Can we measure the magnetic field strength of the quiet solar corona using “EIT Waves”?

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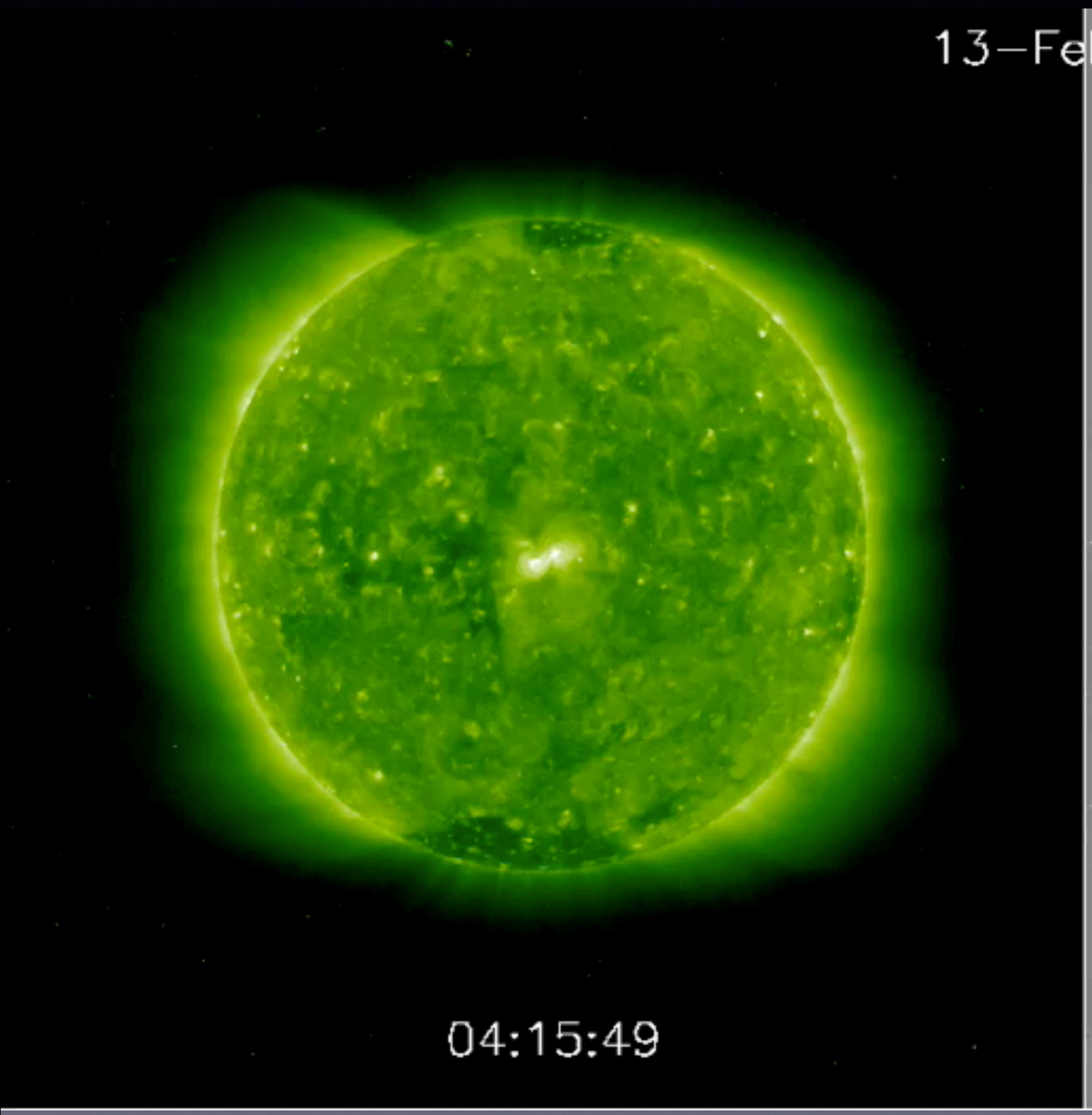
“EIT Waves”



13-February-2009; *STEREO*-B

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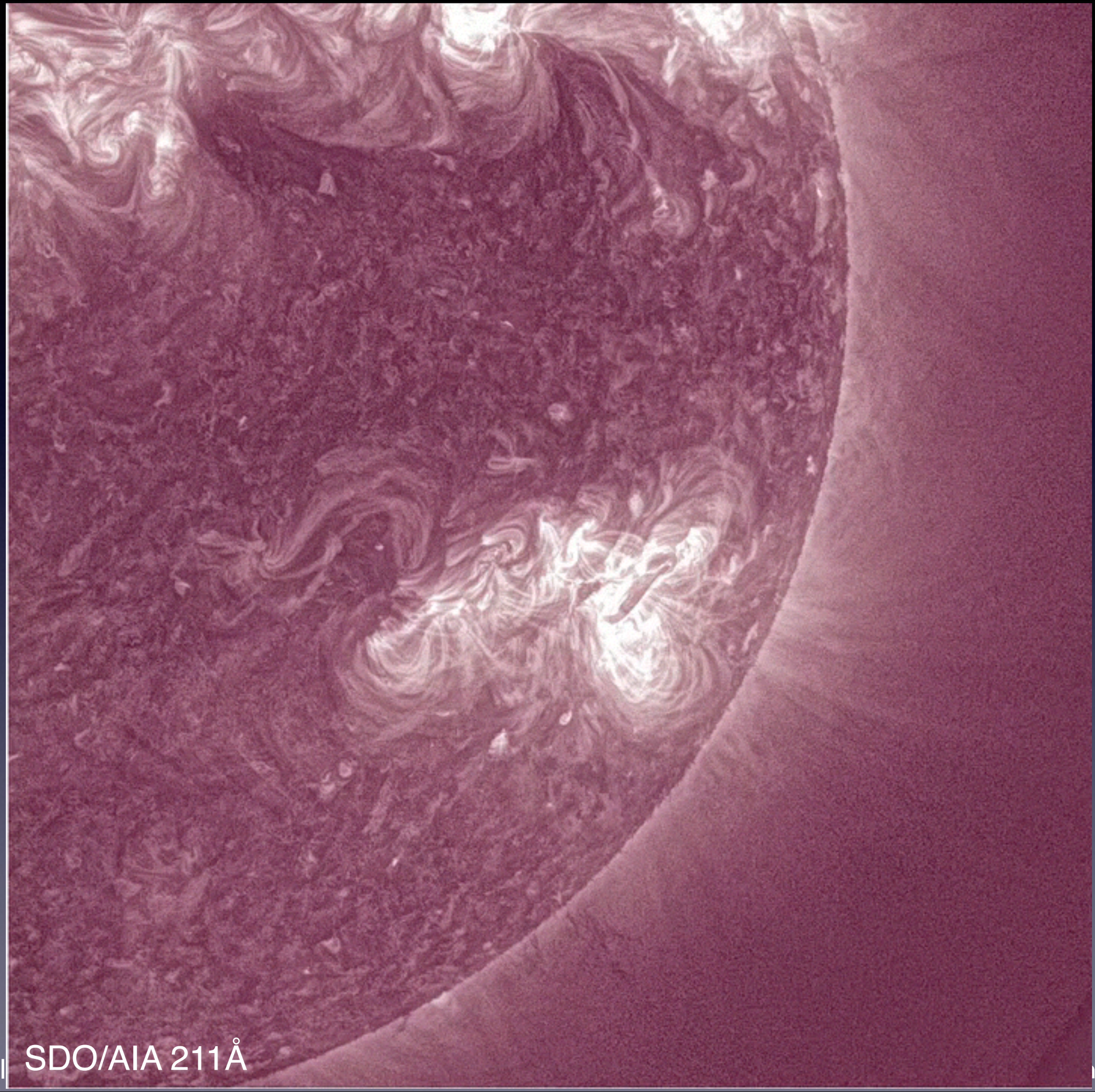
“EIT Waves”

