NuSTAR obs of a quiet Sun minifilament eruption

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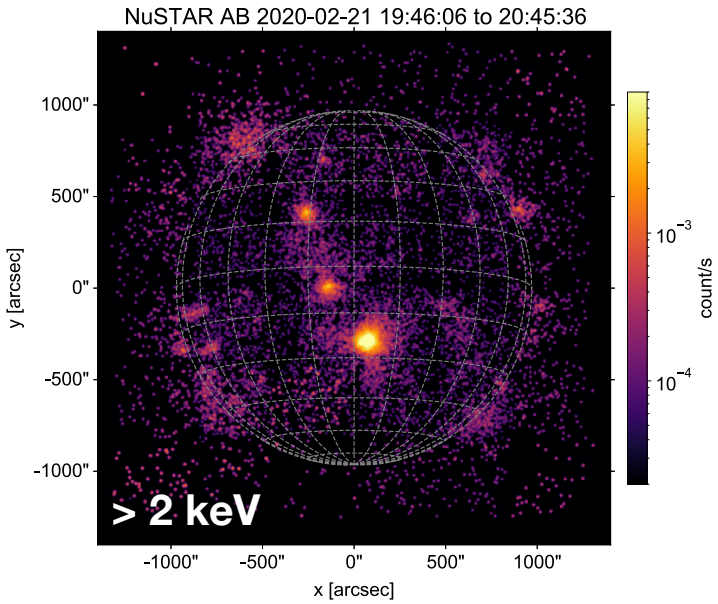
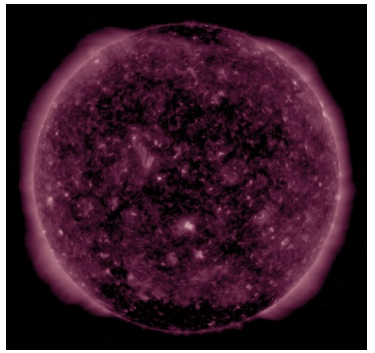
Introduction

- **Nature of Quiet Sun (QS) energy release**
  - "Flare-like" processes with heating >5 MK, >10MK, particle acceleration?
- **A sensitive hard X-ray (HXR) telescope could detect this weak bremsstrahlung emission**
  - NuSTAR direct focussing imaging spectrometer > 2keV, 12'x12' FoV
- **NuSTAR observed QS during recent solar minimum (09/2018 -09/2020)**
  - In sit+stare or full-disk 5x5 mosaic modes
  - Summary of all NuSTAR quiet and active Sun obs: http://ianan.github.io/nsovr/

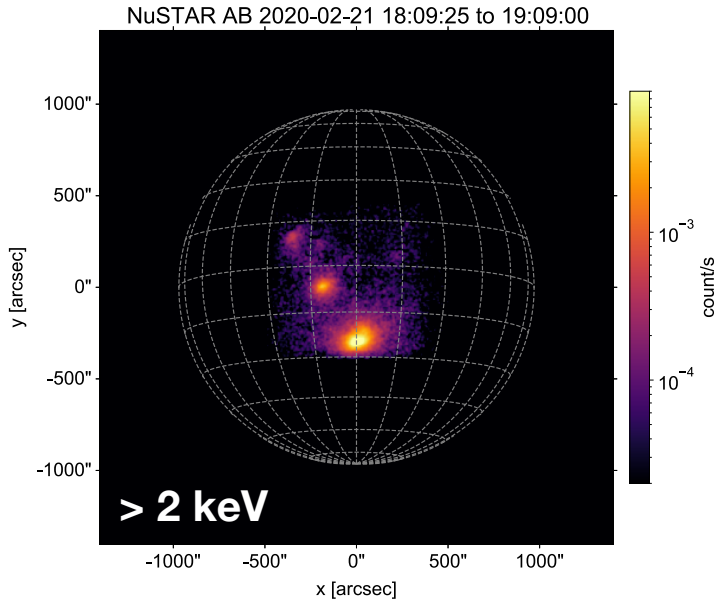


Feb 2020
~1hr mosaic
(25x100s tiles)

