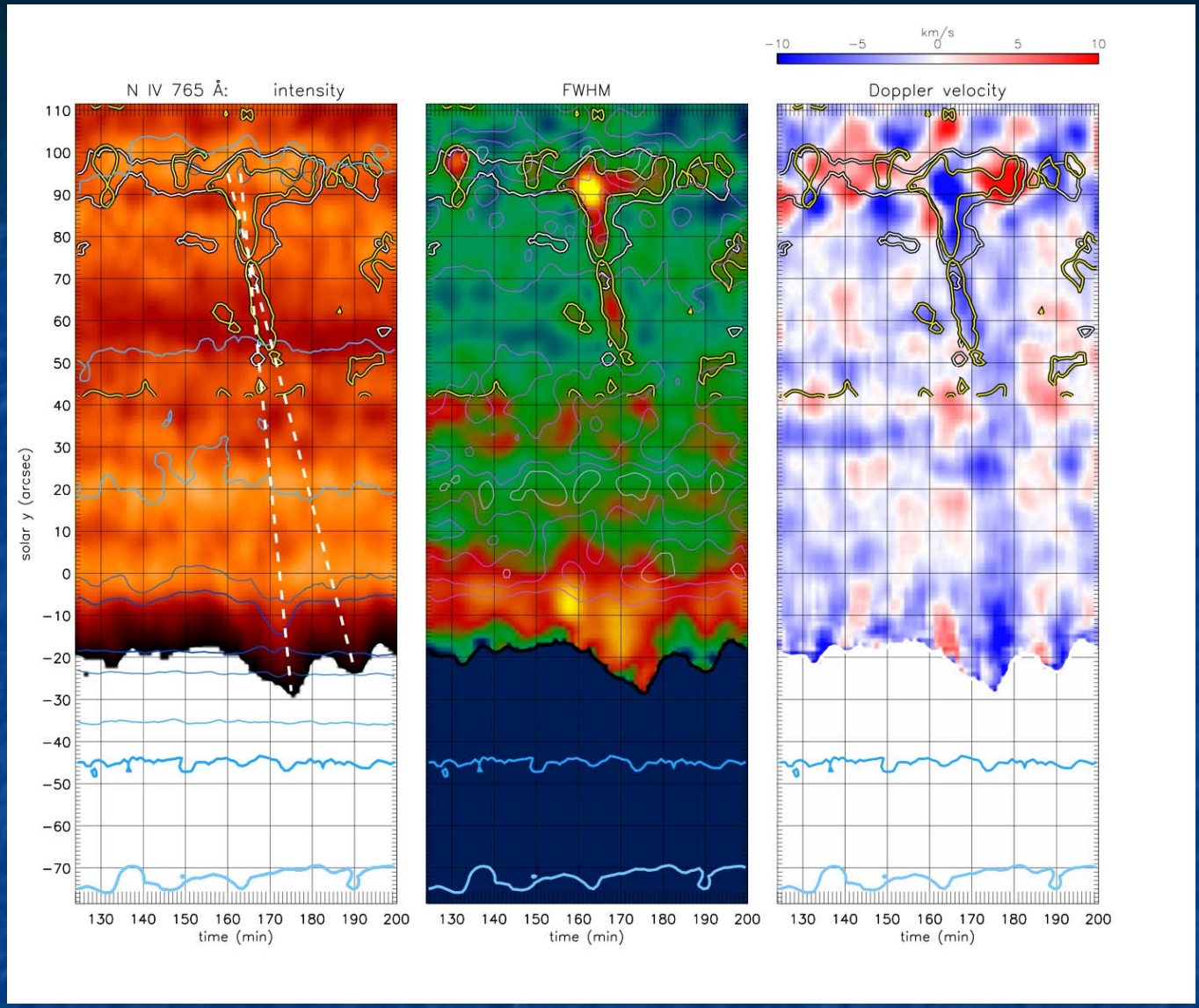
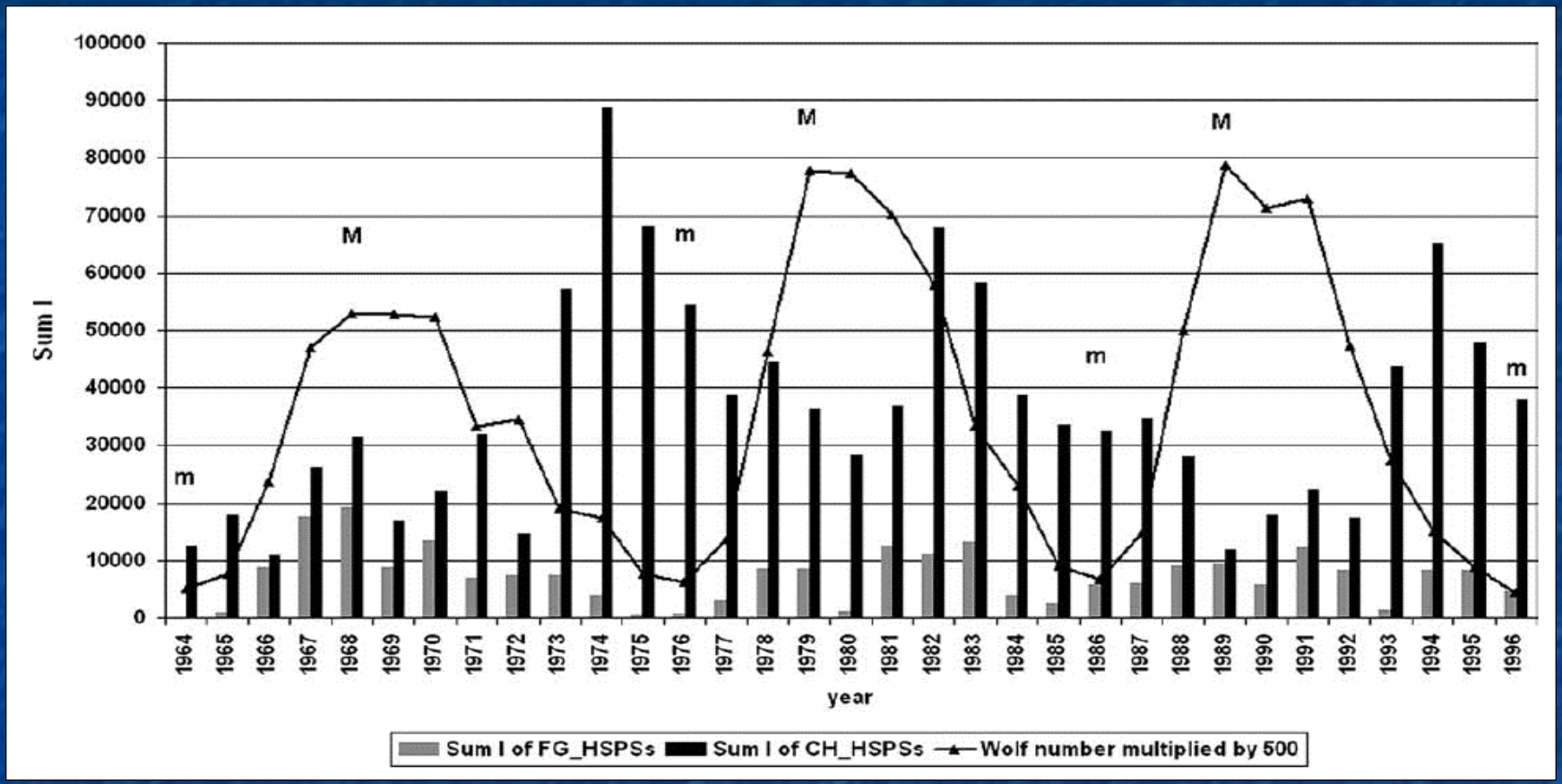