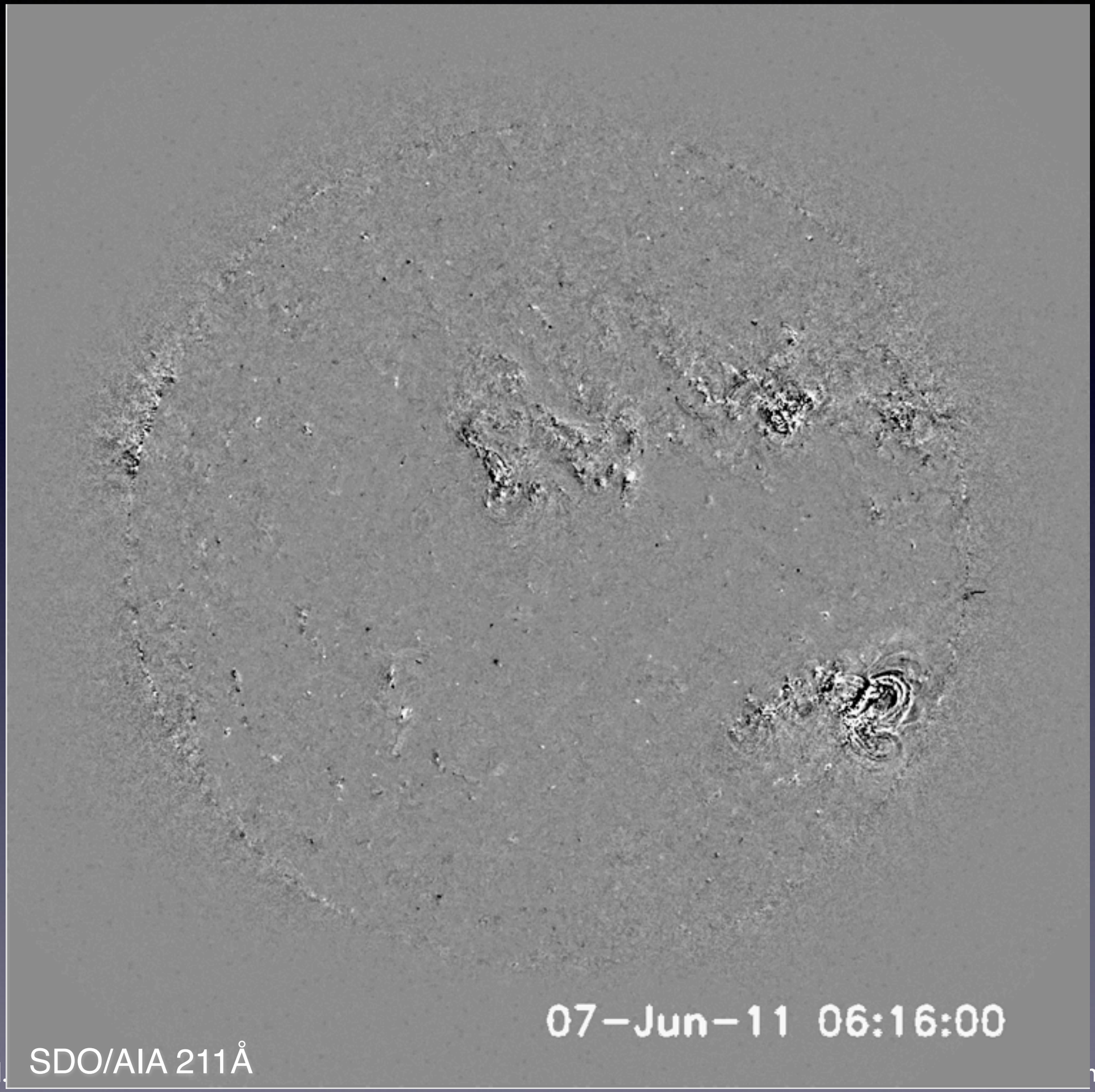
- First observed using 195Å channel on *SOHO*/EIT (Moses et al. 1997, Dere et al. 1997, Thompson et al. 1997)
- Seen in other coronal EUV passbands and spacecraft
  - *STEREO* (Long et al. 2008, 2011a; Veronig et al. 2008,2010)
  - *SDO* (Liu et al. 2010; Patsourakos et al., 2010; Long et al. 2011b)
- Pulses observed to avoid active regions and coronal holes (Thompson et al. 1999)
- Evidence of acceleration (Warmuth et al. 2004), broadening (Long et al. 2011a), reflection (Gopalswamy et al. 2009)

“EIT Waves”

- Interpreted as
  - Fast-mode waves (Thompson 1998,1999; Wu et al. 2001)
  - Pseudo-“waves” (Attrill et al. 2007; Delannée 2008)
  - Hybrids (Chen et al. 2002; Cohen et al. 2009; Downes et al. 2011)

- Multiple kinematic classes (Warmuth & Mann, 2011)
  - Fast pulses with strong deceleration (v > 320 km/s)
  - Pulses with moderate & nearly constant speed (v ~170-320 km/s)
  - Slow pulses with erratic kinematic behaviour (v < 130 km/s)


