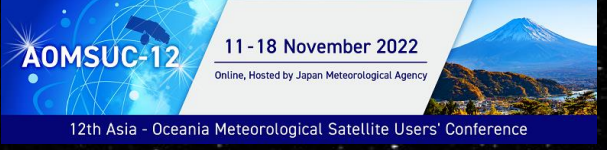


Three-dimensional Propagation of the Global Extreme-ultraviolet Wave Associated with a Solar Eruption on 2021 October 28

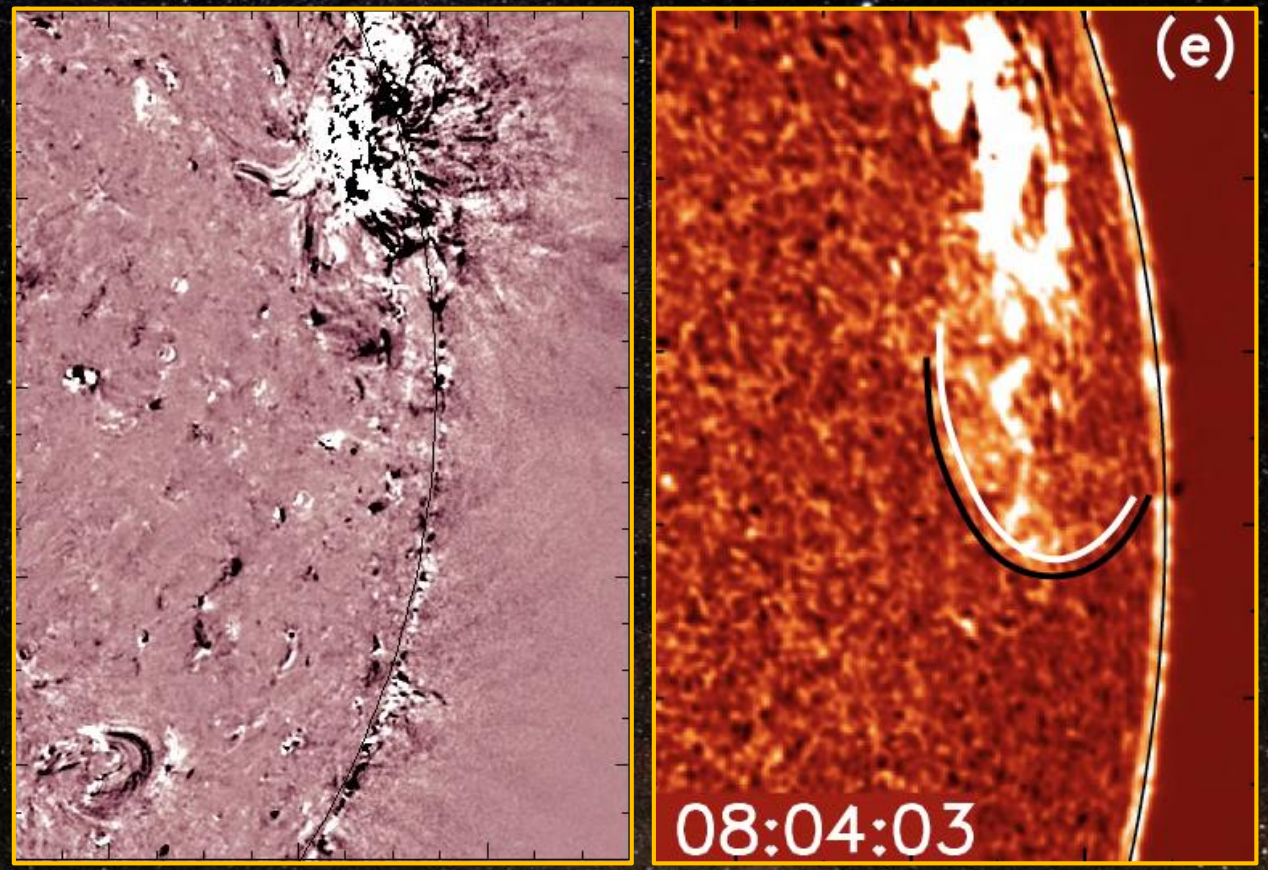
Zhenyong Hou (Peking University)

Hui Tian, Jing-Song Wang, Xiaoxin Zhang, Qiao Song, Ruisheng Zheng, Hechao Chen, Bo Chen, Xianyong Bai, Yajie Chen, Lingping He, Kefei Song, Peng Zhang, Xiuqing Hu, Jinping Dun, Weiguo Zong, Yongliang Song, Yu Xu, and Guangyu Tan

CONTENTS

Background

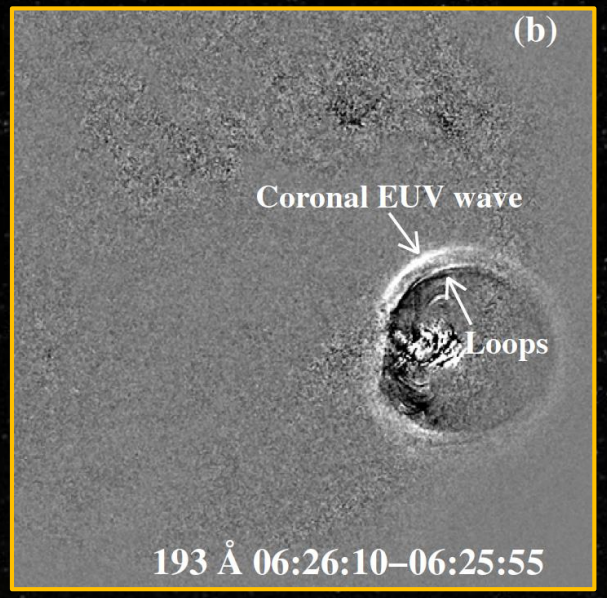
- **The EUV waves** appear as propagating bright or dark fronts in coronal EUV images
- Moreton-Ramsey Waves
- Propagating velocity: 200-700 km s^{-1}
- Deceleration: several hundred m s^{-2}
- Interaction with coronal structures
- Fast-mode MHD waves