Feb 2020
~1hr sit+stare

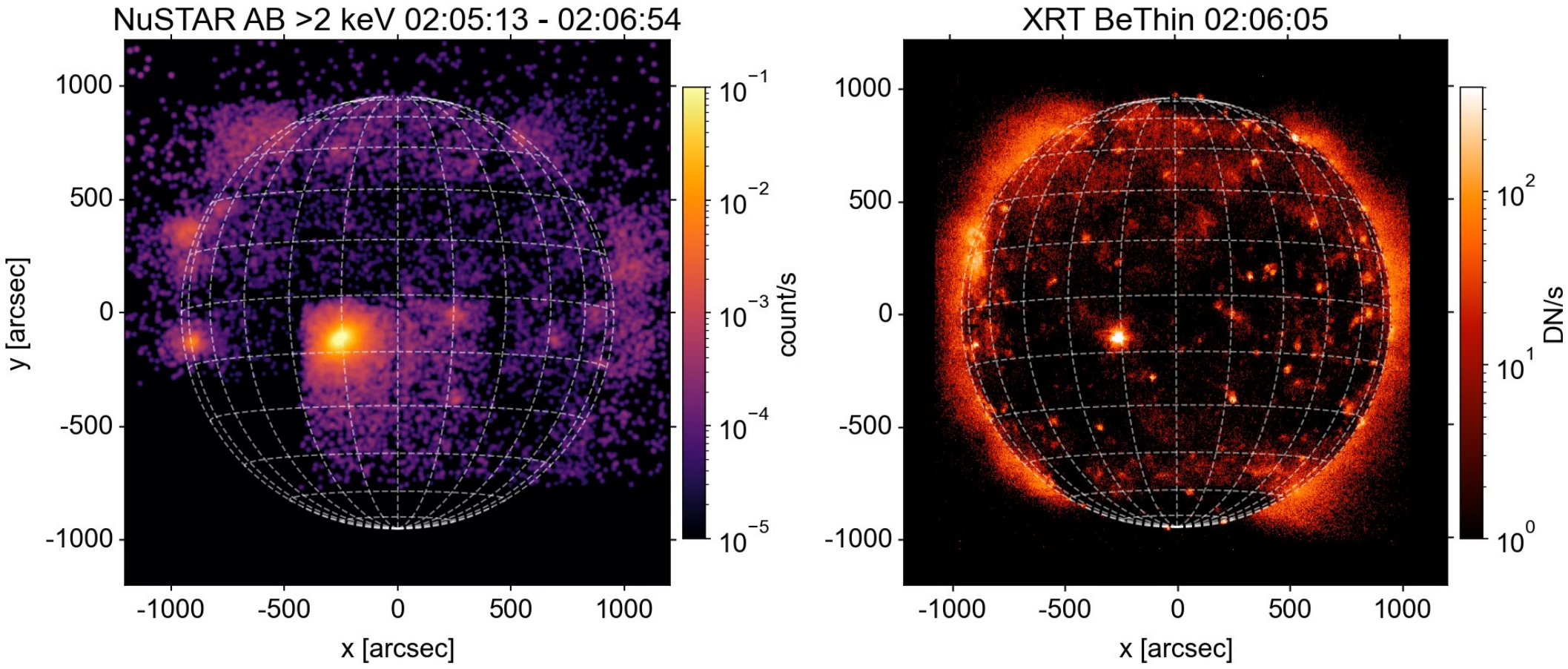


AIA 211Å



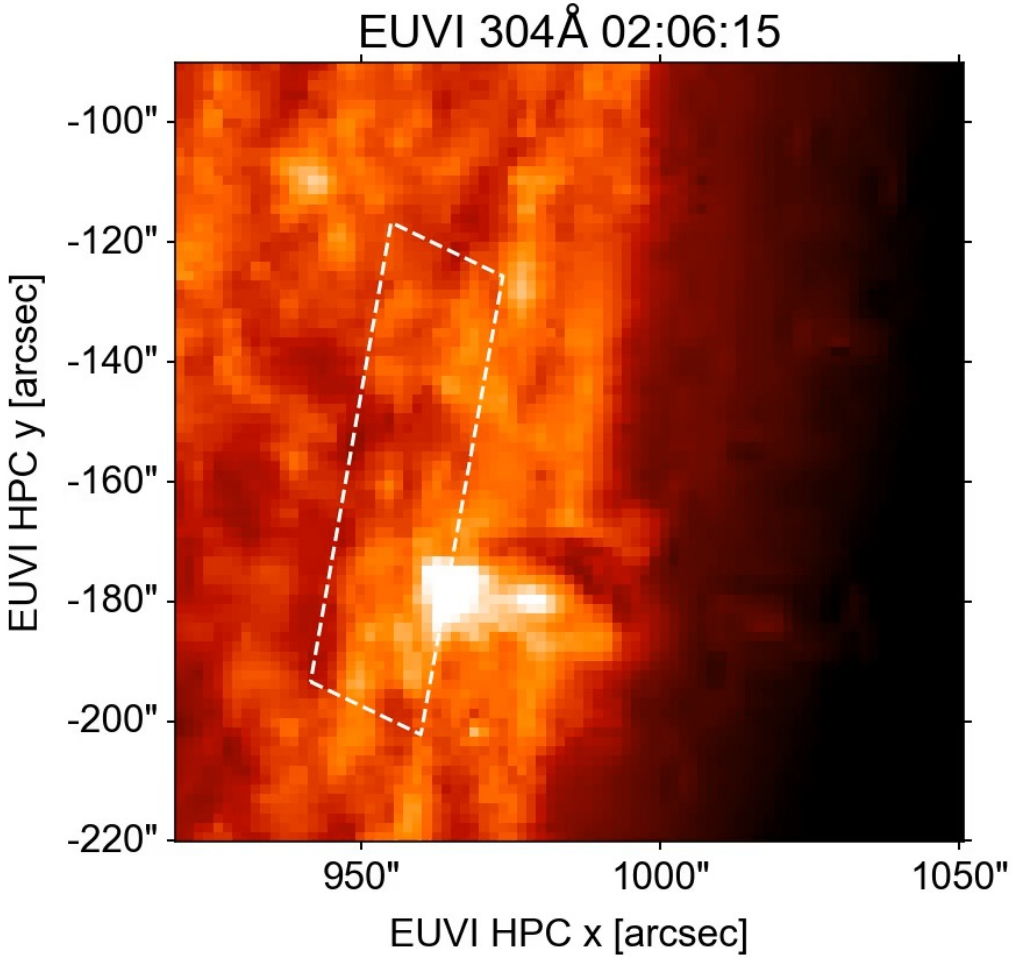
QS 25-26 Apr 2019

