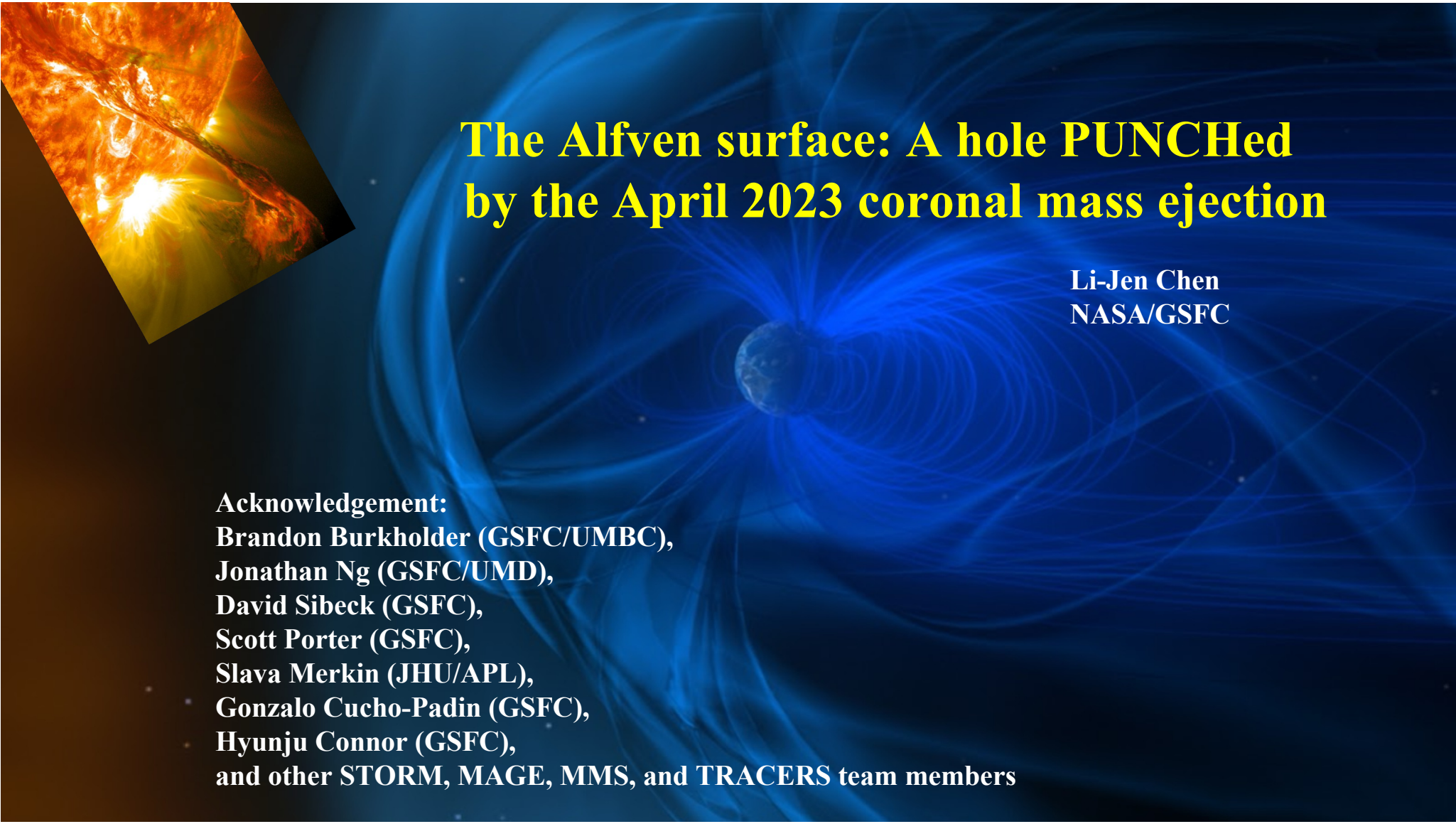




The Alfven surface: A hole PUNCHed by the April 2023 coronal mass ejection

Li-Jen Chen
NASA/GSFC

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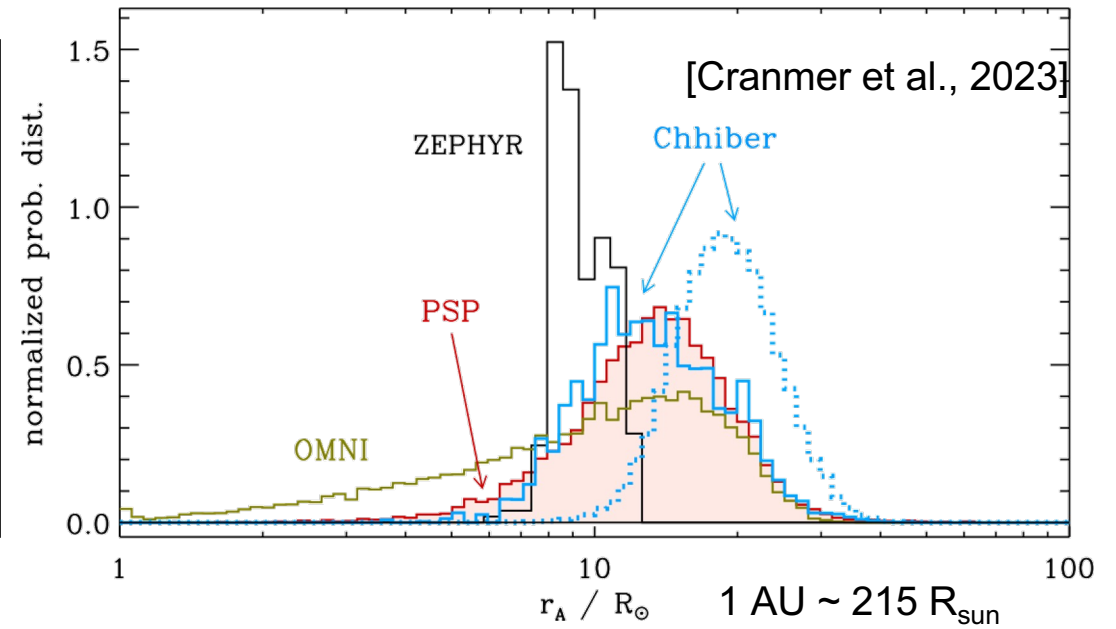
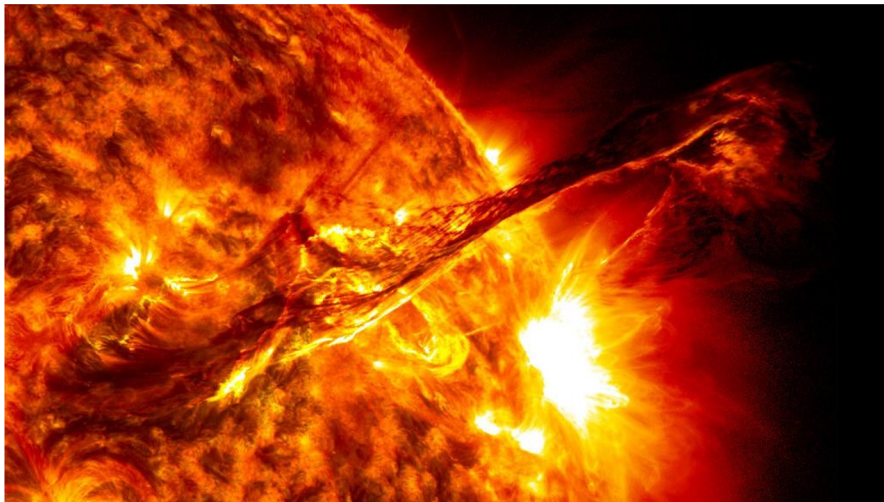
Slava Merkin (JHU/APL),