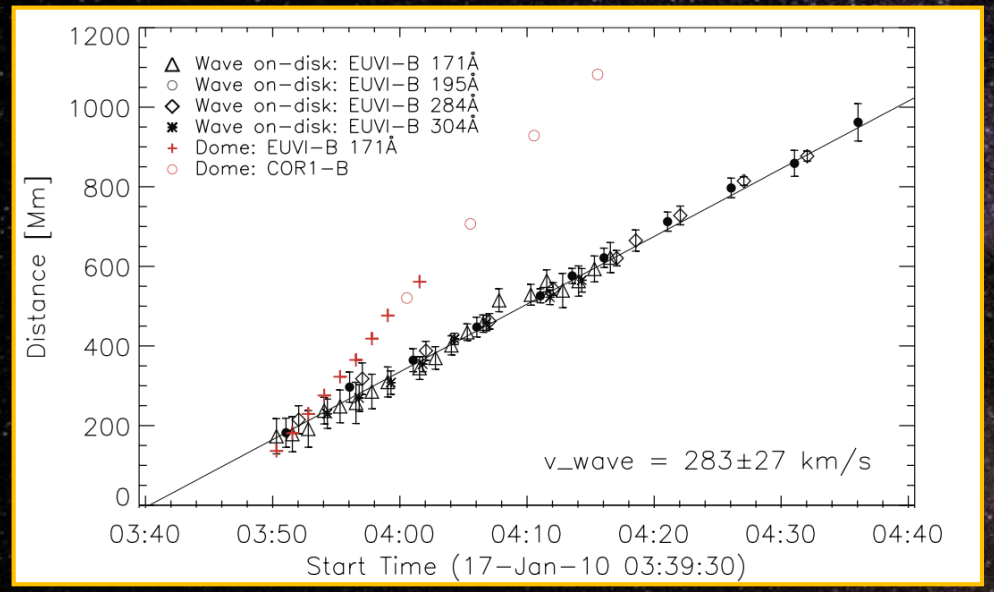
Shen et al. 2012, ApJL

Background

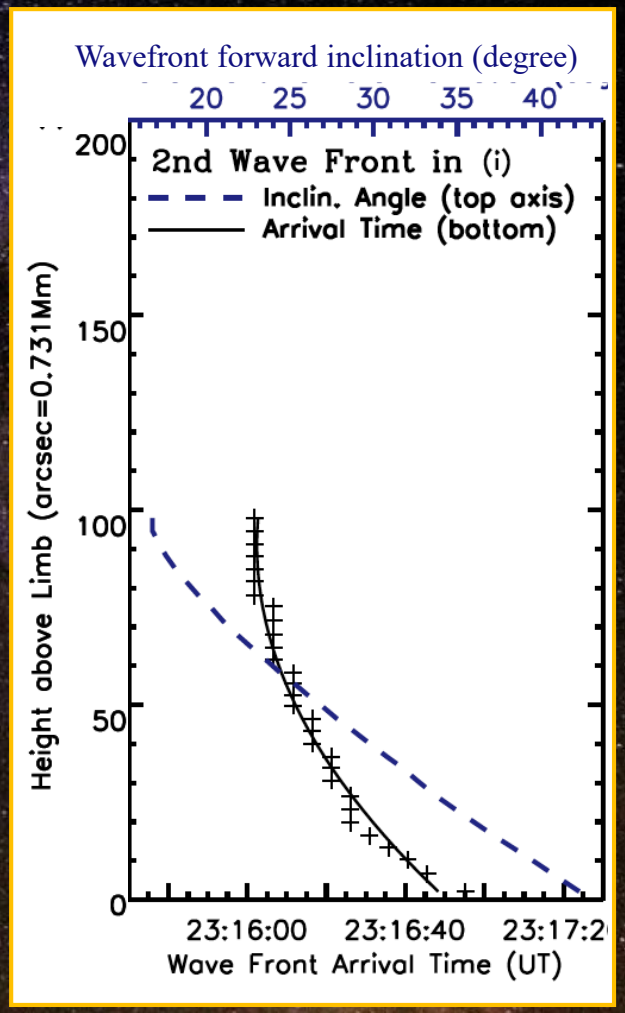
- Dome-shaped structure



Li et al 2012, ApJ



Veronig et al 2010, ApJL



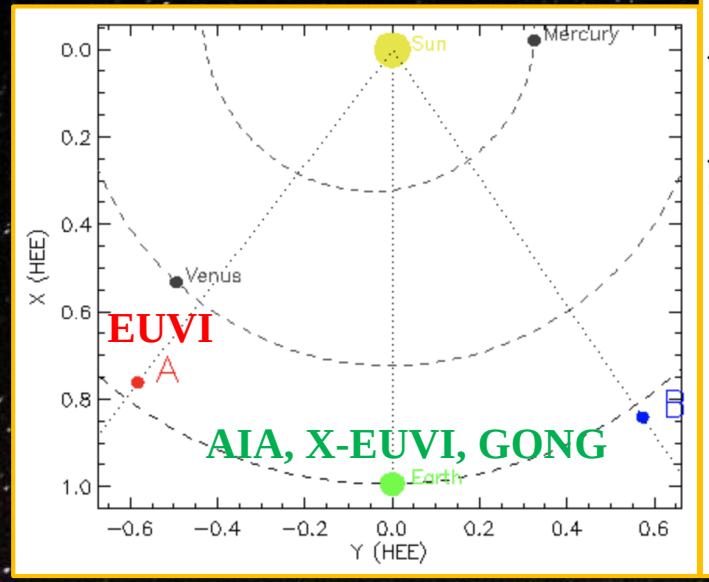
- **The wavefront propagates forwardly inclined toward the surface of the Sun**

