

# AstroSat View of Blazar OJ 287: A complete evolutionary cycle of HBL Component from end-phase to disappearance and Re-emergence

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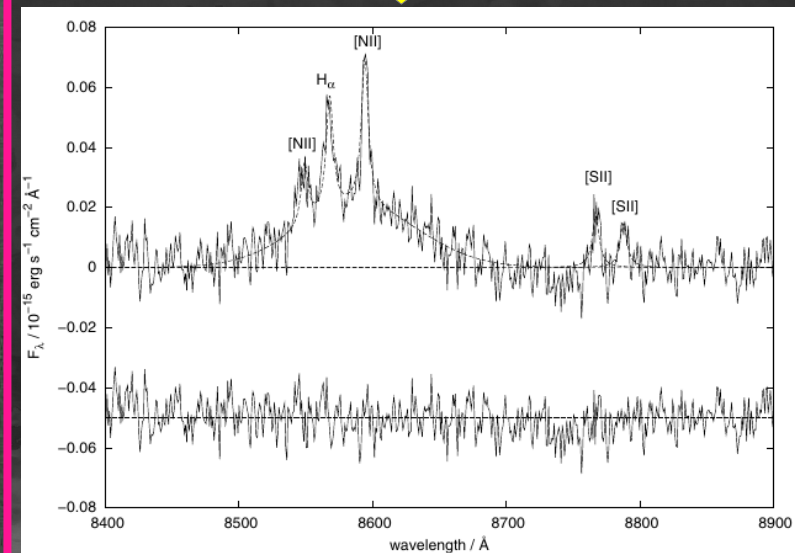
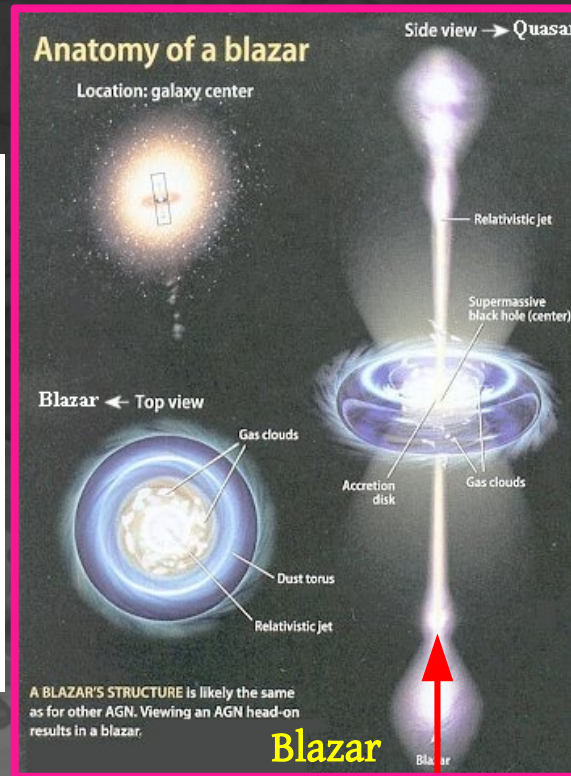
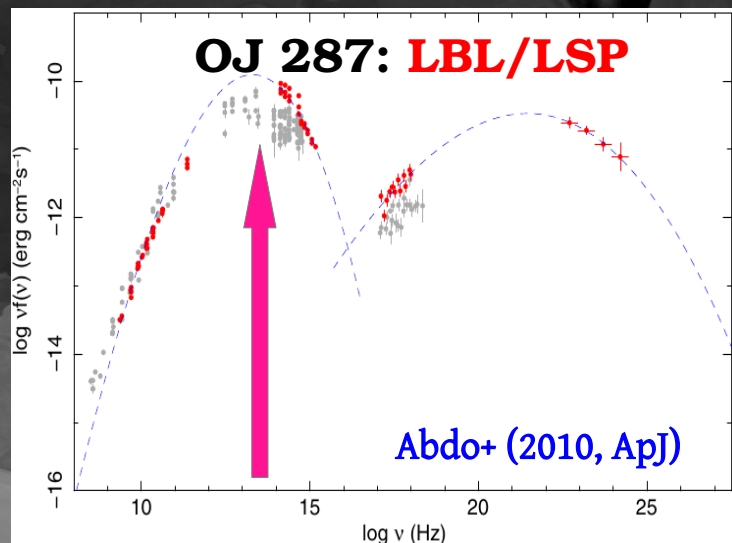
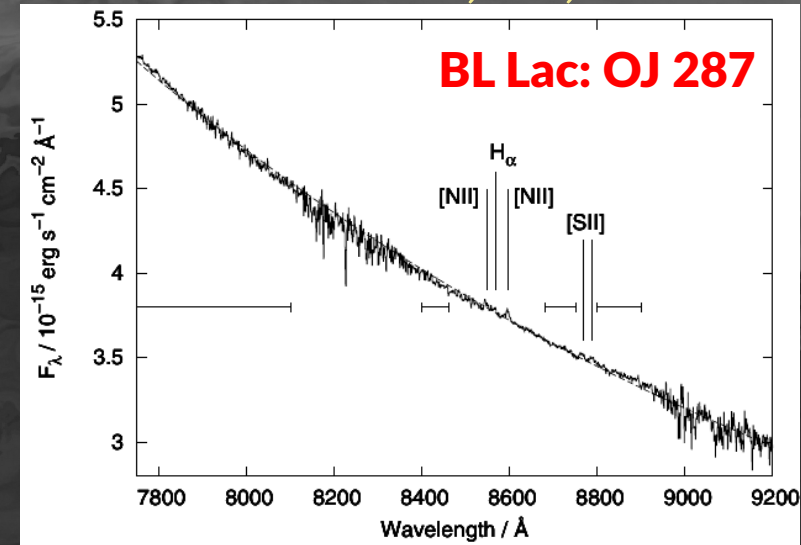
**Collaborators:** K. P. Singh, Atreyee Sinha, Main Pal, Gulab Dewangan,  
A. Agarwal