Gonzalo Cucho-Padin (GSFC),

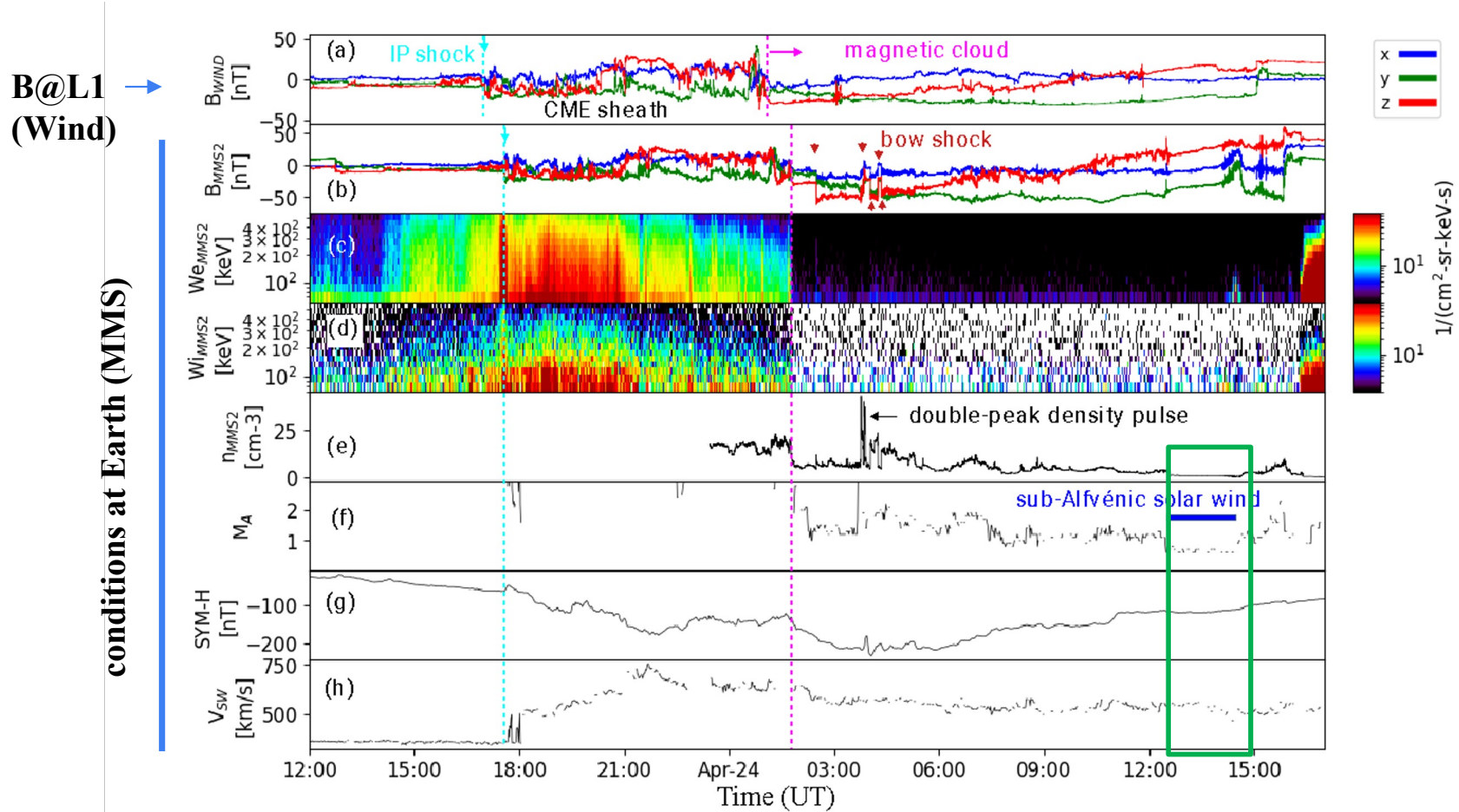
Hyunju Connor (GSFC),

and other STORM, MAGE, MMS, and TRACERS team members

The April 2023 CME PUNCHED a hole in the Alfven surface and took it to 1 AU

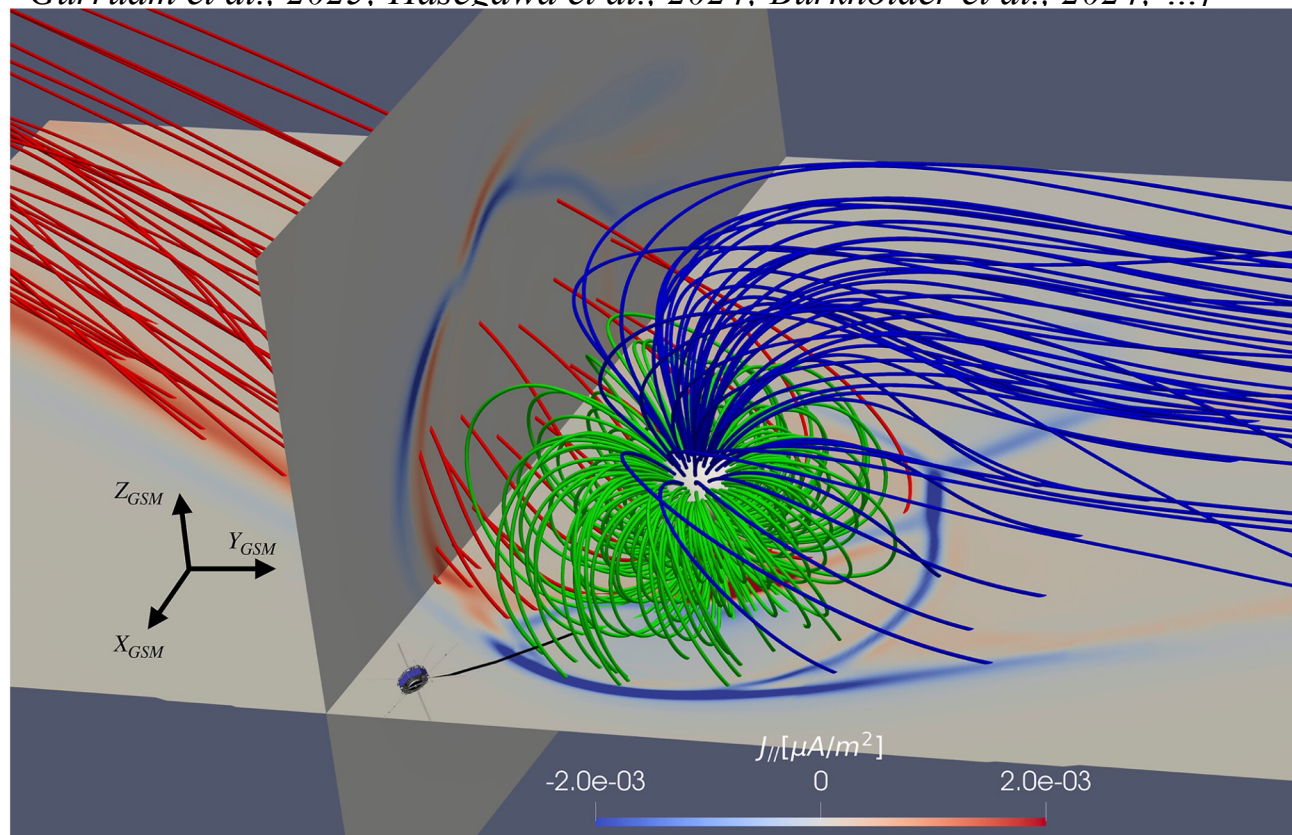


Sub-Alfvénic solar wind in CME transformed Earth's magnetosphere