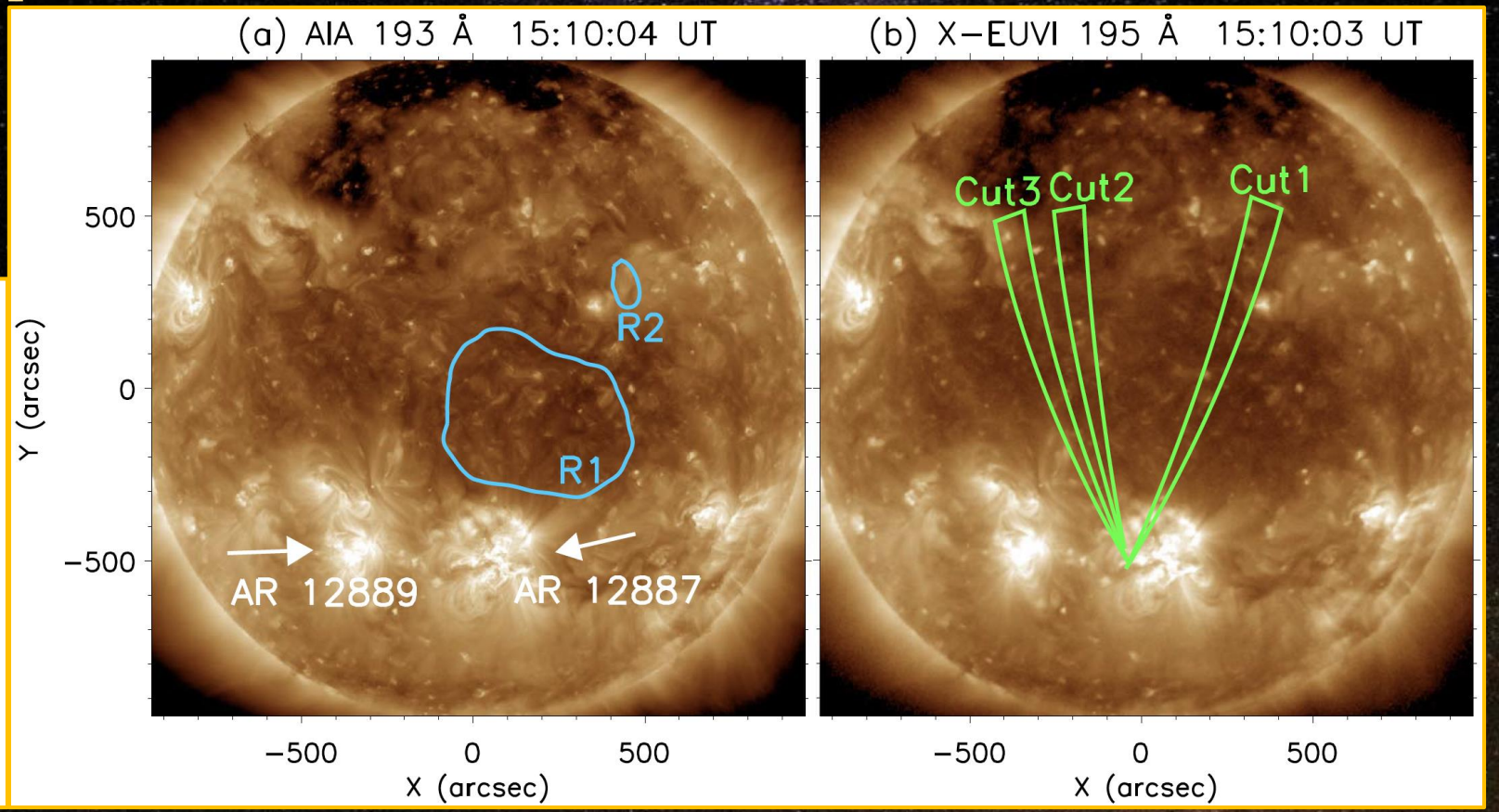
Liu et al 2012, ApJ

CONTENTS

Stereoscopic observations

- **AIA/SDO: 171, 193 Å**
- **X-EUVI/FY-3E: 195 Å**
- **X-EUVI/STEREO: 304, 195 Å**
- **GONG: Hα**
- Target: AR 12887
- Date: 2021-10-28