**Poster-ID: #1417 (Indico), Presenter-Forum Number: 281**

# OJ 287

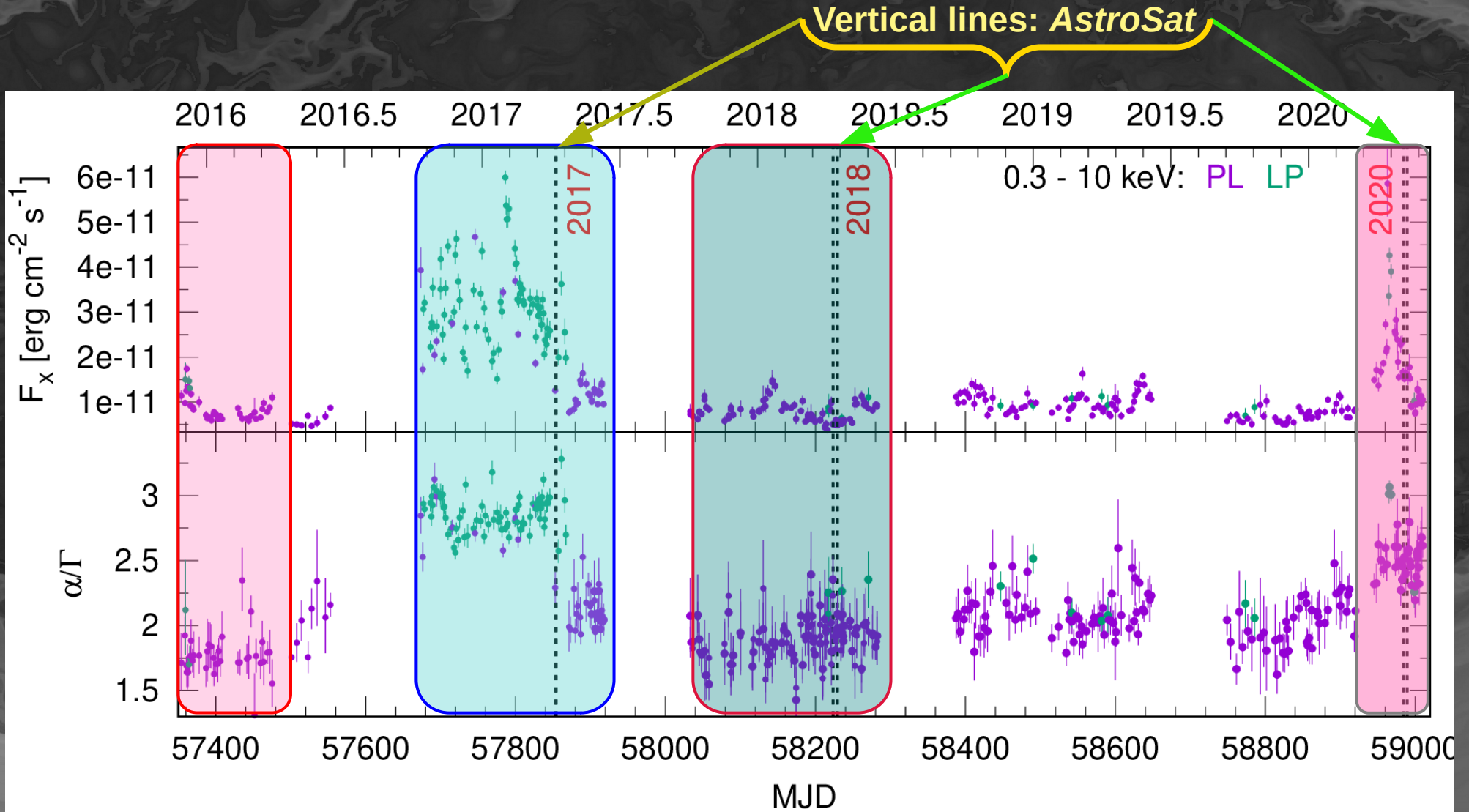
Nilsson+, 2010, A&A

- A BL Lacertae object at  $z=0.306$
- **BL Lacertae**: AGNs with a relativistic jet pointed towards us + weak/absent emission line features
- Highly variable continuum, spans entire electromagnetic spectrum, **double-humped** SED
- Emission entirely **jet dominated** from radio to GeV/TeV gamma-ray



# OJ 287: Continued Activity since end-2015

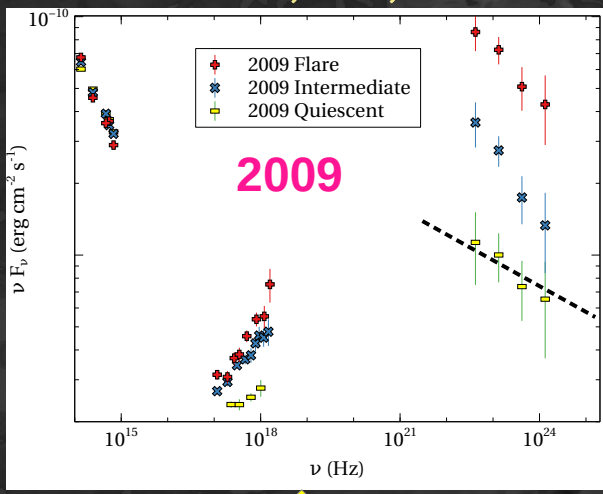
- Multi-wavelength activities in phases since end-2015
- Each phase **spectrally distinct** with respect to the **preceding one**