$V_{sw} < V_A$ Sun's CME field lines reconnect with our magnetosphere **with wings**

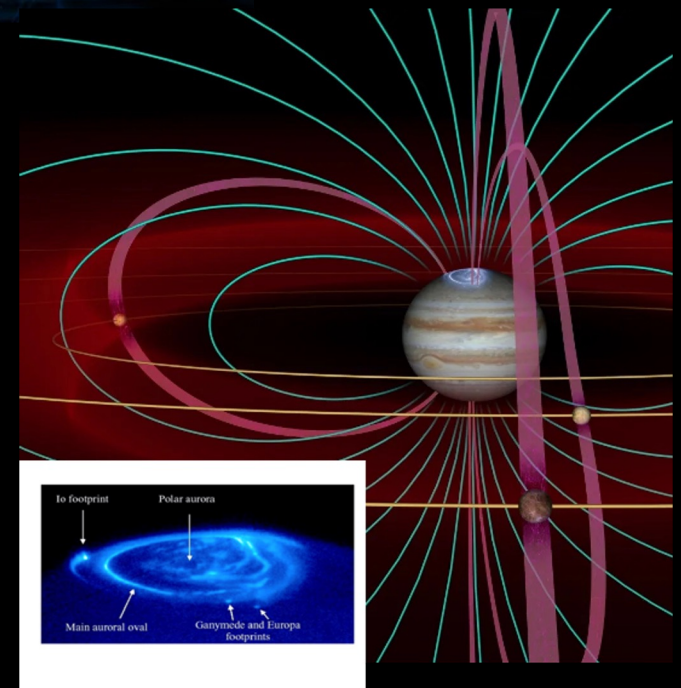
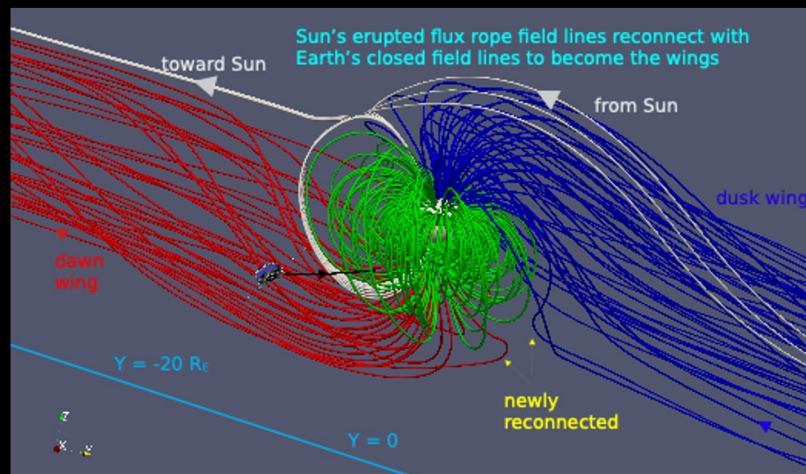
Earth's Alfvén wings driven by the April 2023 CME [Chen et al., 2024; Beedle et al., 2024; Gurruam et al., 2025; Hasegawa et al., 2024; Burkholder et al., 2024; ...]