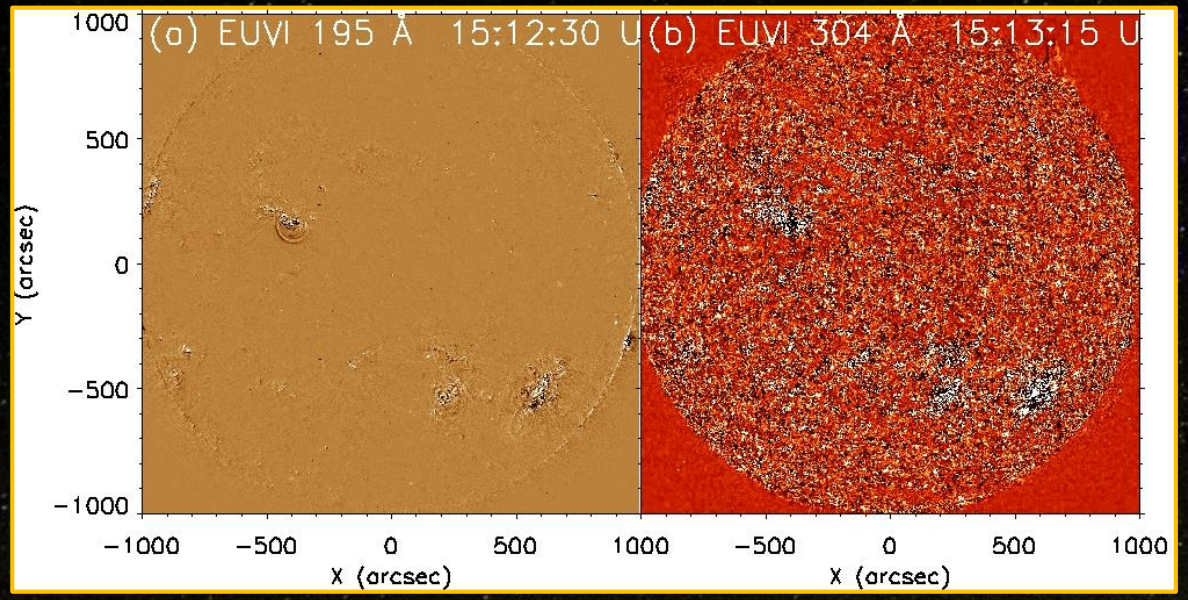


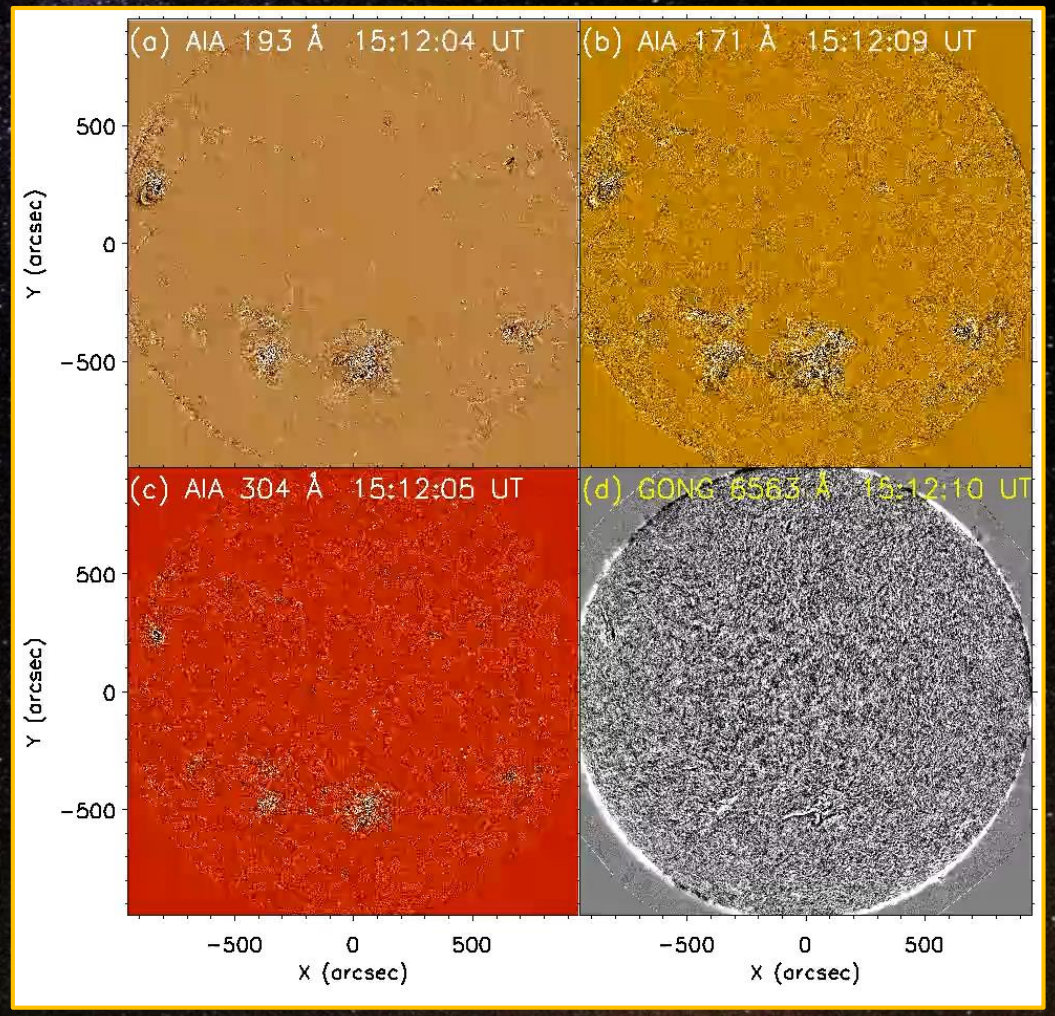


CONTENTS

Results: overview of the EUV Wave

- The morphological evolution of the global wave
- Related to an X1.0 flare and a Halo CME