SDO/AIA 211Å

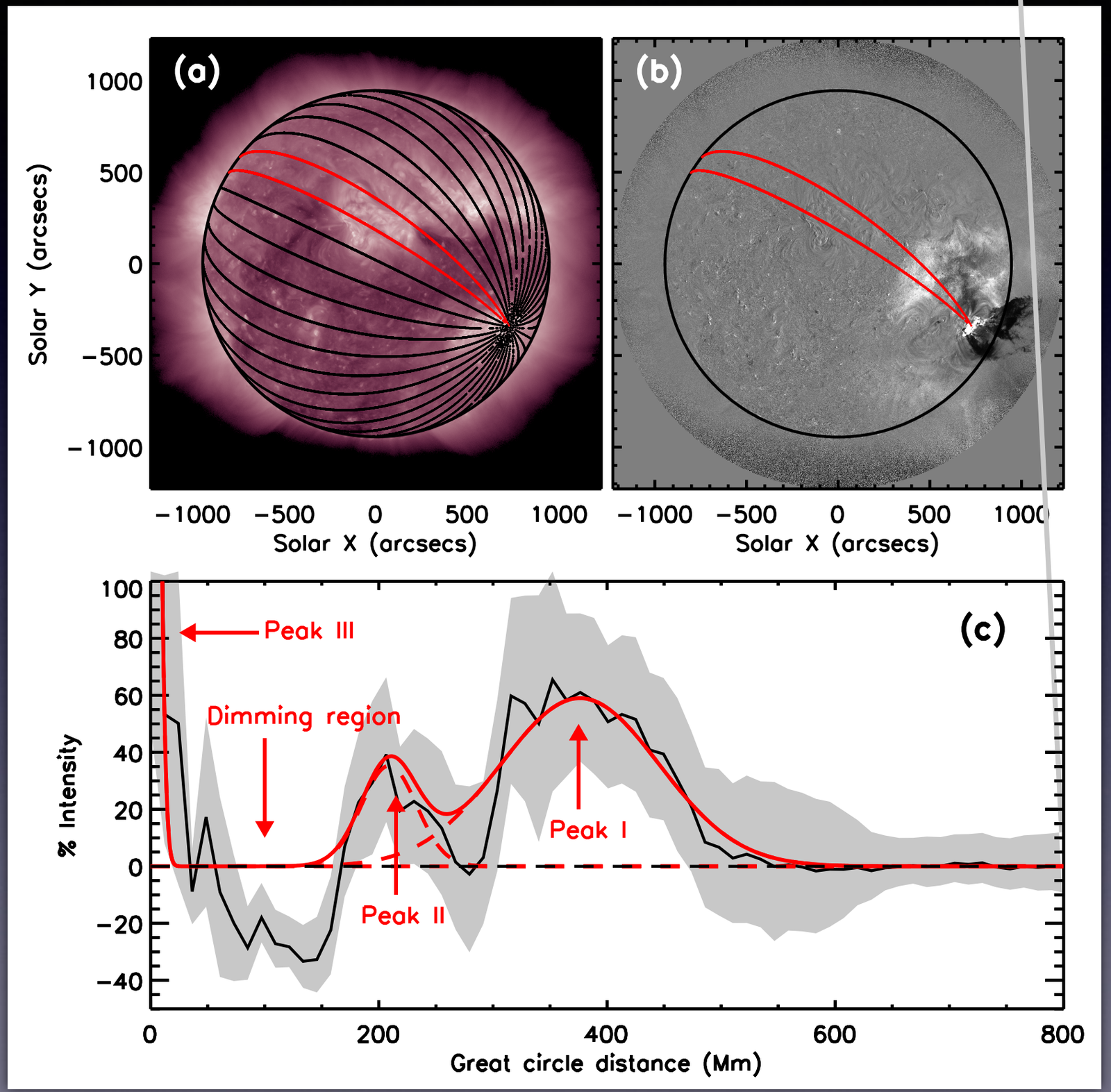

07-Jun-11 06:16:00
SDO/AIA 211Å

Coronal Pulse Identification and Tracking Algorithm (CorPITA)

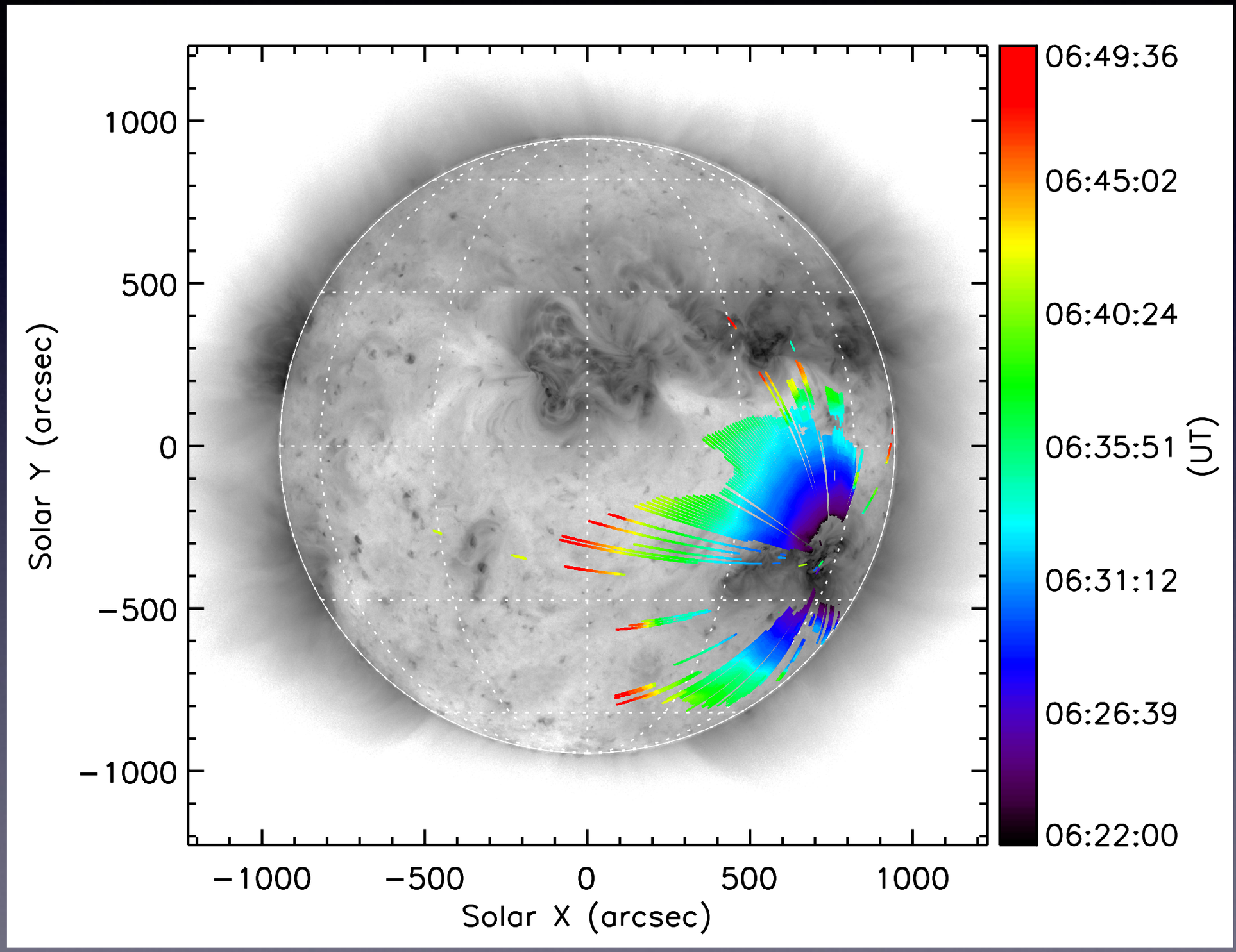
Long et al., 2013 *submitted*

- Automated algorithm designed to identify, track and analyse "EIT Waves" in SDO data
- Part of SDO Feature Finding Team initiative
- Pulse identified using intensity profile technique across 360° from source
- Once pulse can no longer be tracked, pulse properties (kinematics, broadening) measured and returned
- Algorithm output will form part of Heliophysics Event Knowledgebase