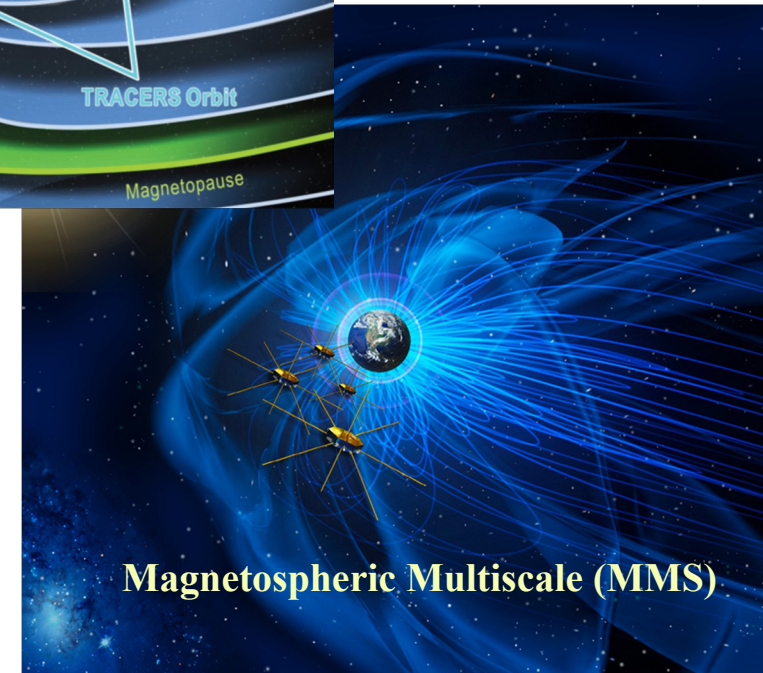
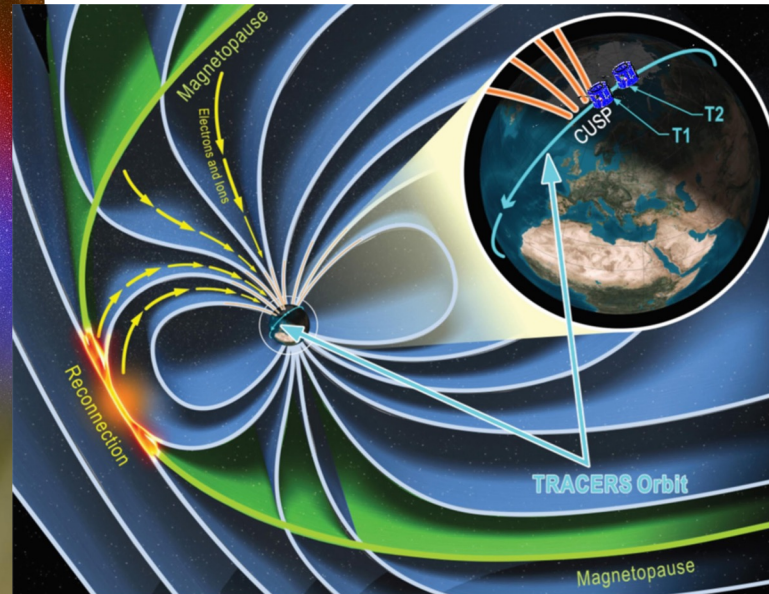
If stellar wind is super-Alfvenic