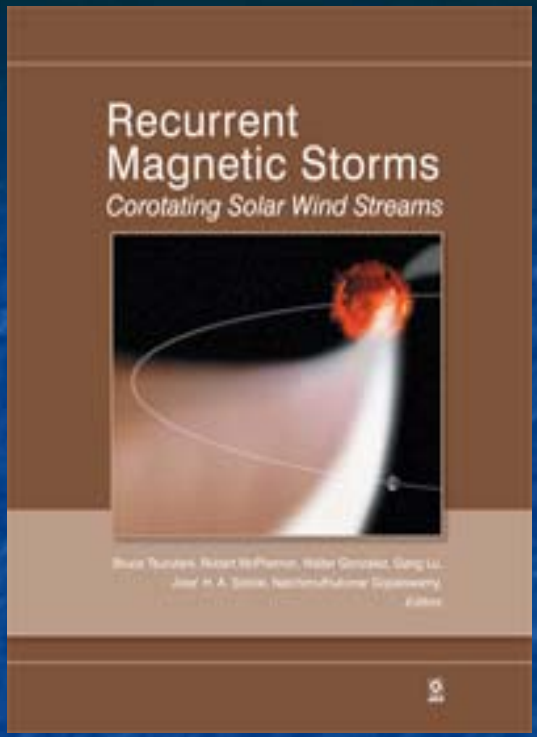


