

# ON THE ASSOCIATION BETWEEN TYPE II RADIO BURSTS AND CMES

Theodor Claßen, Henry Aurass

Astrophysikalisches Institut Potsdam, An der Sternwarte 16, D-14482 Potsdam, Germany



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

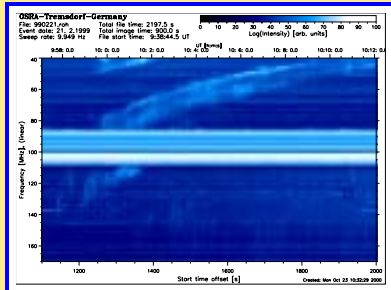


Fig. 1: Type II for two simultaneous E/W CMEs

## Plasma emission process

- $f_{em} \propto \sqrt{N_e(r)}$
- $D_f \propto \vec{V}_{source} \cdot \vec{N}_e(r)$

## Height-Time Plots

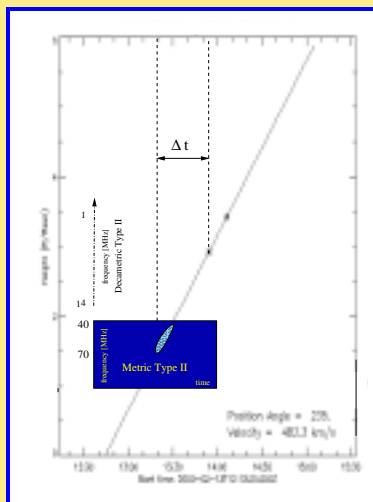


Fig. 2: Levels of data analysis

## 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

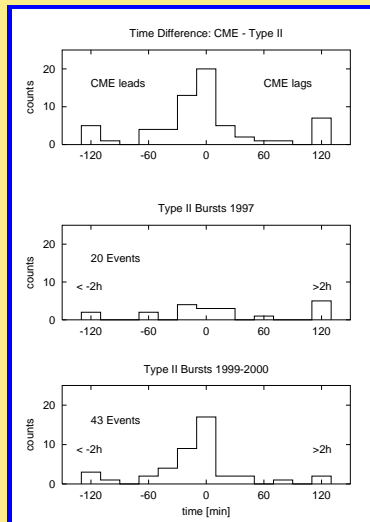


Fig. 3: Type II – CME correlation (1997 events: Klassen et al., 2000)

### • Categorisation

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

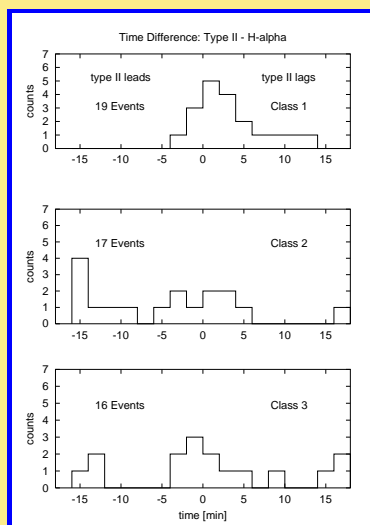


Fig. 4: Type II – H-alpha flare correlation

## Discussion

### • Time difference CME – Type II

– 1997 :  $\langle \Delta t \rangle = -7 \text{ min}$

– 1999/2000:  $\langle \Delta t \rangle = -8 \text{ min}$

### \* density model or deceleration

– class 2:  $\langle \Delta t \rangle = -5 \pm 10 \text{ min}$

– class 3:  $\langle \Delta t \rangle = -10 \pm 13 \text{ min}$

### \* 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

### • consecutive type IIs (m → 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

- Claßen T., Aurass H., 2002, A&A, in press  
 Cliver E.W., Webb D.F., and Howard R.A., 1999, Sol.Phys., 104, 4743  
 Klassen A., Aurass H., Mann G., and Thompson B., 2000, A&AS, 141, 357  
 Mann G., Claßen H.-T., Aurass H., 1995, A&A, 295, 775  
 Reiner M.J., Kaiser M.L., and Bougeret J.-L., 2001, JGR, in press