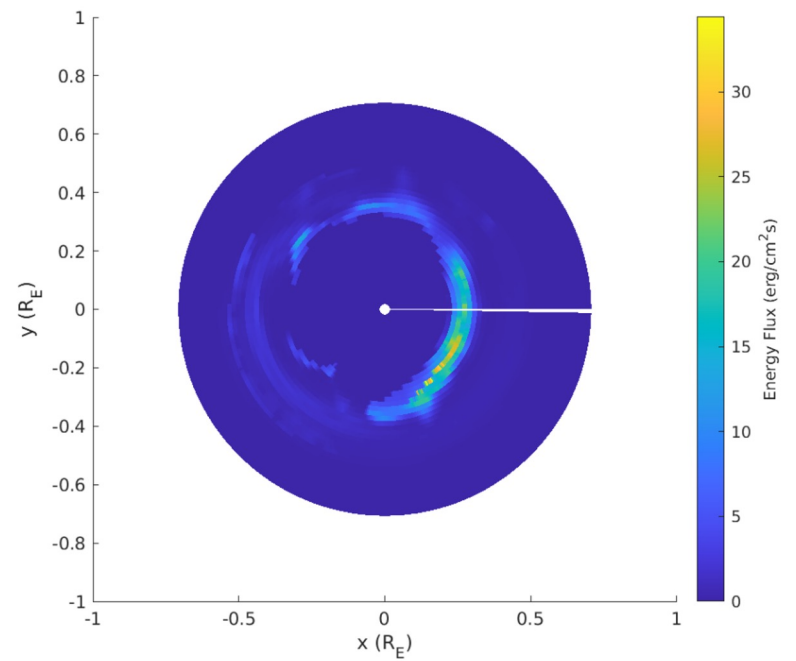
If stellar wind is sub-Alfvenic



CME field lines connecting with Earth's polar ionospheres



What will PUNCH see? Sub-Alfvenic CME solar wind
April 2023 Alfven
wing aurora

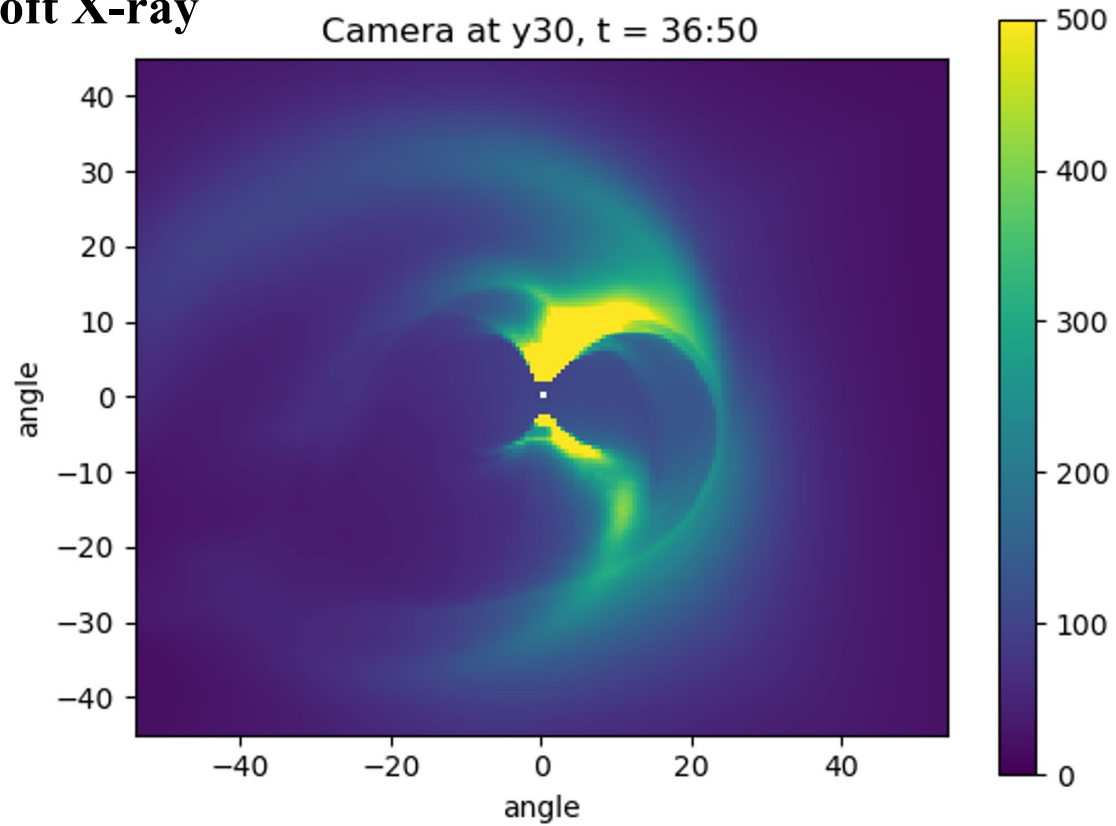


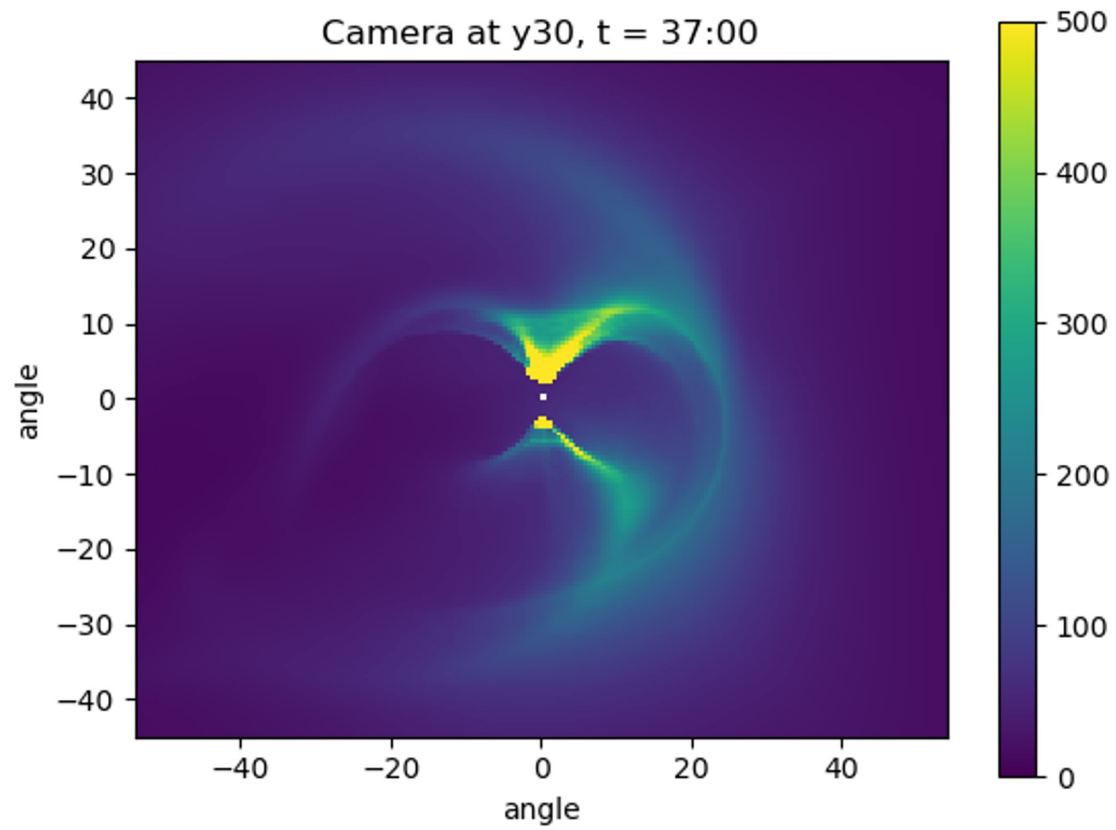
What will PUNCH see?

