ON THE ASSOCIATION BETWEEN TYPE II RADIO BURSTS AND CMES

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AIP

Type II Radio Bursts are signatures of *coronal* and *interplanetary* shock waves and enable a remote study with *ground based* and *spaceborne* observations.

Question: Are metric type IIs associated with blast-waves or with piston-driven shocks?

(Recent discussions: Cliver et al., 1999; Reiner et al., 2001; Claßen and Aurass, 2002)

Dynamic Radio Spectra

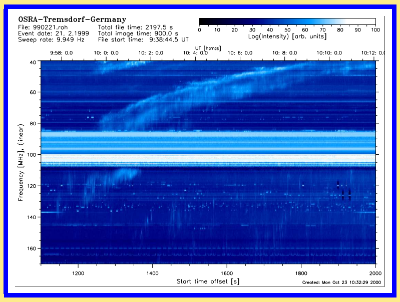

Fig. 1: Type II for two simultaneous E/W CMEs

Plasma emission process

- $\boxed{f_{em.} \propto \sqrt{N_e(r)}}$
- $\boxed{D_f \propto \vec{V}_{source} \cdot \vec{\nabla} N_e(r)}$

Height-Time Plots

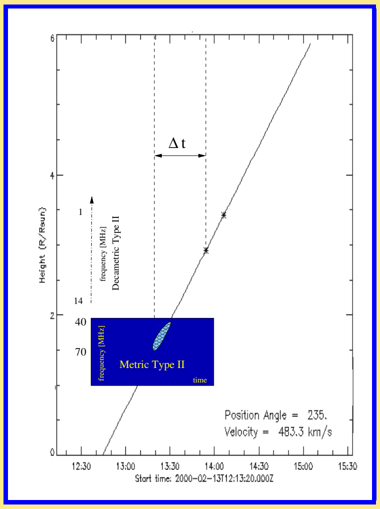

Fig. 2: Levels of data analysis

Observations

- **Metric type IIs: AIP Potsdam** (http://www.aip.de/People/AKlassen)
- **CMEs: SOHO/LASCO** (http://lasco-www.nrl.navy.mil/cmelist.html)
- **Decam. type IIs: WIND/Waves** (http://lep694.gsfc.nasa.gov/waves/waves.html)

Data Analysis

- Time difference

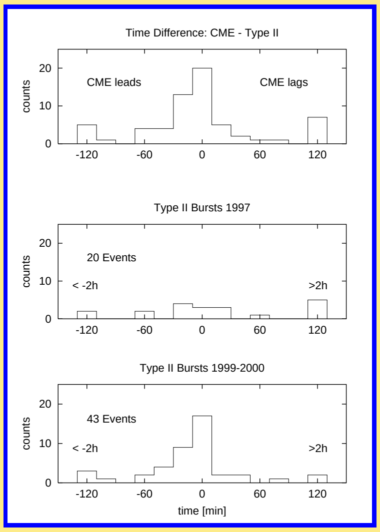

Fig. 3: Type II – CME correlation (1997 events: Klassen et al., 2000)

- Categorisation
  1. Class: Delta t $>$ 1h
  2. Class: Delta t $<$ 1h and (Delta V)/V $<$ 2
  3. Class: Delta t $<$ 1h and (Delta V)/V $>$ 2

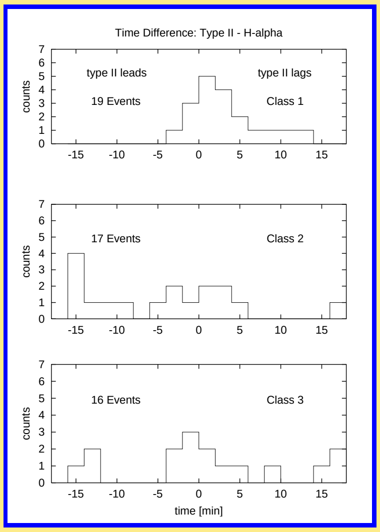

Fig. 4: Type II – H-alpha flare correlation

Discussion

- Time difference CME – Type II
  - 1997 : $\langle Dt \rangle = -7$ min
  - 1999/2000: $\langle Dt \rangle = -8$ min

⋆ density model or deceleration
  - class 2: $\langle Dt \rangle = -\ 5 \pm 10$ min
  - class 3: $\langle Dt \rangle = -10 \pm 13$ min

⋆ leading edge/internal parts

- Velocities CMEs – Type IIs
  - 1997 : $\langle V_{CME} \rangle = 500 \pm 200$
  - 1997 : $\langle V_{II} \rangle = 1,000 \pm 300$

⋆ different sources
  - 1999/2000: $\langle V_{CME} \rangle = 690 \pm 250$
  - 1999/2000: $\langle V_{II} \rangle = 770 \pm 350$

⋆ identical sources

- consecutve type IIs (m$\rightarrow$ Dm)
  - class 1: 26 %
  - class 2: 26 %
  - class 3: 39 %

⋆ "text-book" examples $<$ 10 %

Results

- Three kinds of metric type IIs
  1. blast-wave shocks: No type II – CME correlation
  2. "bow-shocks": velocity and start-time correspond
  3. internal parts/flanks: velocities do not correspond.
- Solar cycle dependence
- Decametric type IIs
  1. most likely different sources
  2. "perfectly" fitting events: 5.

References

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