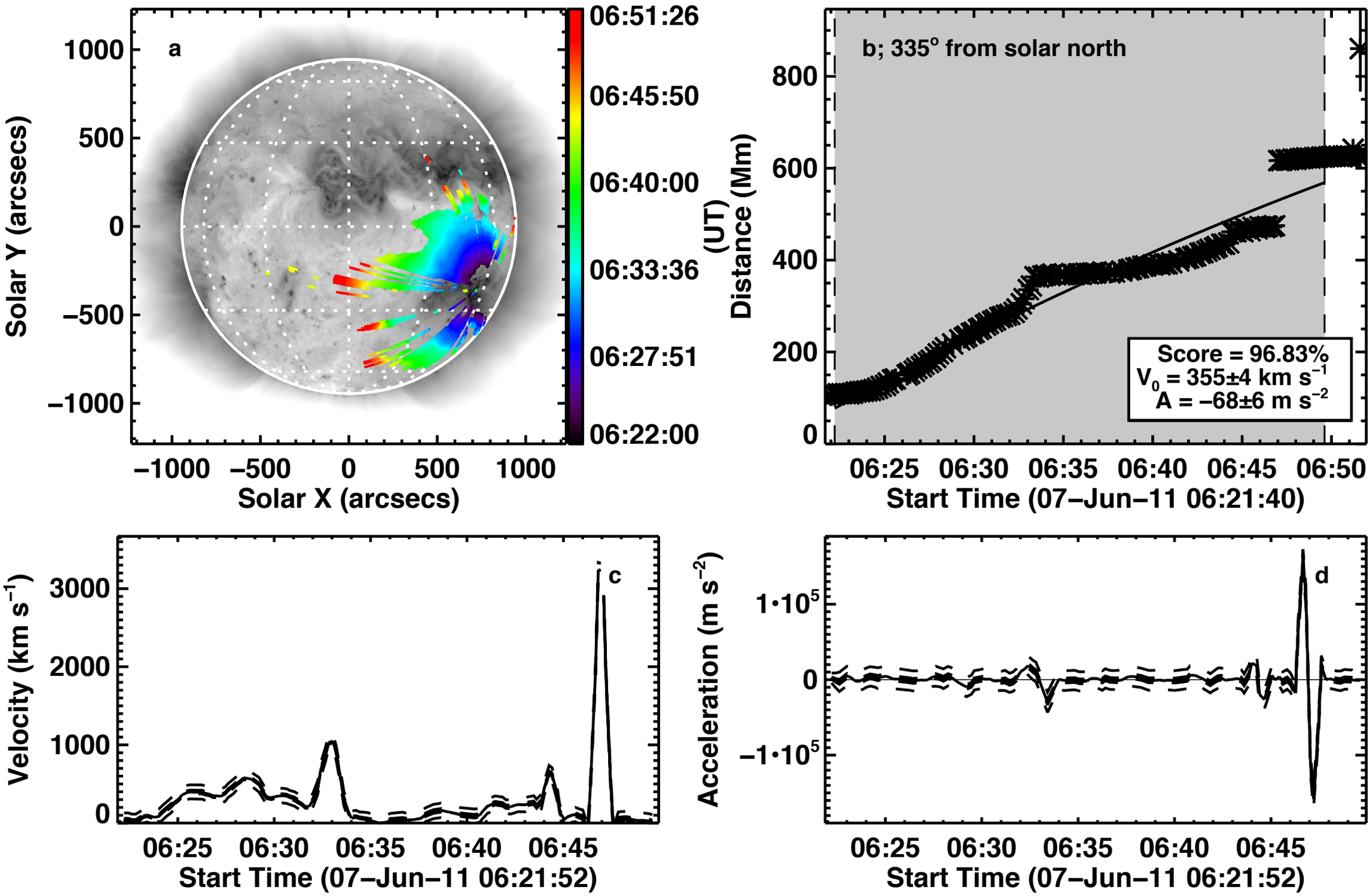
CorPITA output



CorPITA output

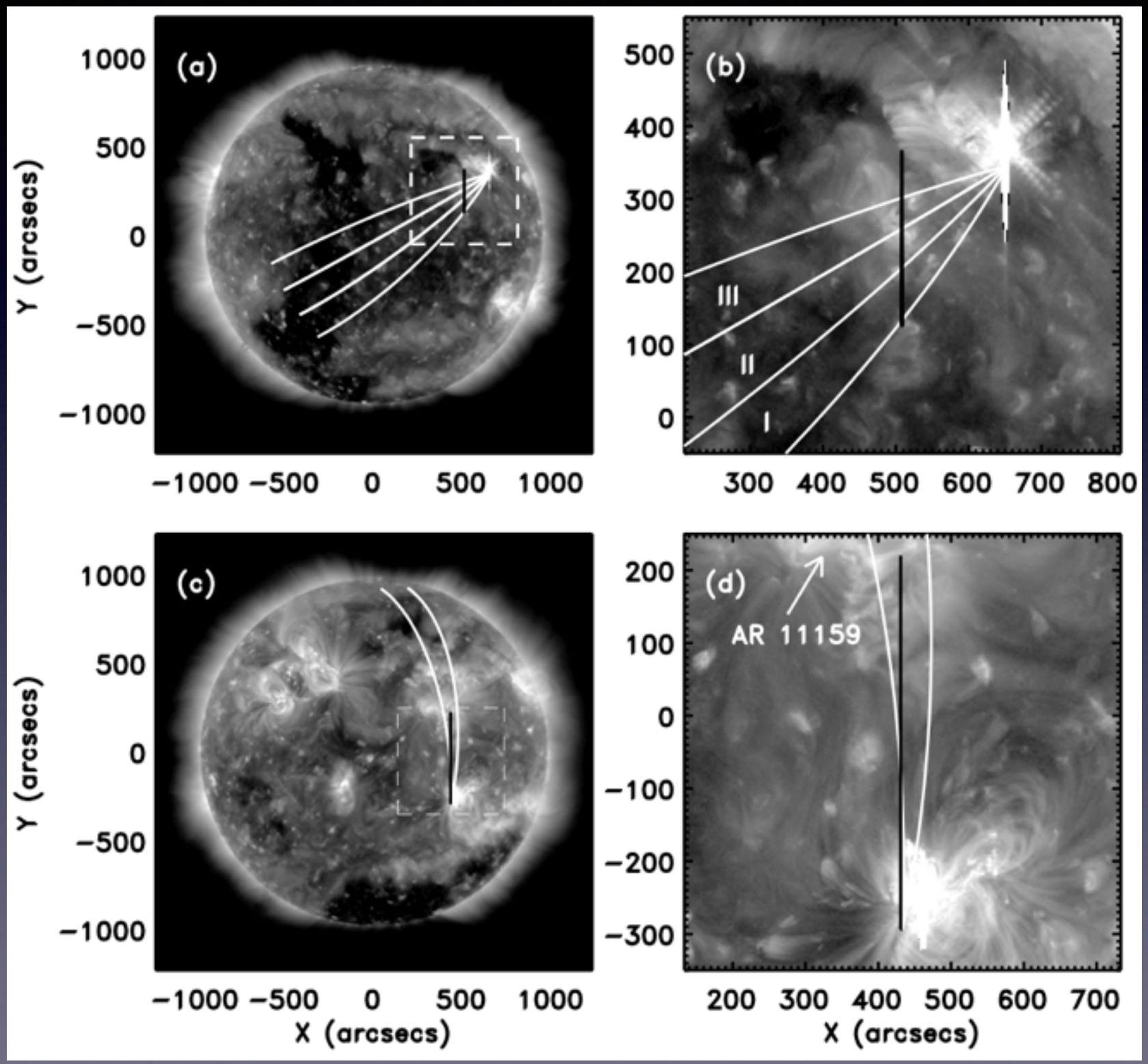


CorPITA output



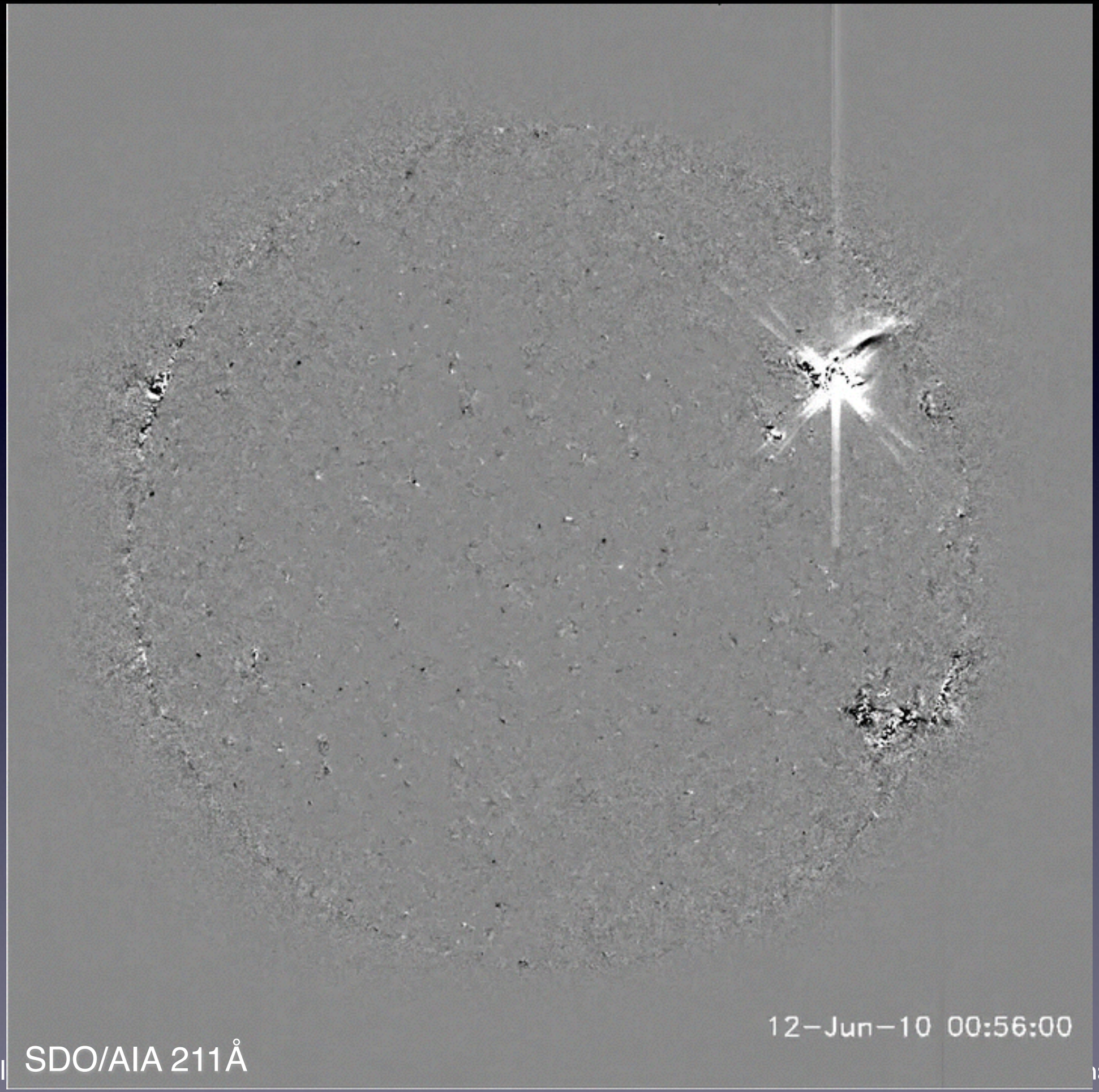
cf. Byrne, Long, Gallagher et al., 2013, A&A, 557, A96

EIS data identification



12-June-2010

16-February-2011



SDO/AIA 211Å

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Coronal Seismology