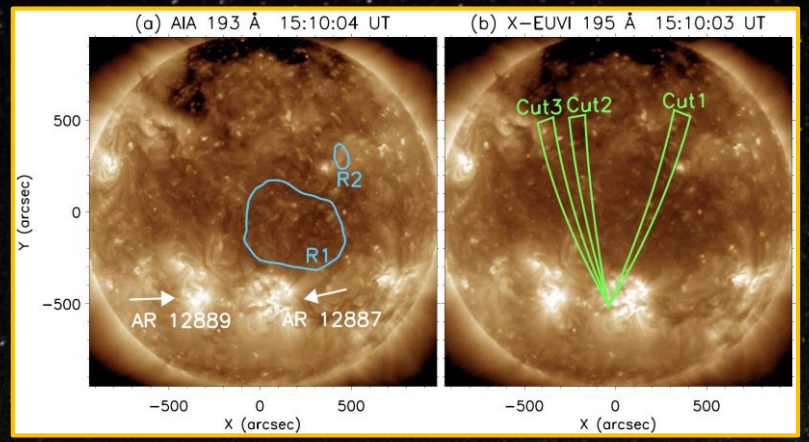


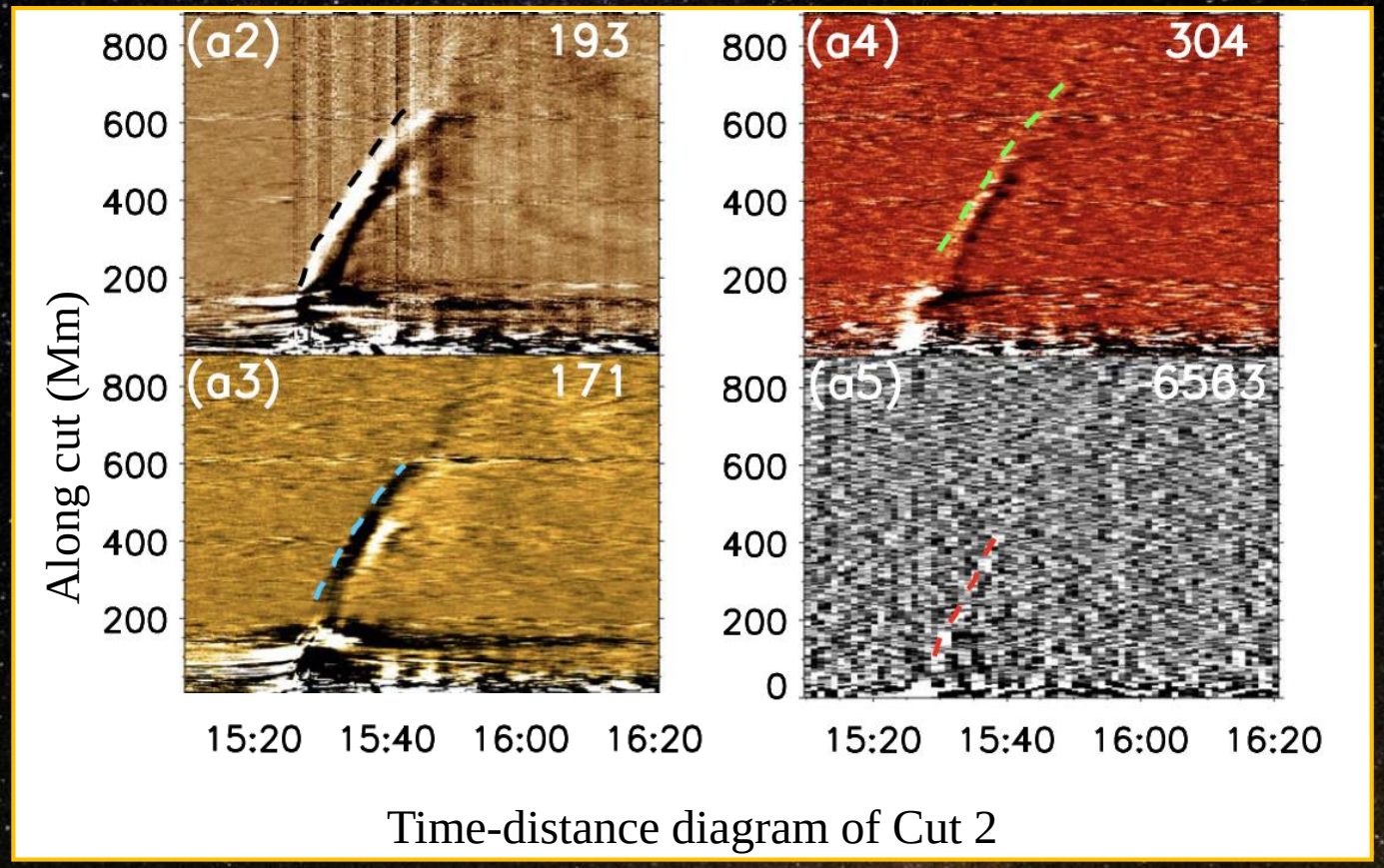


Results: propagation of the EUV Wave

- The propagation of the EUV Wave in AIA 193 Å, 171 Å, 304 Å and GONG Hα

- 150 Mm away from the eruption center
- The wavefront is bright in 193/195 Å and dark in 171 Å