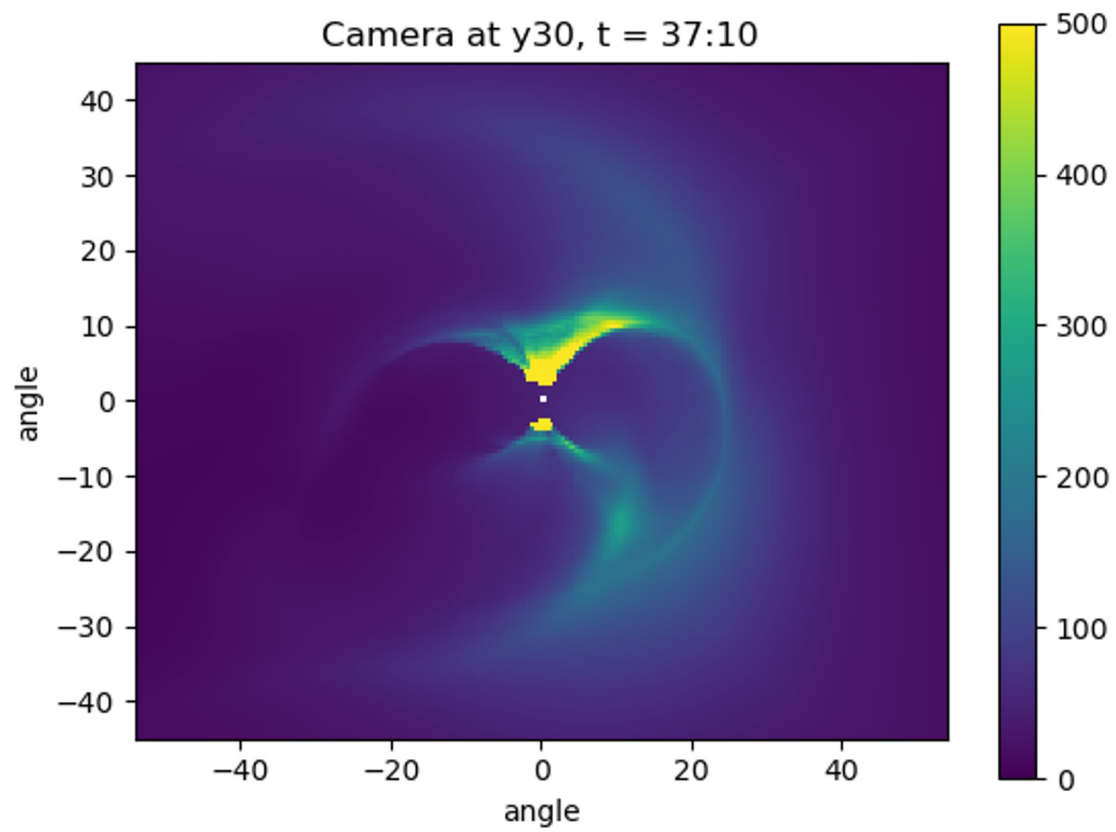
Sub-Alfvenic CME solar wind

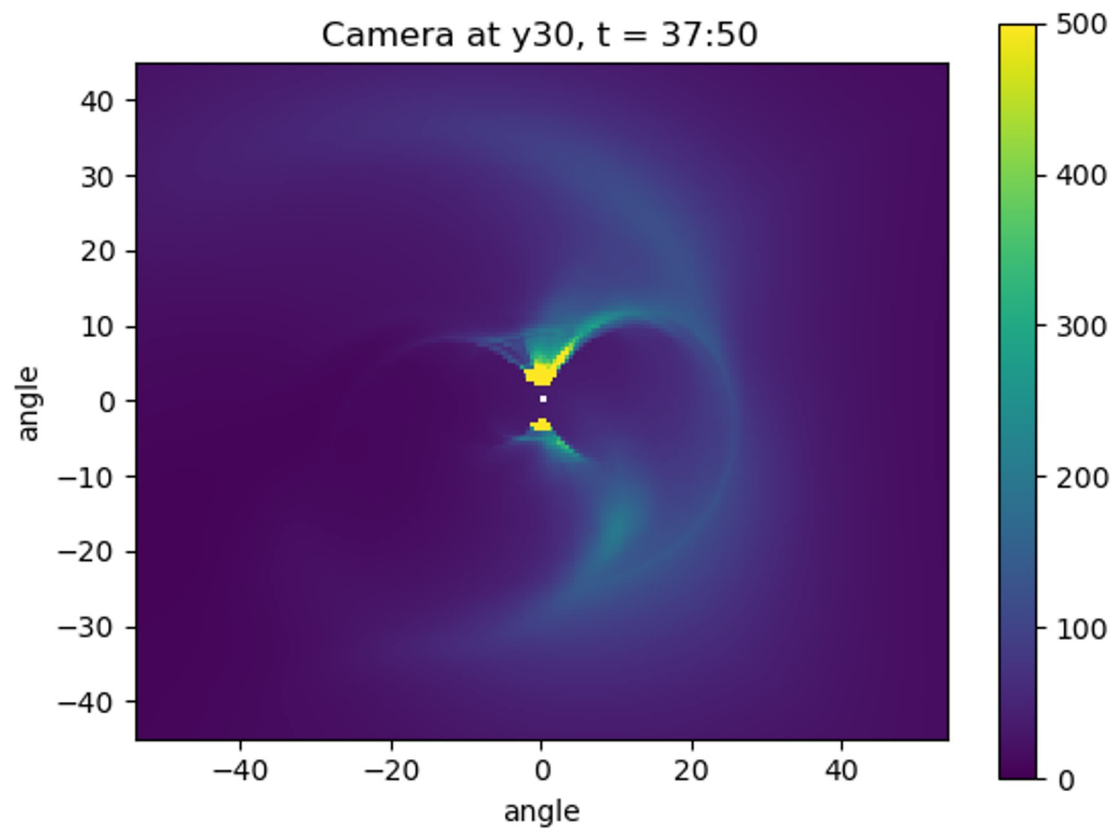
soft X-ray