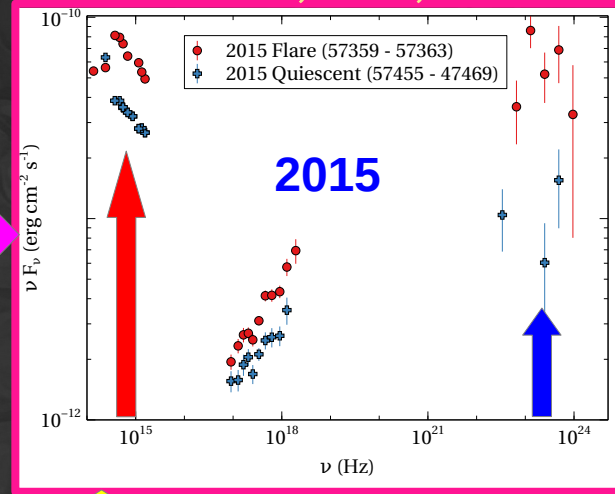
# OJ 287: end-2015 – mid-2016

- NIR-optical spectral break: consistent with **thermal emission**
- MeV-GeV spectral **hardening** + peak shift (high energy hump)

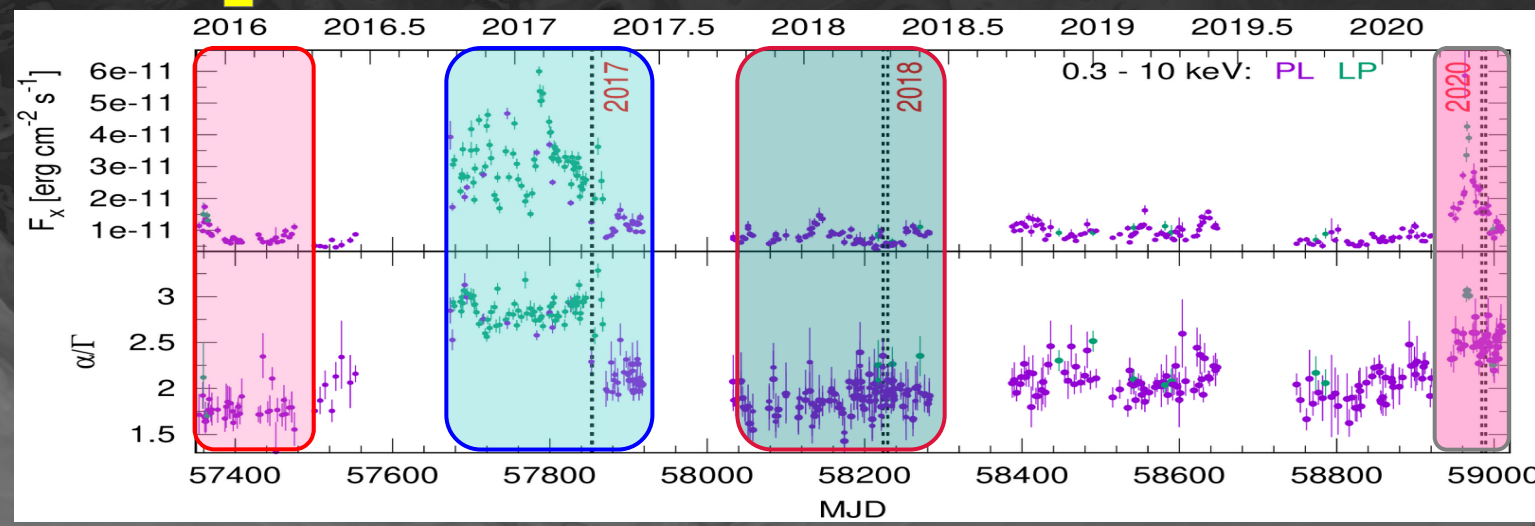
Kushwaha+, 2013, MNRAS



Kushwaha+, 2018a, MNRAS