Fig. 6 - Two of the detected jets, with velocities of 50 km/s and 130 km/s and heights of more than 100,000 km, as seen in a temporal series dataset (in the N IV 765 A line, originating at approx. 140,000K close to the base of the transition region)

HIGH-SPEED STREAMS IN SOLAR WIND





B. Tsurutani, R. McPherron, W. Gonzalez, G. Lu, Jose' H. A. Sobral, N. Gopalswamy, Eds.

Geophysical Monograph Series, Volume 167, 340 pages, 2006, ISBN: 0-87590-432-7, ISBN 13: 978-0-87590-432-0, AGU Code GM1674327.

Response of the Upper / Middle Atmosphere to Coronal Holes and Powerful High-Speed Solar Wind Streams in 2003

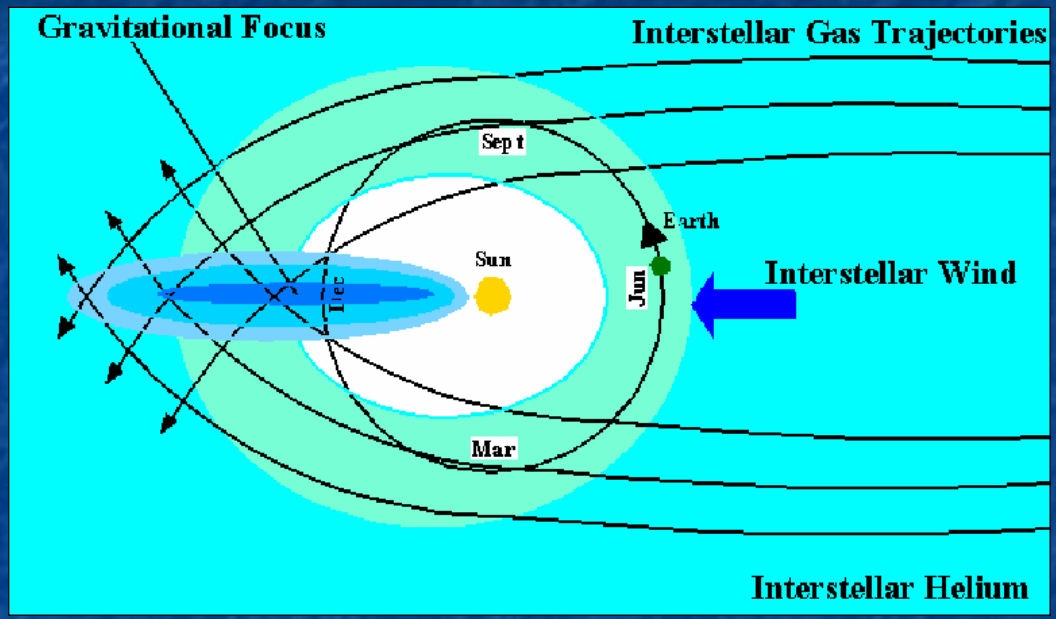
J.U. Kozyra, G. Crowley, B. A. Emery, X. Fang, **G. Maris,** M. G. Mlynczak, R. J. Niciejewski, S. E. Palo, L. J. Paxton, C. E. Randall, P.-P. Rong, J. M. Russell III, W. Skinner, S. C. Solomon, E. R. Talaat, Q. Wu, and J.-H.Yee

Changes in the Upper / Middle Atmosphere during Powerful High-Speed Streams in 2003: A New Pathway for Forcing Long-Term Variability

J.U. Kozyra, G. Crowley, B. A. Emery, X. Fang, **G. Maris,** M. G. Mlynczak, R. J. Niciejewski, S. E.Palo, L. J. Paxton, C. E. Randall, P.-P. Rong, J. M. Russell III, W. Skinner, S. C. Solomon, E. R. Talaat, Q. Wu, and J.-H.Yeee **(ISSC2, 13 – 16 September 2006, Sinaia, Romania).**

- **Future Project with Inst. Of Nuclear Physics, Moscow University;**
- **Cooperative studies with Prof. Brian Tinsley, Univ. of Texas, Dallas**

HELIOSPHERIC PLASMA DIAGNOSTIC



- The presence in heliosphere of the cool neutral helium, among the other interstellar neutrals, was analyzed.
- The neutrals are ionized by charge exchange, photo ionization, and electron impact.