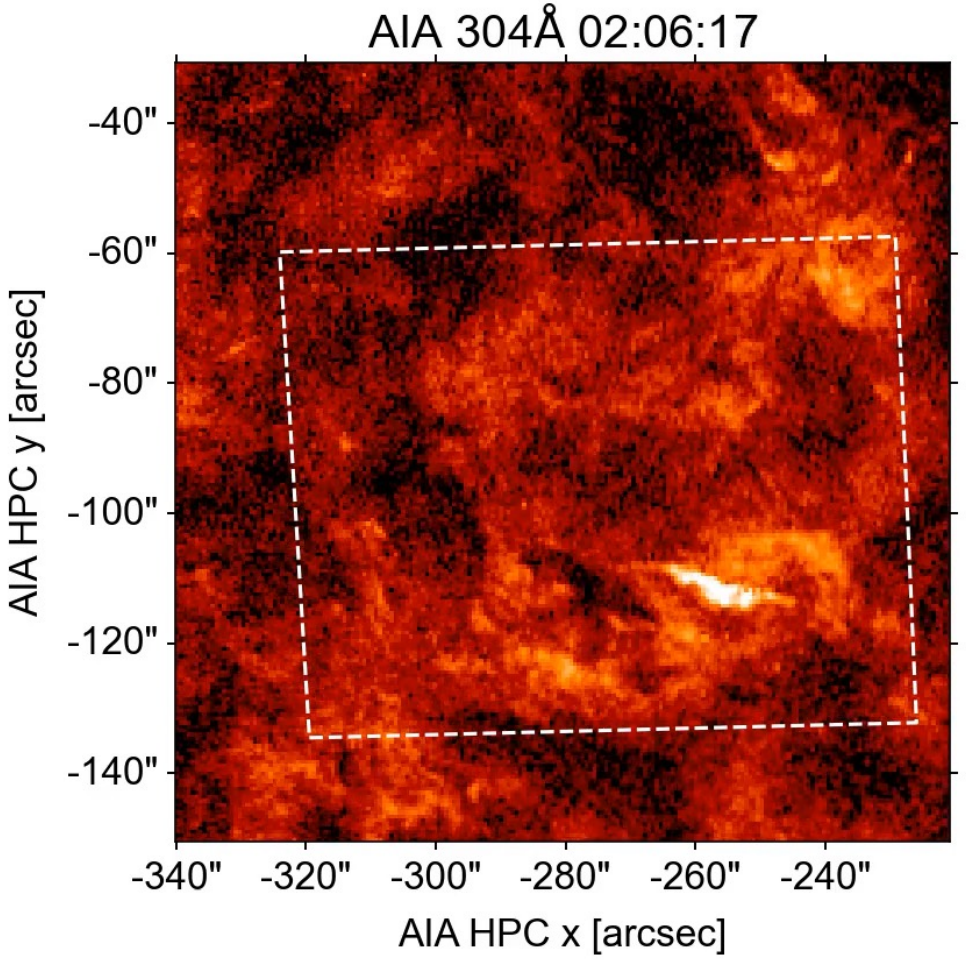
- **Something brief + bright occurred 26 Apr 2019 02:00 in 3rd of 4 full disk mosaics**
  - NuSTAR only saw it in mosaic tile M18 and M19