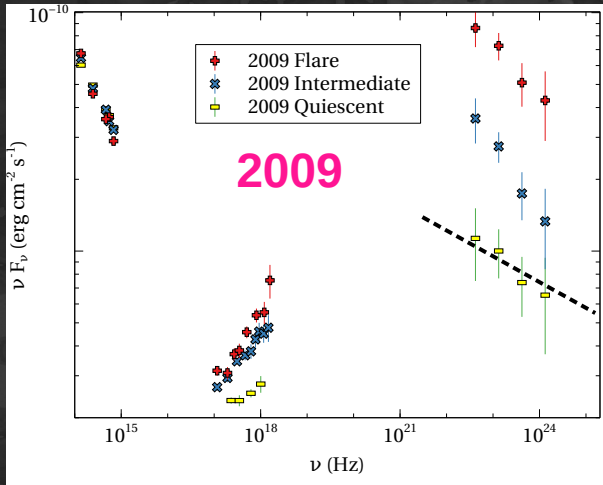
Power-law spectrum  
in different energy  
bands



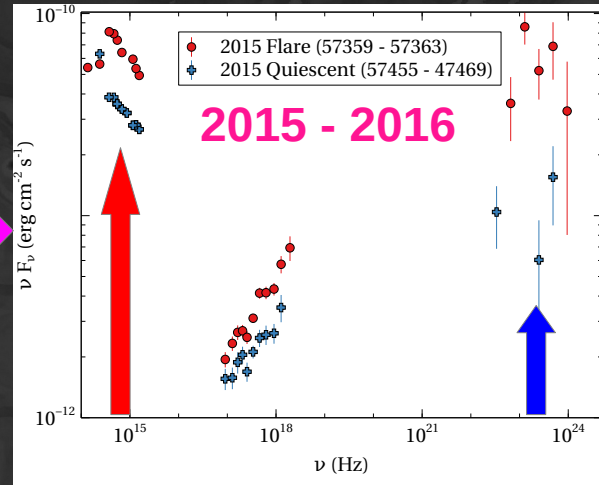
# OJ 287: mid-2016 – mid-2017

- Super soft X-ray spectrum, hardened UV and MeV-GeV spectra
- Broadband SED: LBL (typical OJ 287) + additional HBL-like