- We have:
  - Pulse kinematics from AIA using automated approach
  - Density estimates from EIS

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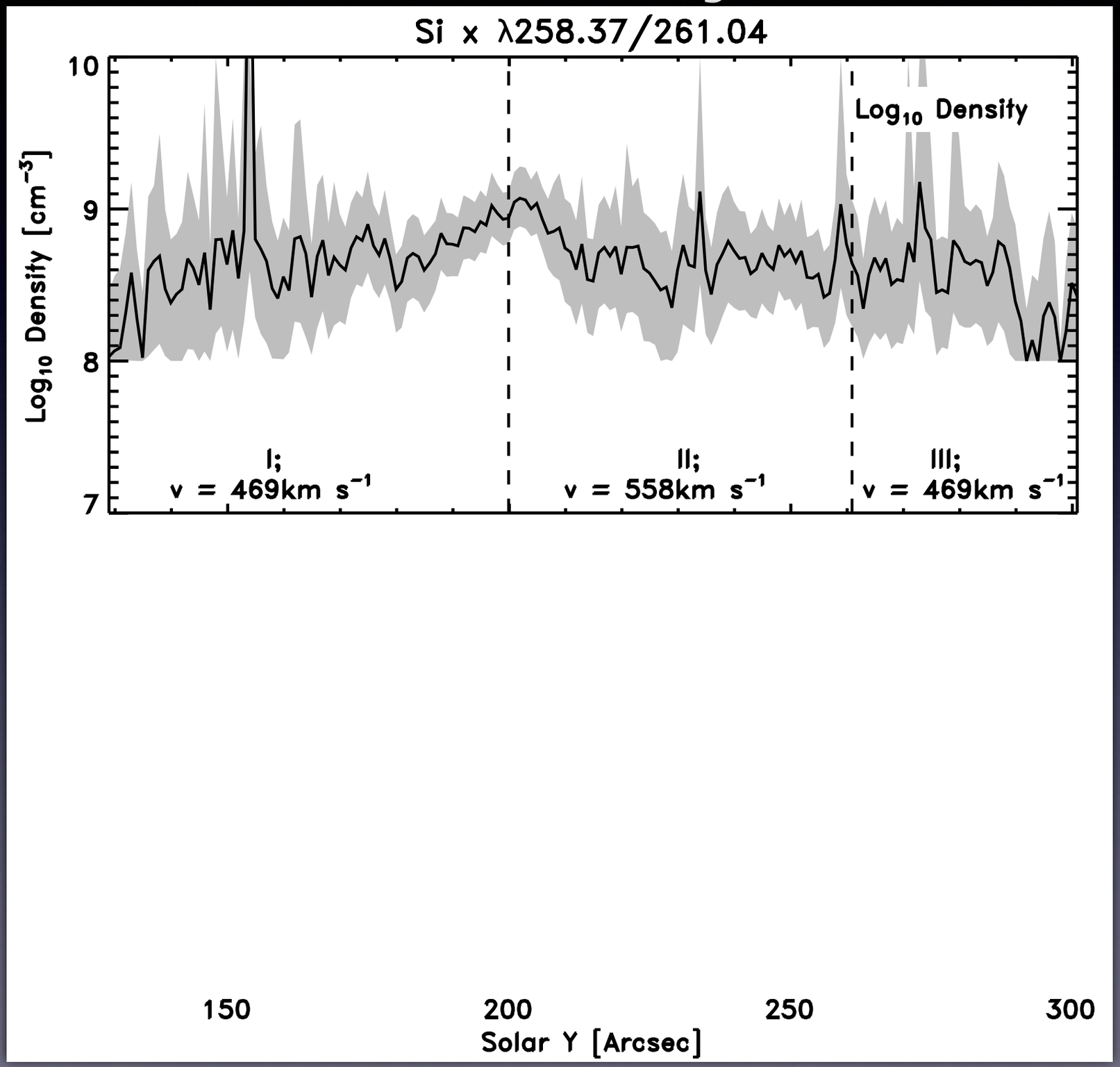
- Can use “EIT Waves” to study the quiet Corona
  - e.g., West et al. (2011), Long et al. (2011)
  - Assuming “EIT Wave” is a fast-mode wave, then