Time-distance diagram of Cut 2

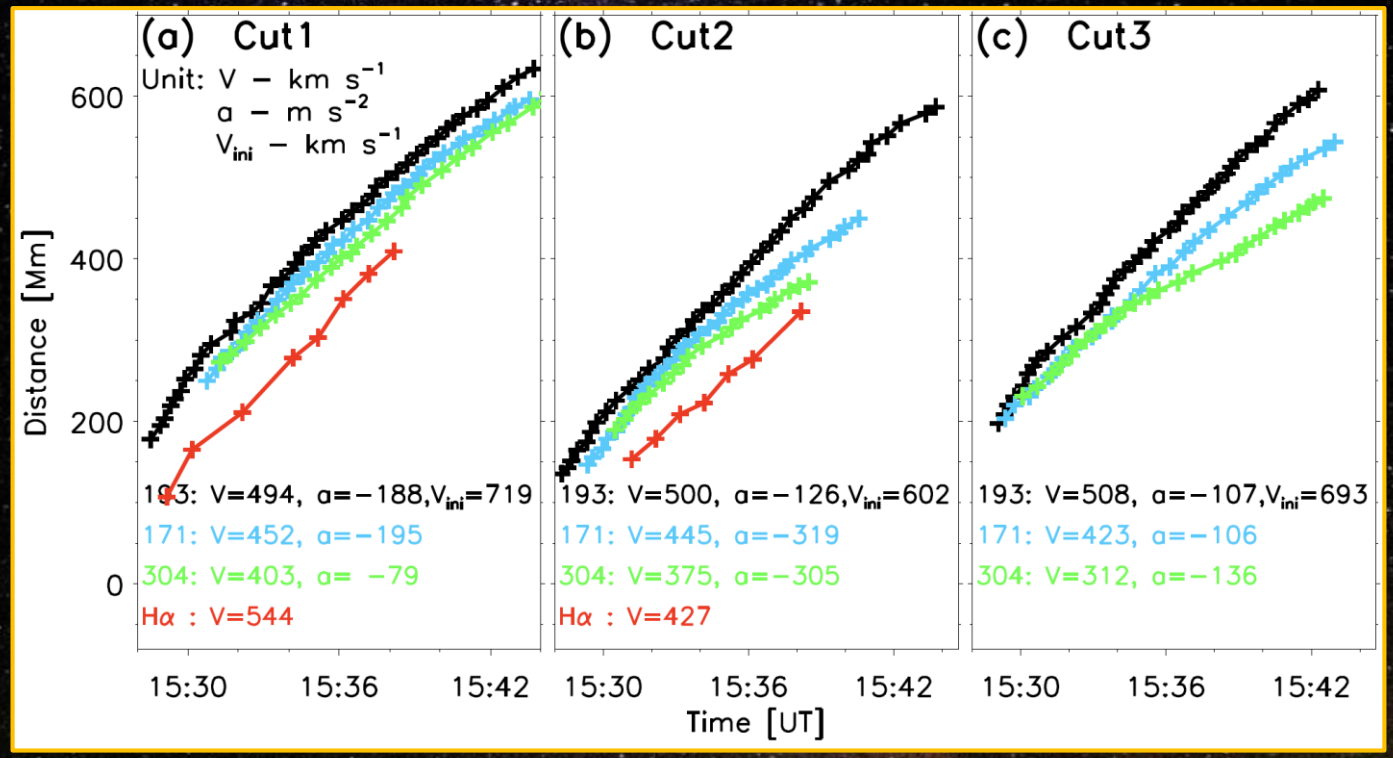
Results: propagation of the EUV Wave

In 193/195 Å and 171 Å

- Averaged propagating velocity: 420 – 510 km s^{-1}
- Deceleration: 110 – 320 m s^{-2}
- The initial propagating velocity: 600 – 720 km s^{-1}

In 304 Å and Hα

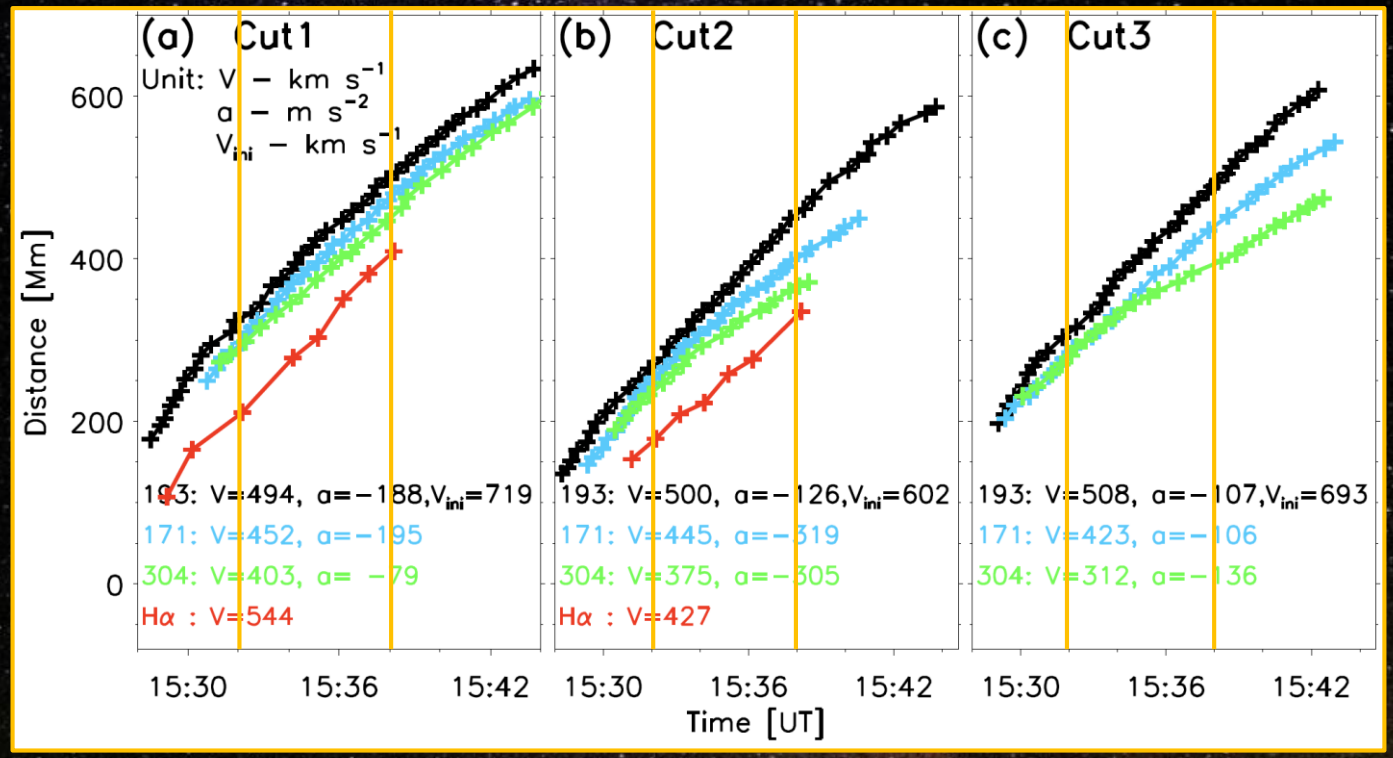
- Averaged propagating velocity: 310 – 540 km s^{-1}