QS Minifilament Eruption

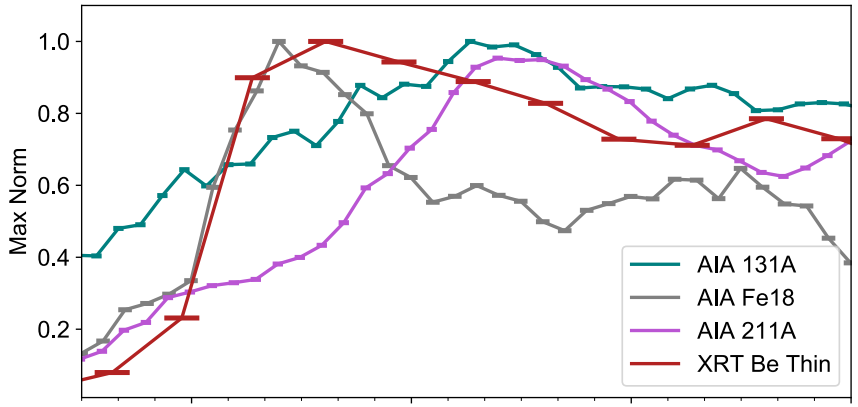
- **Clearer picture of eruption from SDO/AIA and STEREO-A 304Å (HG longitude -96.3°)**