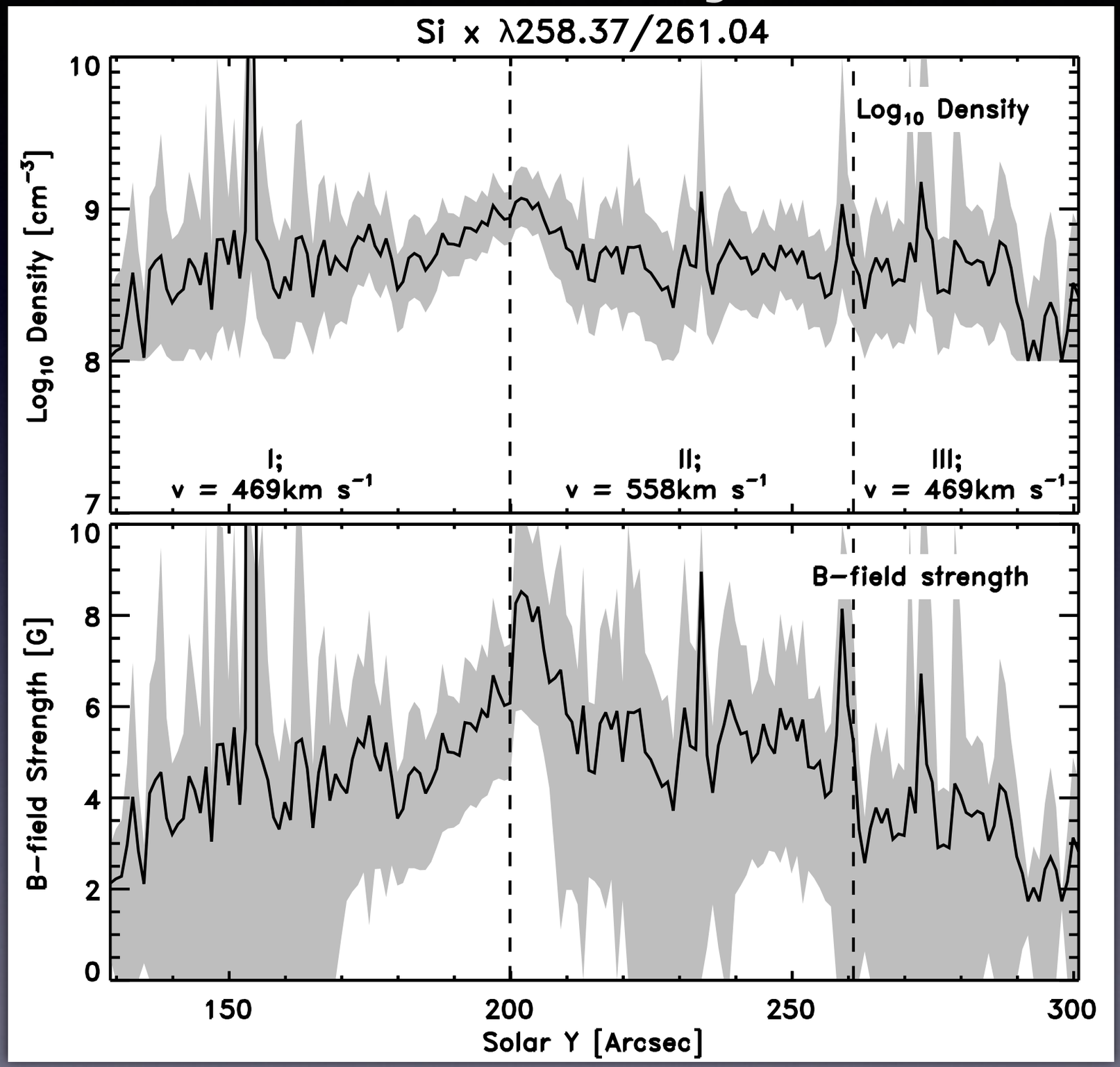
$$B = \sqrt{4\pi n(mv_{fm}^2 - \gamma kT)}.$$