Results: propagation of the EUV Wave

- **The propagating tracks in 193 Å significantly precede those in the other passbands with lower temperatures such as 304 Å and Hα**

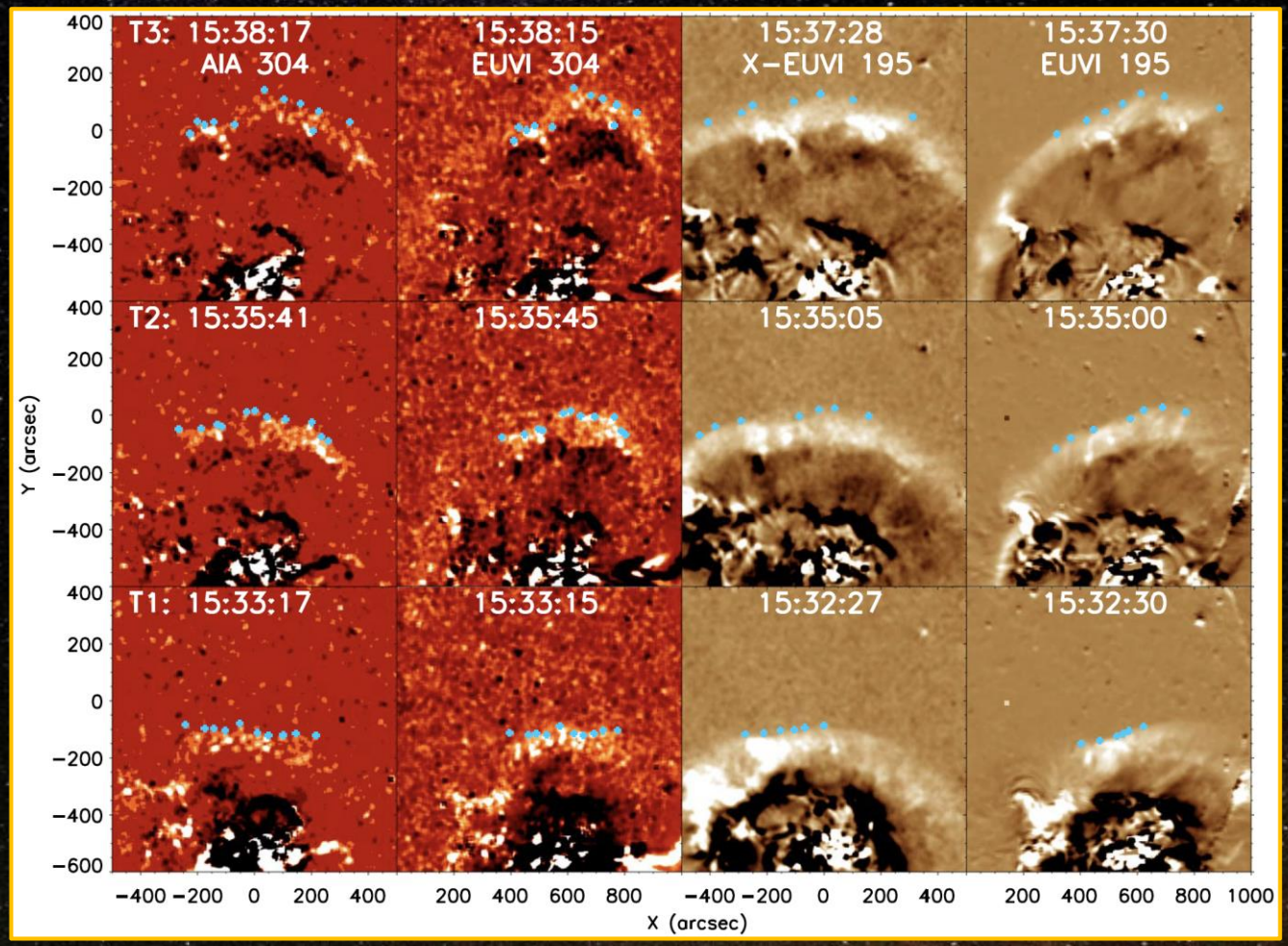
- The averaged difference in the 193 Å and 304 Å passbands is 50.5 Mm



Results: propagation of the EUV Wave

- scc_measure.pro
- Height: 3-4 Mm in 304 Å and 40-90 Mm in 195 Å
- The averaged height difference between the 195 Å and 304 Å passbands is 67.4 Mm