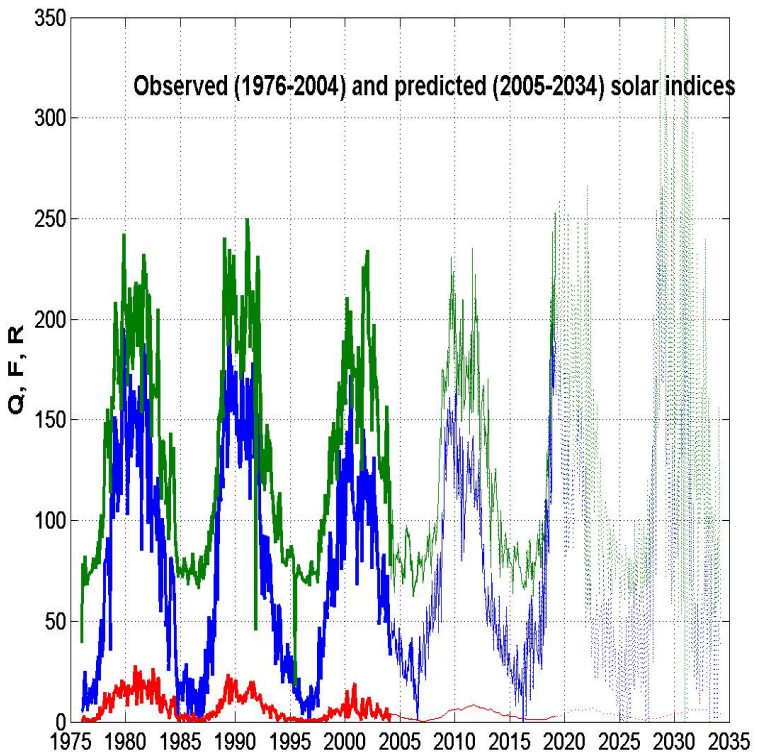
Main results:

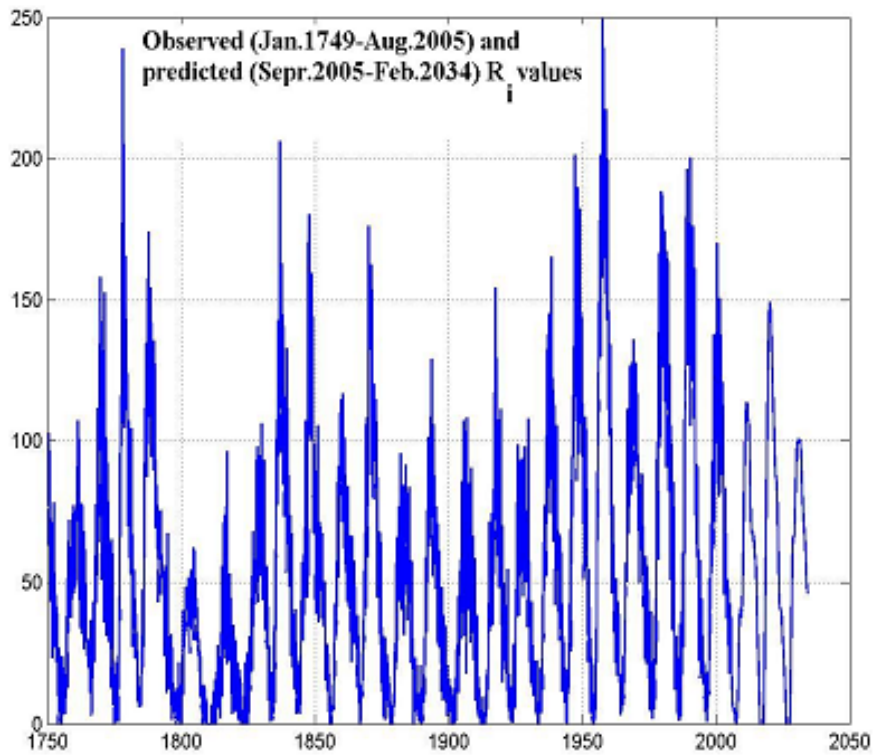
•There's a neutral He corona at $I>10^{-7}$ solar disk units near the Sun;

•Helium is brighter at $1.3R_{\odot}$ in the "down wind" direction;

•Local interstellar neutral He wind looks interesting as a tool for learning about coronal electron density and velocity.

NEURAL NETWORK FORECAST OF THE 24th SOLAR CYCLE AND BEYOND





Forecasted SC 24 epochs and values

	Min	Max	Min
Q	2007	2012 → 9	2018
F_0	2006	2009→210; 2012 → 190	2016
R_i	2006	2009 → 150; 2012 → 130	2016

- two maxima for R_i and F_0 at the same epochs;
- Q maximum coincides with the second maximum of R_i and F_0 ;
- Q minimum is shifted by 2 years behind the R_i and F_0 ones.

Forecasted SCs 24 – 26 epochs and values

	Min–SC24	Max–SC24	Min–SC25	Max–SC 25	Min–SC 26	Max–SC 26
R_i	End 2007	2011→120	2017	2020 →150	2027	2030 →100!

⇒ Different neural network structures and horizons gave different maxima of SC 24;

⇒ It would be possible to face with **a Dalton minimum**.

THANK YOU

FOR ATTENTION !