EIS analysis



12-June-2010

EIS analysis



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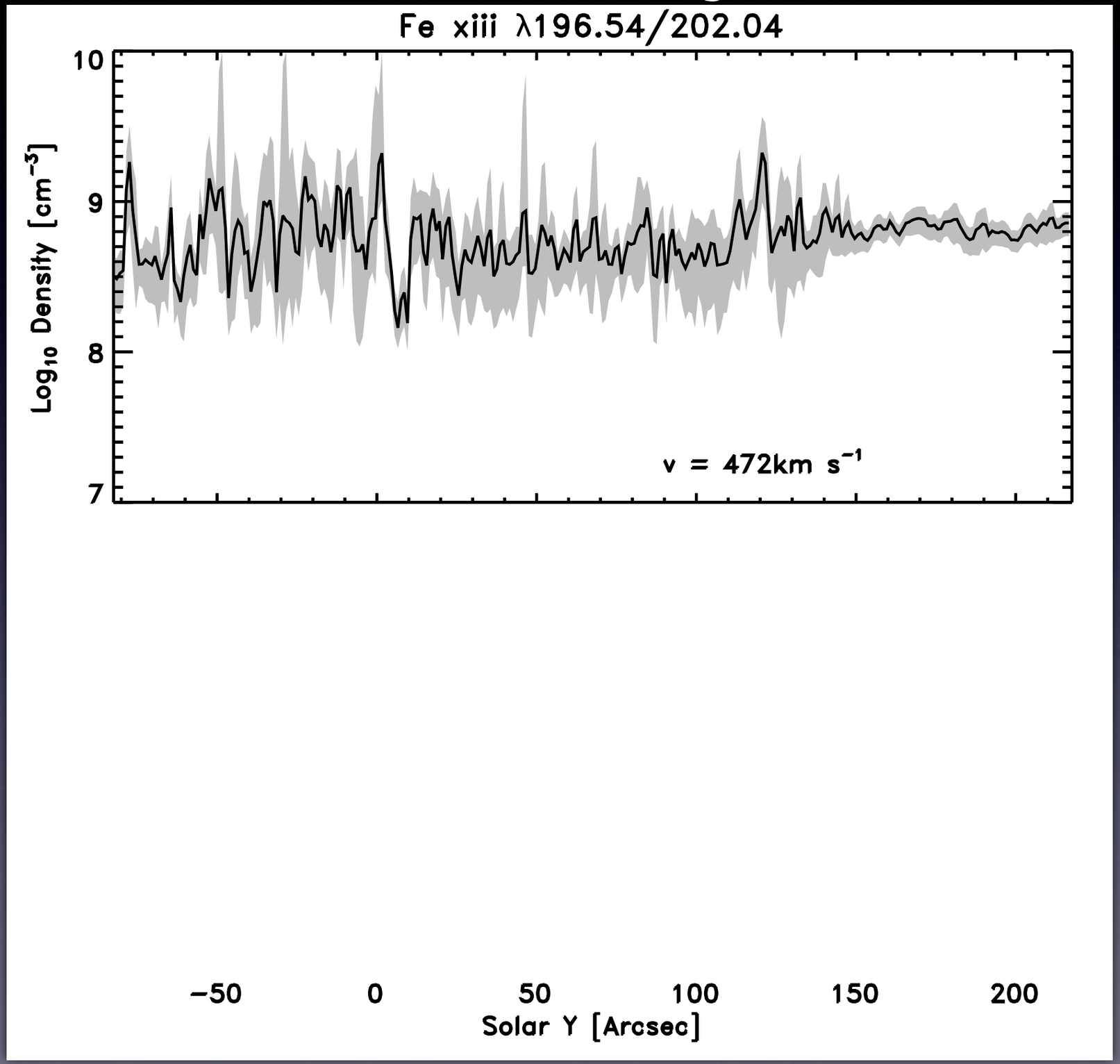
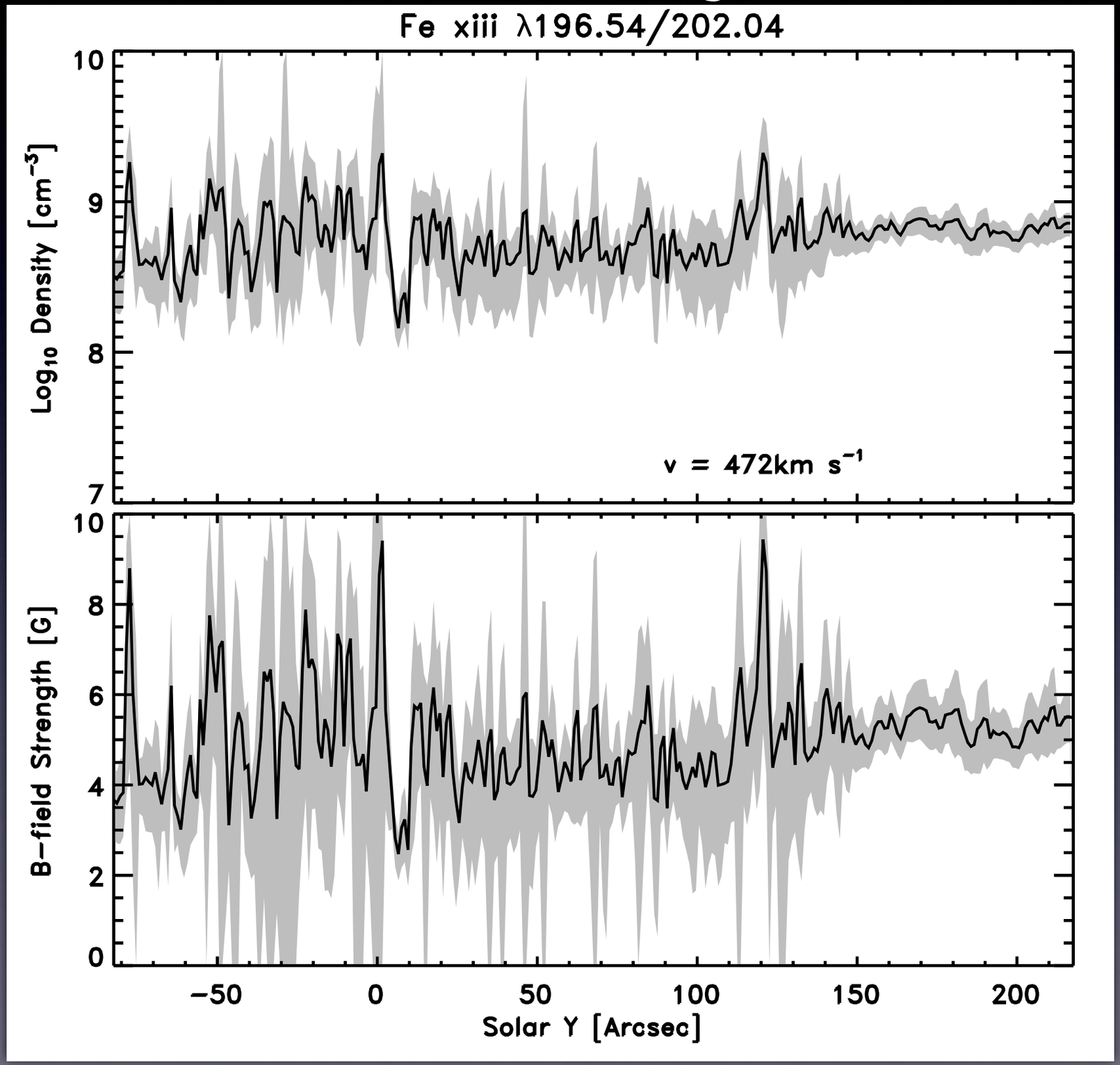
EIS analysis