Camera at y30, t = 36:50







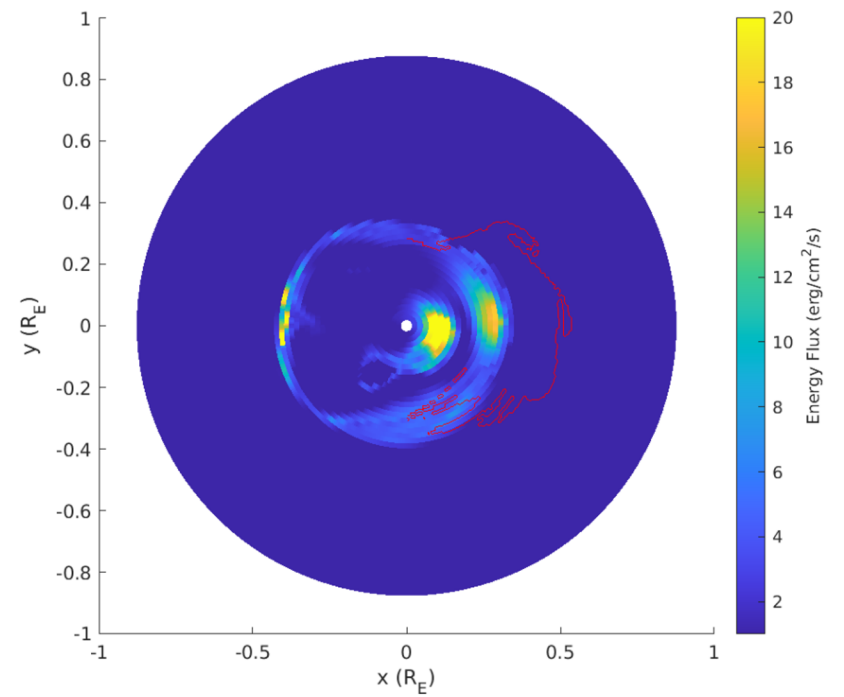
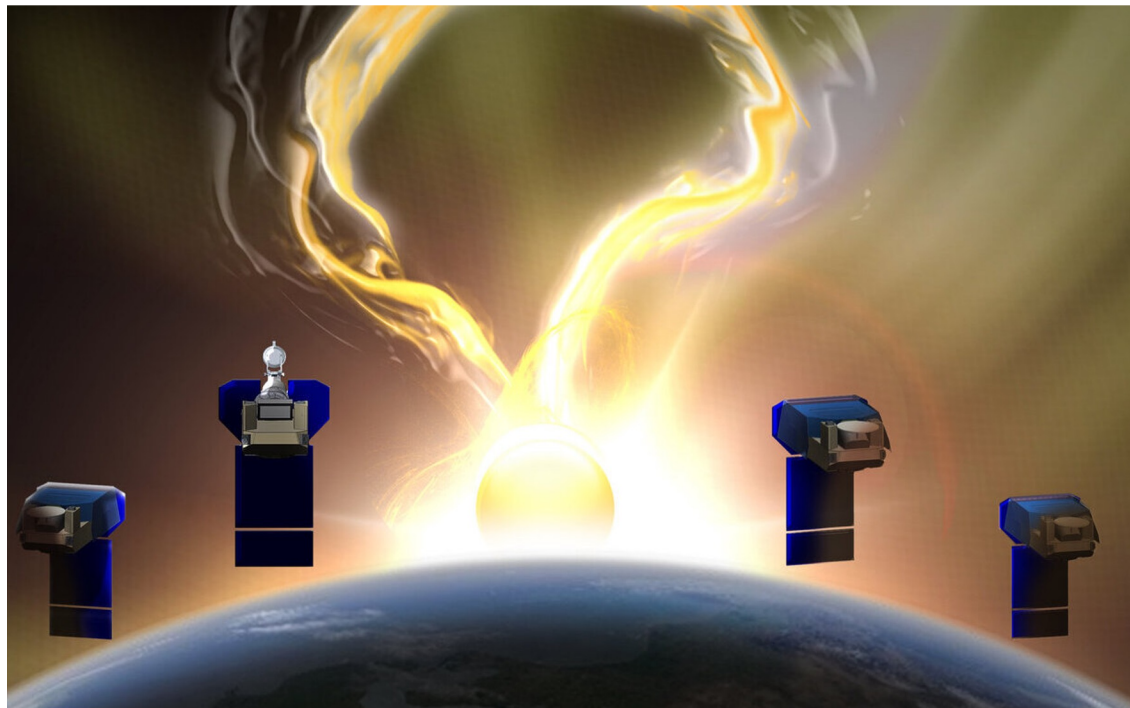