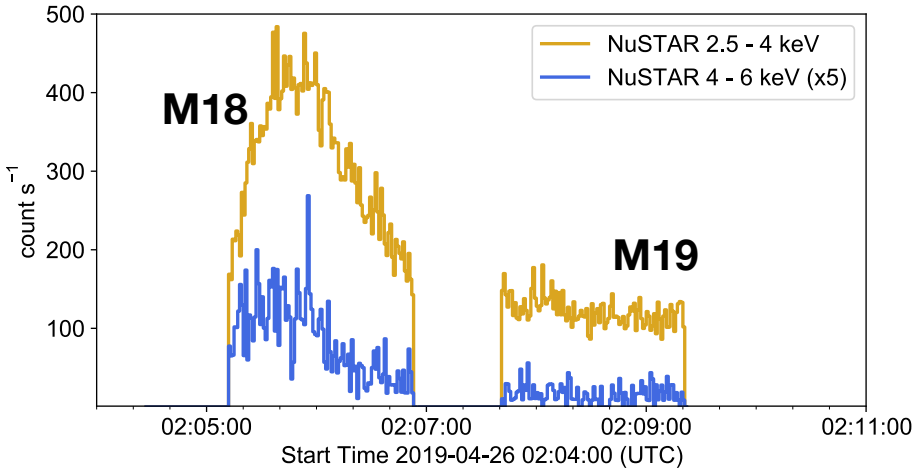


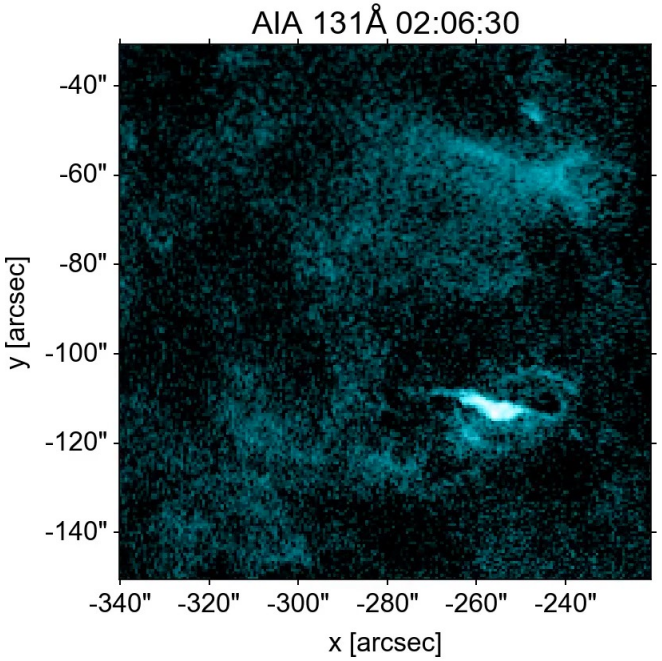


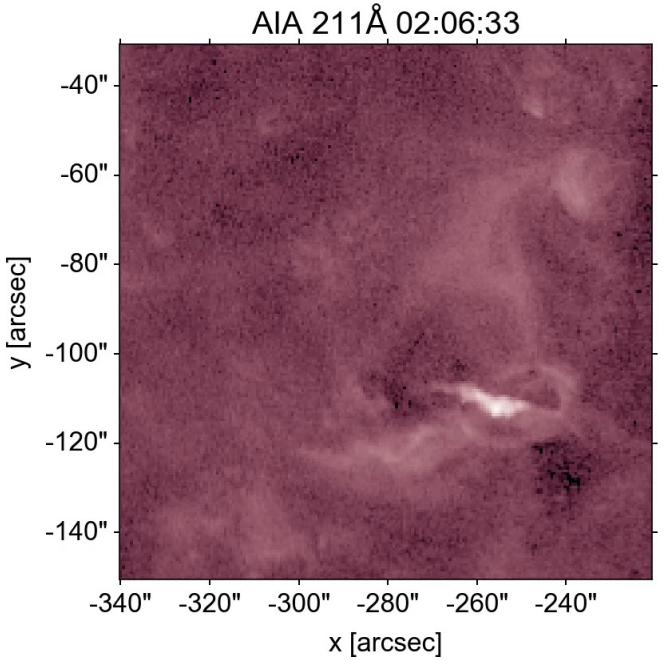
QS Minifilament Eruption

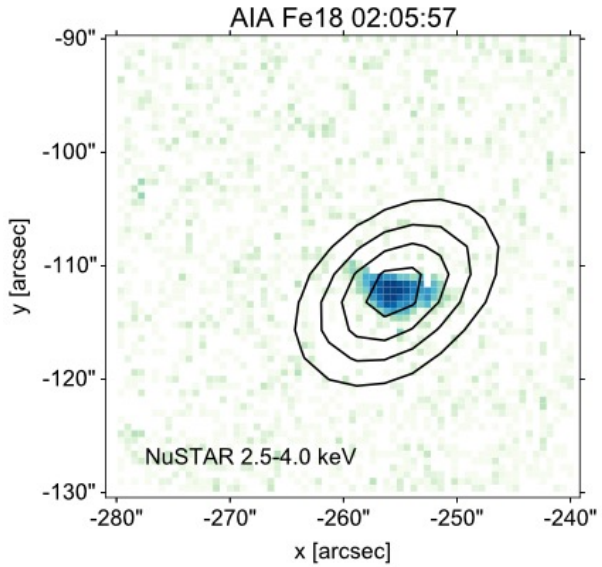
- **NuSTAR time profile rises with XRT and AIA/Fe18 but decays faster**