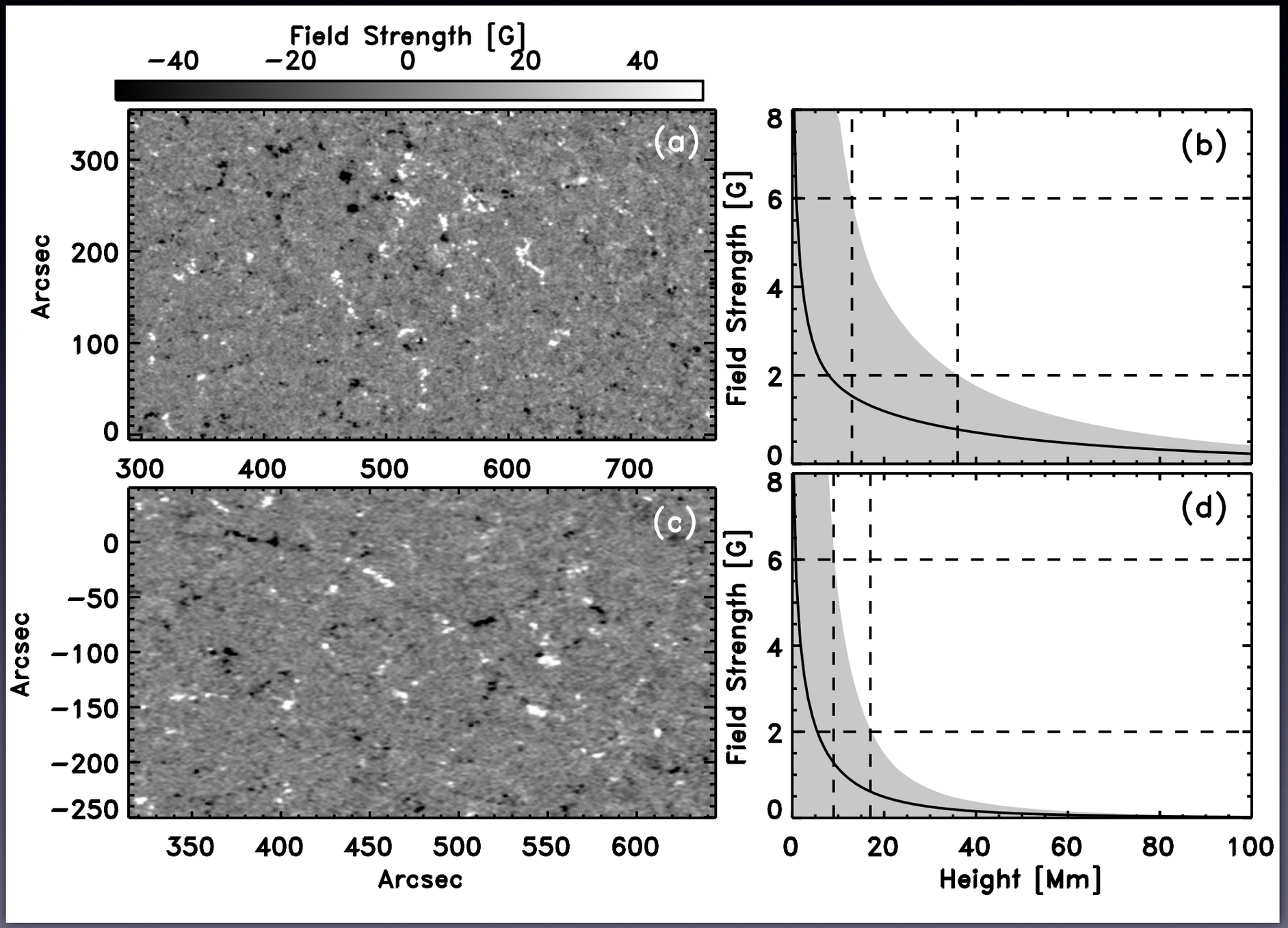
16-Feb-2011

EIS analysis



16-Feb-2011

Magnetic field; Quiet Sun



12-June-2010

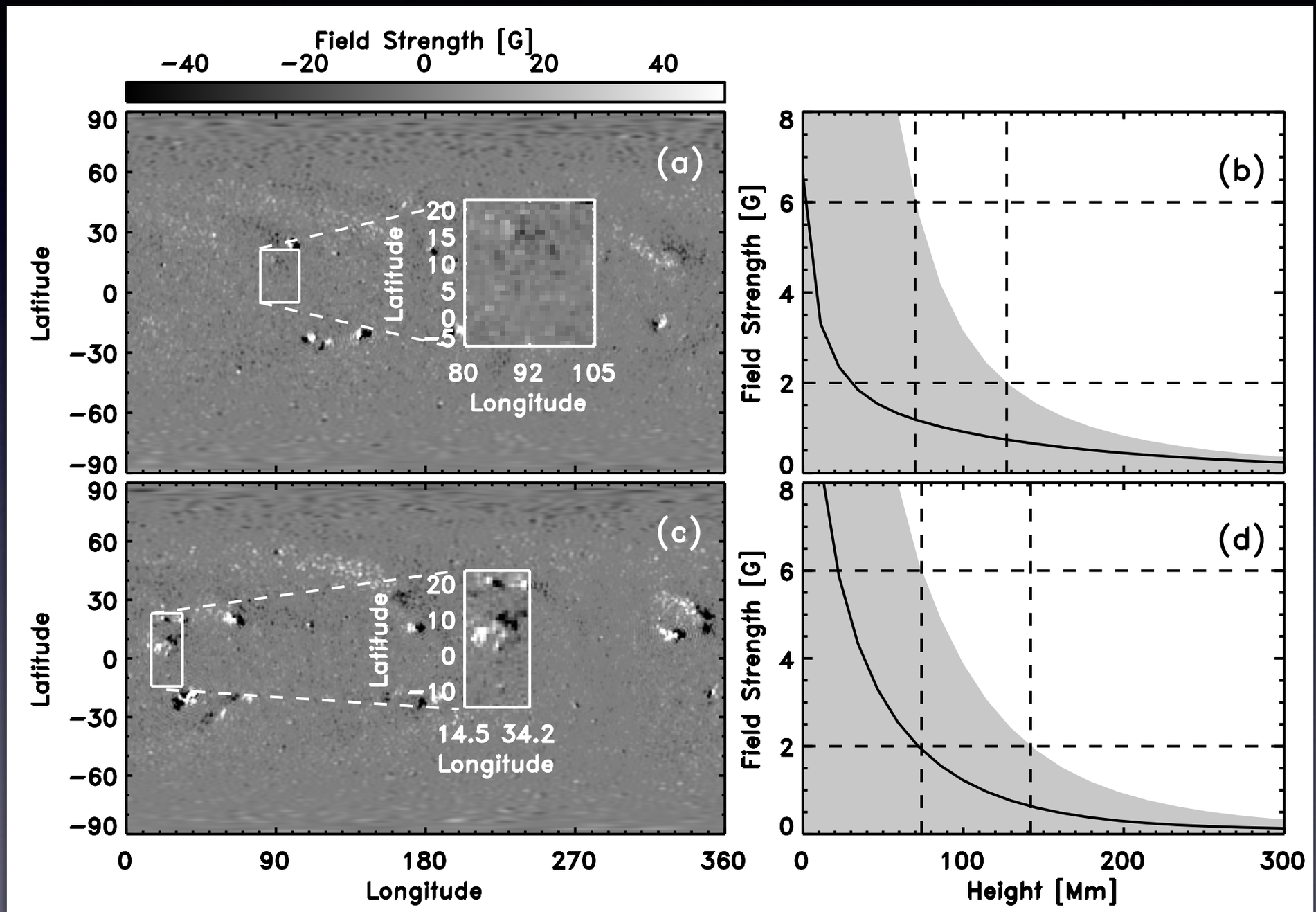
13-36 Mm

16-February-2011

9-17 Mm

(Régnier et al., 2008)

Magnetic field; PFSS



12-June-2010

70-128 Mm

16-February-2011

72-141 Mm

Conclusions

- Can use”EIT waves” to probe the magnetic field of the quiet corona

- Two “EIT Wave” events studied
  - Kinematics measured using automated approach (CorPITA)
  - Coronal densities inferred using EIS observations

- Both height and magnetic field measurements consistent with:
  - Global PFSS extrapolation
  - Previous results (cf. Patsourakos & Vourlidas, 2009; Kienreich et al., 2009)

- Able to estimate the magnetic field strength in the quiet corona
  - ~2 - 6 G