What will PUNCH see? IP shock arrival

May 2024 CME

shock

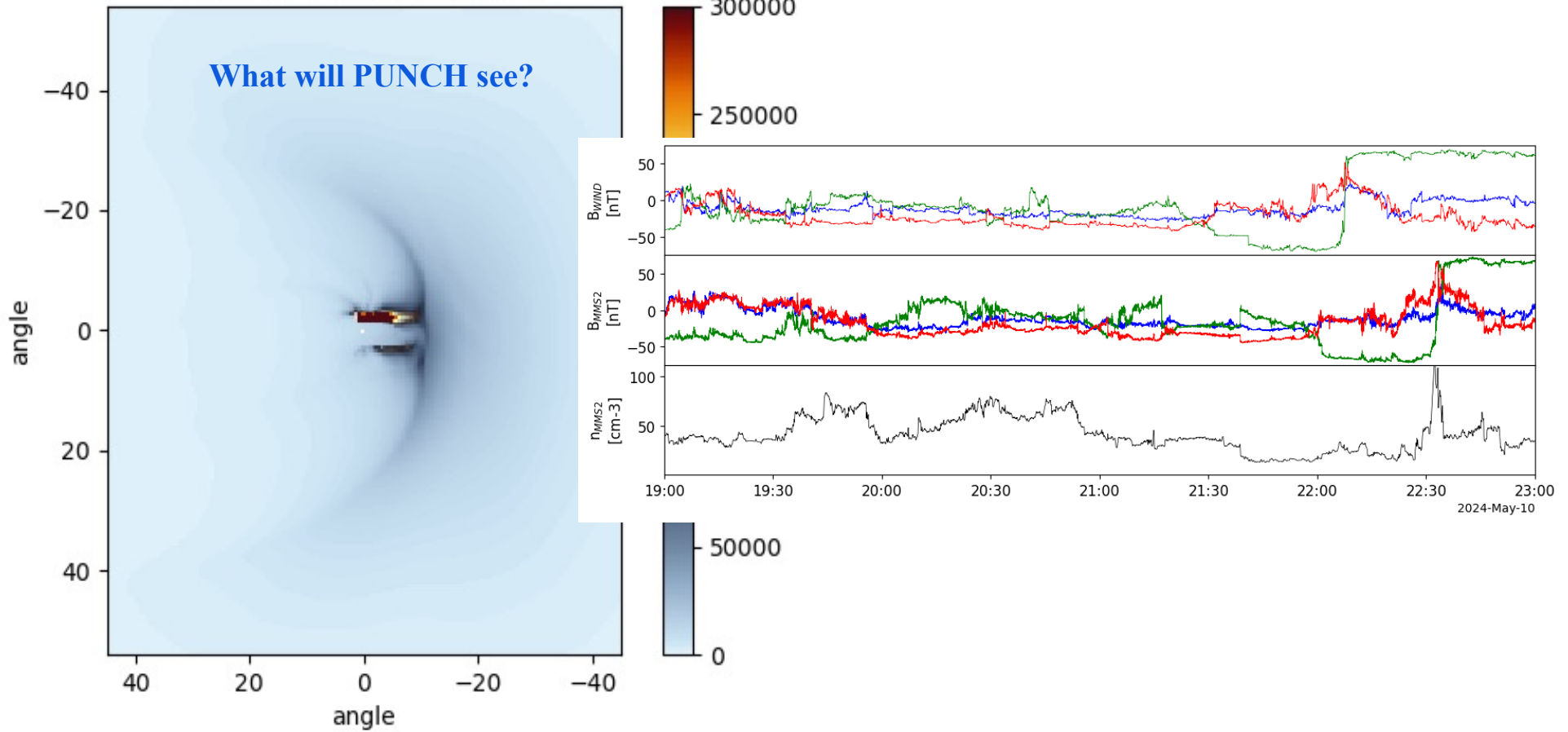
aurora



May 2024 CME impact on the dayside magnetopause and cusps

soft X-ray

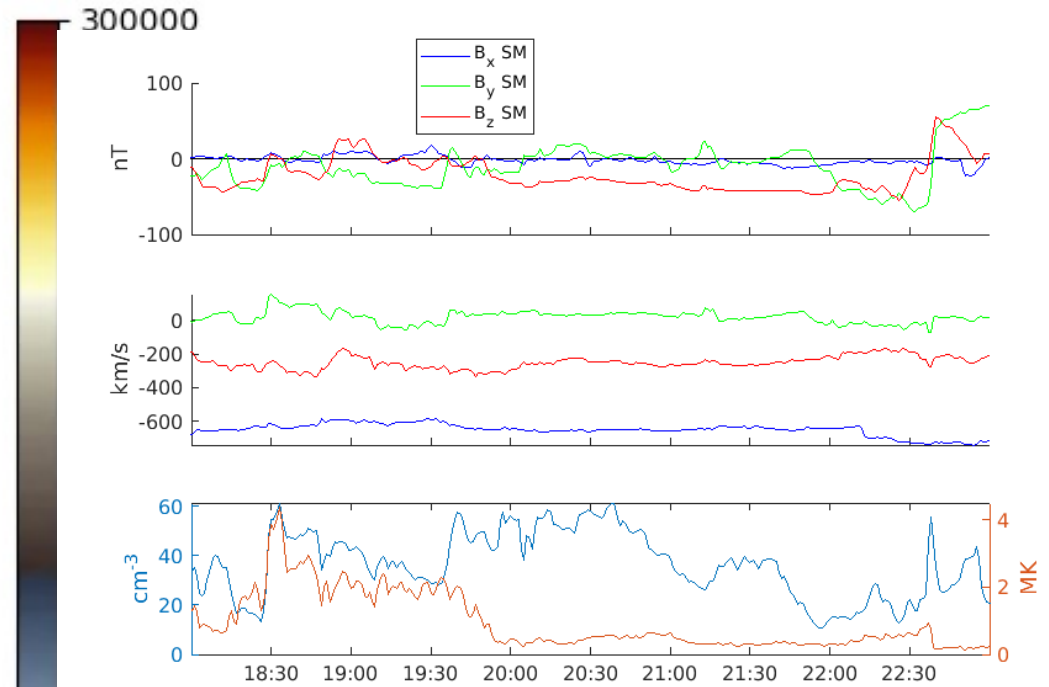
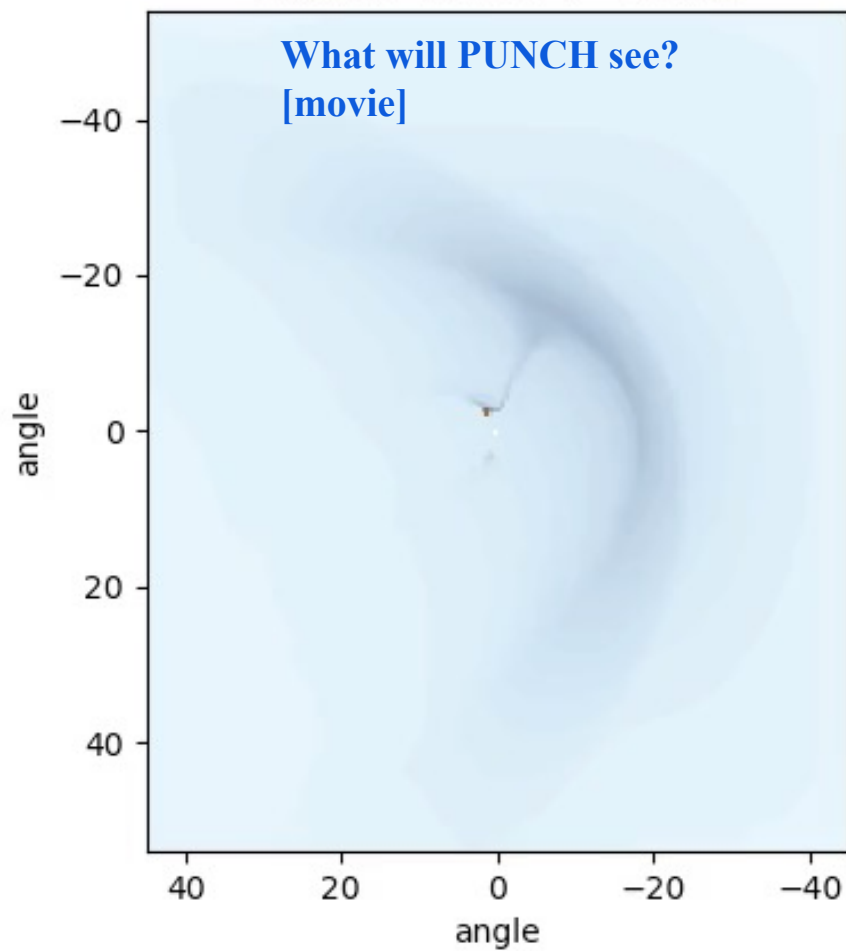
Camera at y30, t = 22:33



May 2024 CME impact on the dayside magnetopause and cusps

soft X-ray

Camera at y30, t = 16:40



PUNCH will empower humanity to grasp star-(exo)planet interaction!