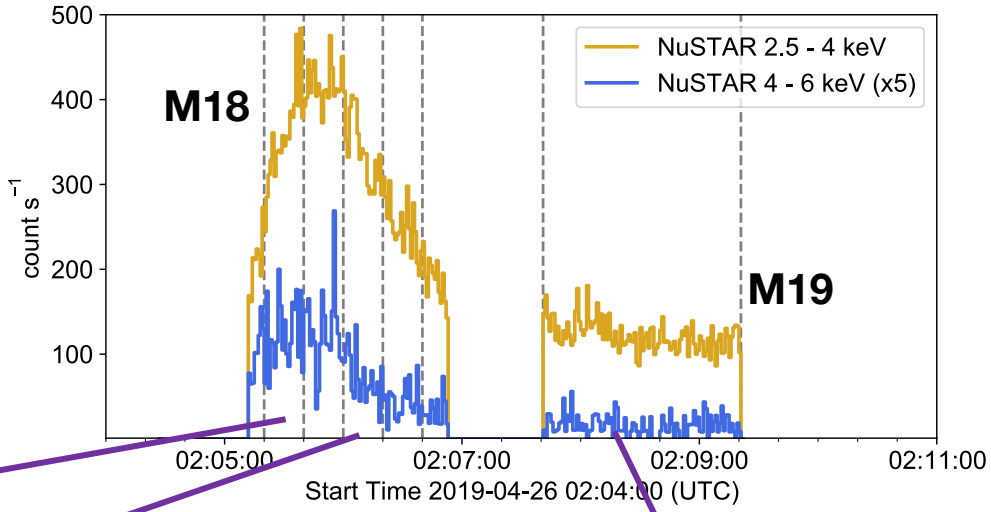


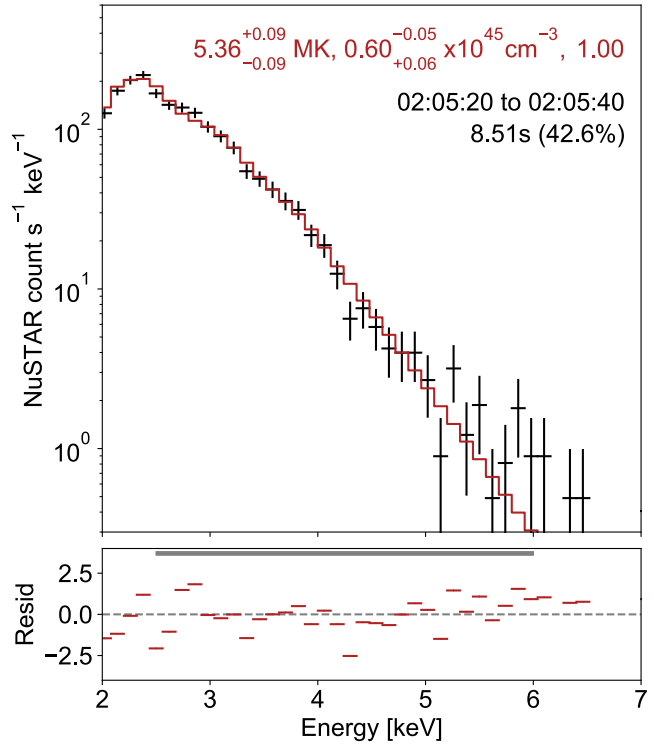


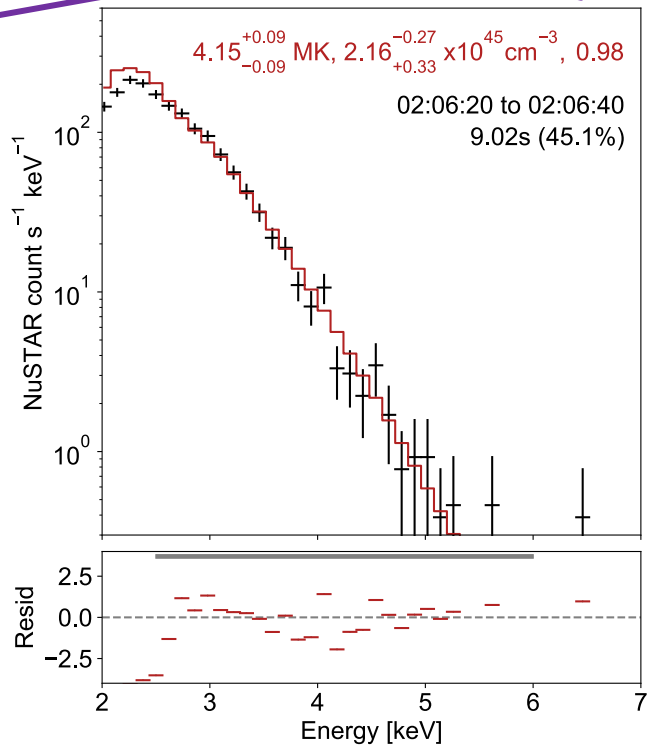
NuSTAR M18 contours with psf deconvolved [30,50,70,90]%

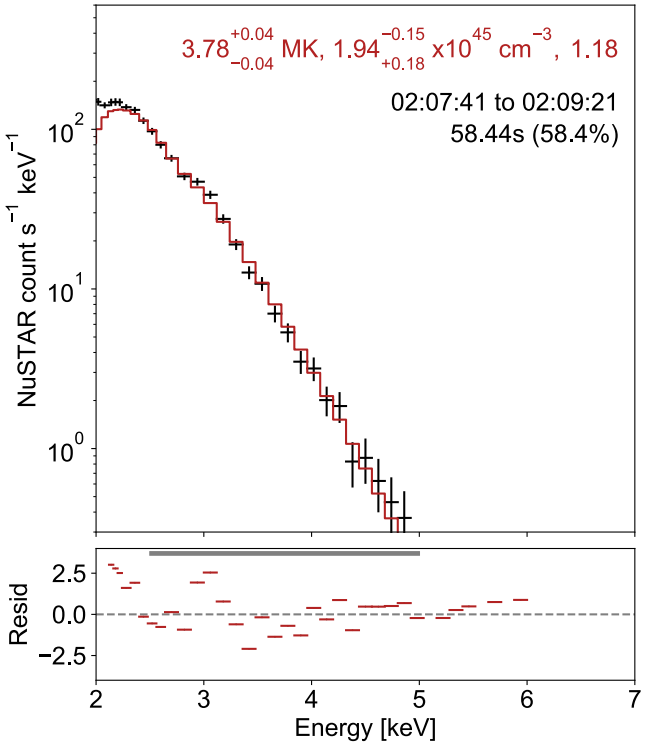
NuSTAR X-ray Spectra

- **M18: Poor fit to whole time range => temperature evolution. Sufficient counts do 4x 20s instead**
  - Isothermal 5.36MK falling to 4.15MK
  - Rise needs additional model component > 5keV?
- **M19: Isothermal 3.78MK fit for whole time**