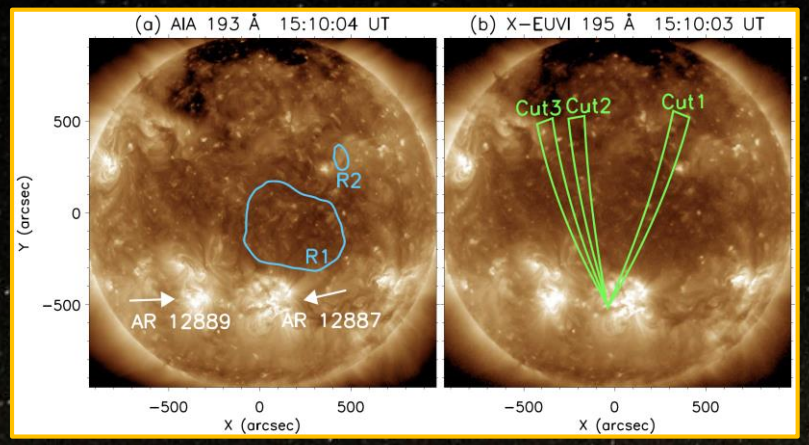
- The wavefront propagated forwardly inclined to the solar surface with an averaged tilt angle of arctan (67.4/50.5) = 53.2º in the time period of 15:32 – 15:38 UT

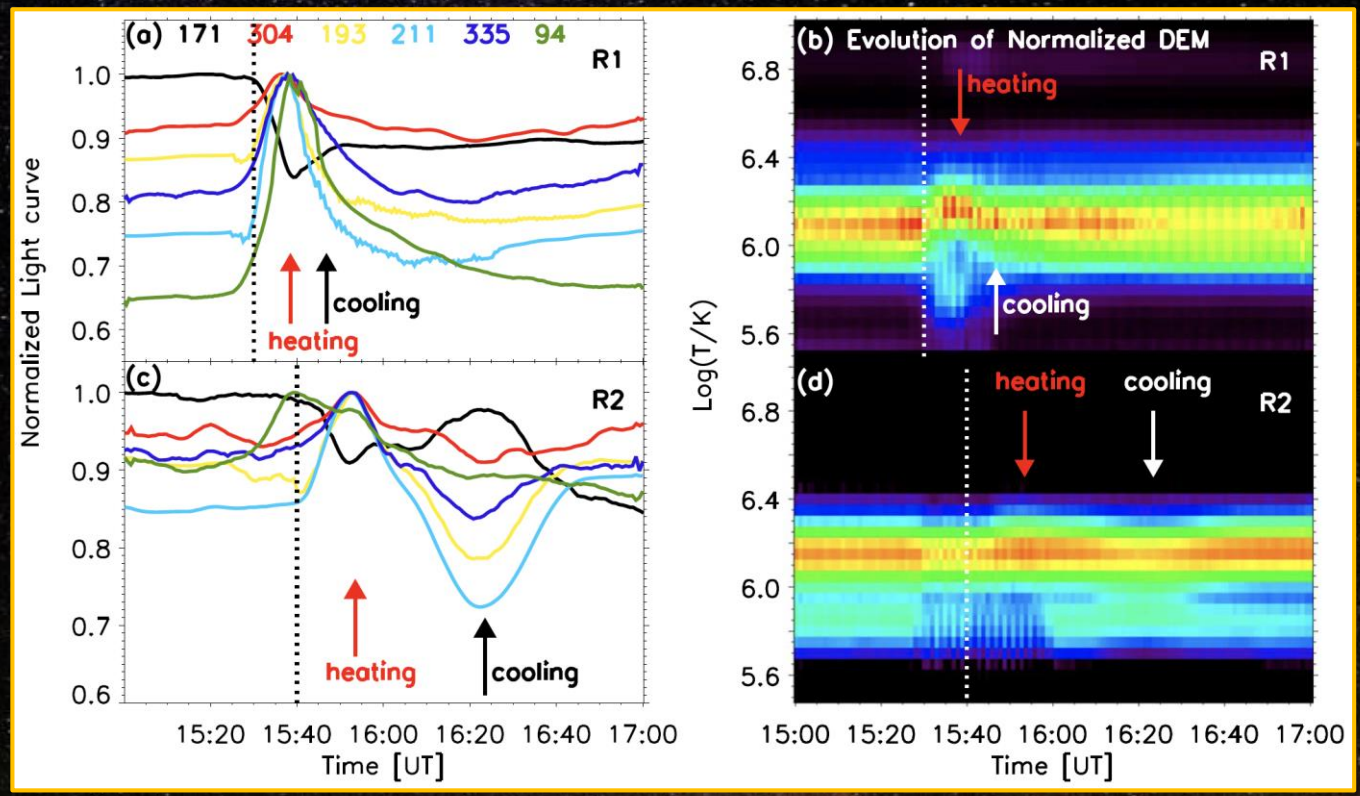


Results: heating of the Coronal Plasma

- **Heating:** Intensities in 193/211/335/94 Å and DEM (log(T/K)~6.2) all increase, while the 171 Å and DEM (log(T/K)~5.9) intensity decreases

- **Cooling:** The 193/211/335/94 Å and DEM (log(T/K)~6.2) intensities begin to decrease and the 171 Å and DEM (log(T/K)~5.9) intensity increases





CONTENTS

Summary

- The EUV wave is associated with an X1.0 flare and a halo CME, and appears in the Hα and EUV passbands with different characteristic temperatures (e.g., 304 Å, 171 Å, and 193/195 Å).
- The EUV wave becomes evident at a distance of ~150 Mm away from the eruption center and propagates circularly outward with an initial velocity of 600–720 km s^{-1} and a significant deceleration of 110–320 m s^{-2}.
- During the propagation of the EUV wave, the wave front propagates forwardly inclined to the solar surface with a tilt angle of ~53.2º. **A dome-shaped structure**.
- The plasma in the low corona is heated from log(T/K) ≈ 5.9 to log (T/K) ≈ 6.2 on the propagation path of the wave front.
- **A fast-mode MHD wave or shock driven by the expansion of its associated CME.**


THANKS