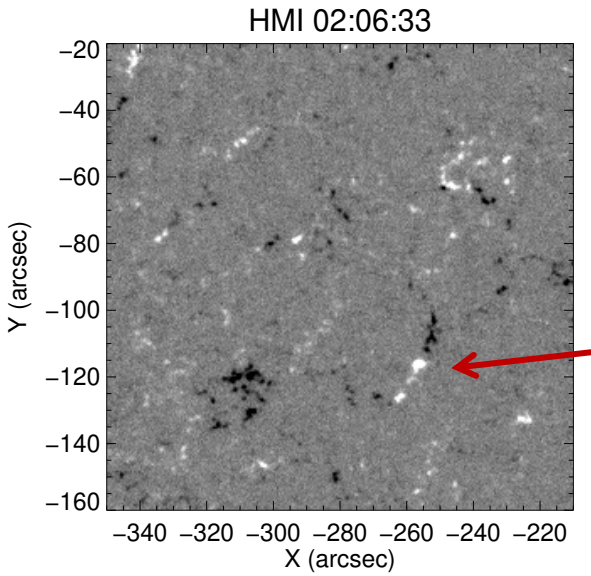




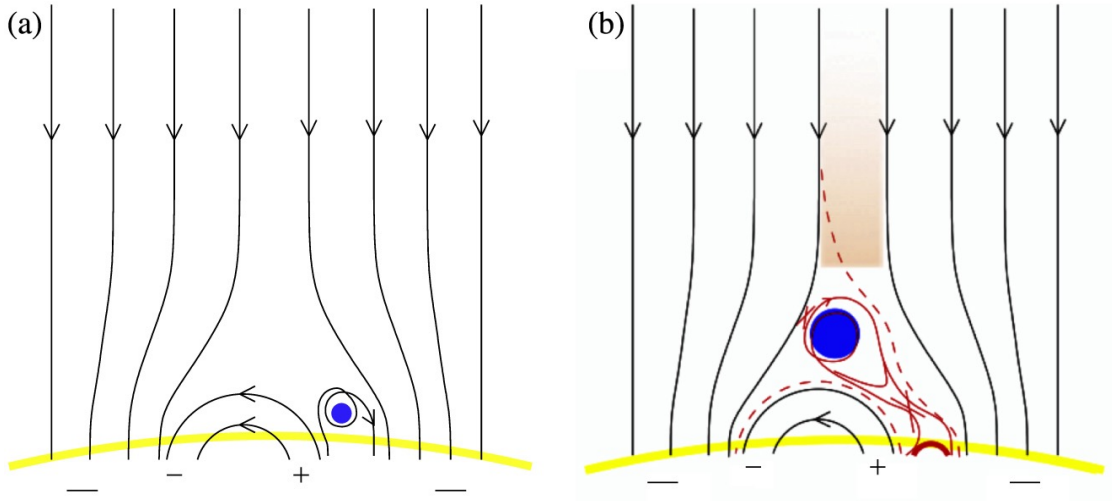


Source of HXR emission?

- **NuSTAR X-rays from mini-flare arcade low in the corona beneath the erupting minifilament**
  - "Internal reconnection": flux rope connected to the photosphere, collapse, or implode in upon themselves (Hudson et al. 2000)
- **So similar to standard solar-eruption model (e.g., Moore et al. 2001; Shibata & Magara 2011) just much smaller**
- **Jet-like setup but no (obvious) jet**
  - Erupting field did not have access to sufficient open field for the "external" reconnection to occur and create a substantial spire (Sterling et al. 2015,2018)



HMI shows opposite polarity flux moving together and cancelling



Sterling et al. 2018

Summary

- **Several NuSTAR observations over the recent solar minimum**
  - Many features currently under study
  - See also Paterson poster in §1.3
- **From April 2019 observations find a confined minifilament eruption**
  - Similar behaviour to eruption of filaments in ARs, and minifilaments that produce coronal jets
- **NuSTAR continues to observe weakly flaring ARs, coordinated with other solar missions**
  - See Cooper poster in §4.4
  - See http://ianan.github.io/nsovr/