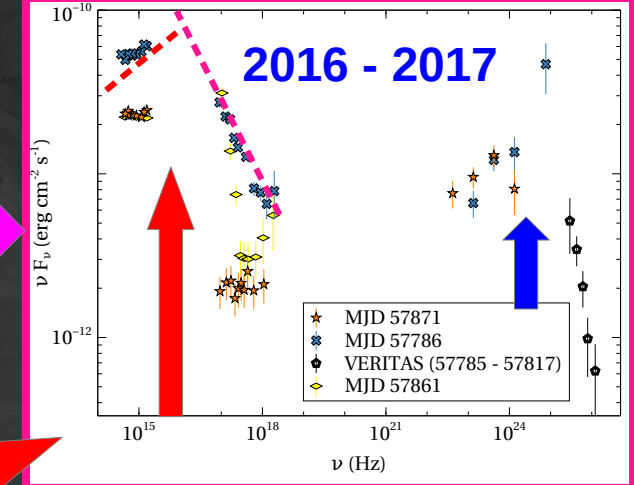
Kushwaha+, 2013, MNRAS



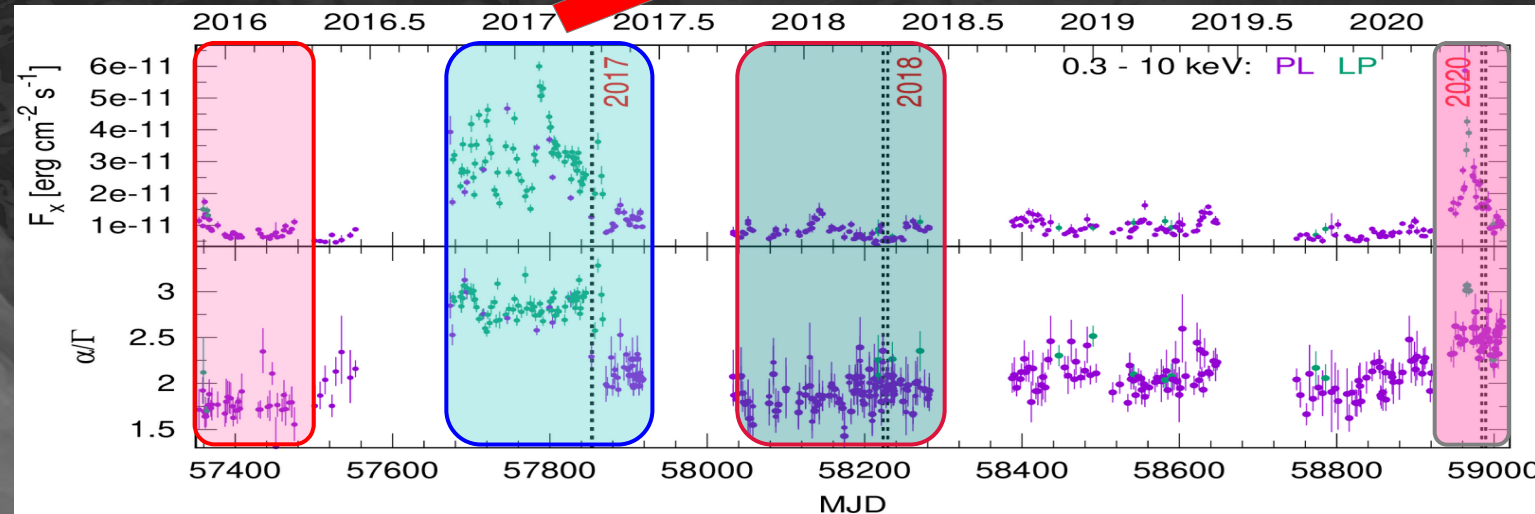
Kushwaha+, 2018a, MNRAS



Kushwaha+, 2018b, MNRAS



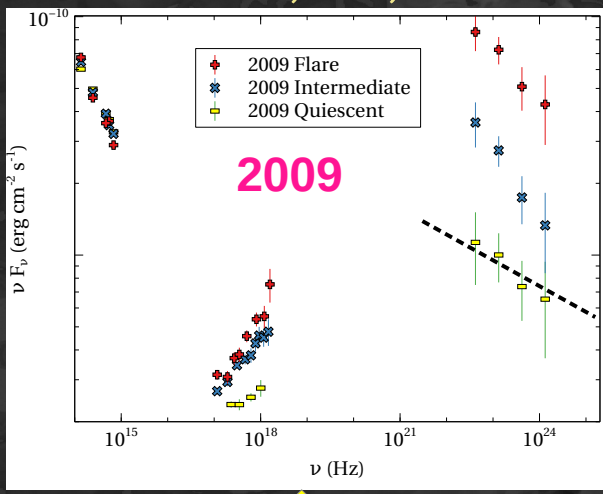
Power-law spectrum  
in different energy  
bands



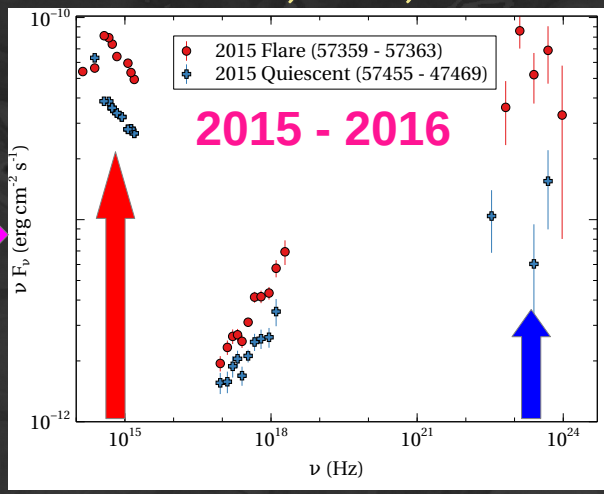
# OJ 287: 2020 Activity

- Again **Super soft X-ray spectrum**, hardened UV and MeV-GeV spectra
- **Broadband SED: LBL** (typical OJ 287) + additional **HBL-like**

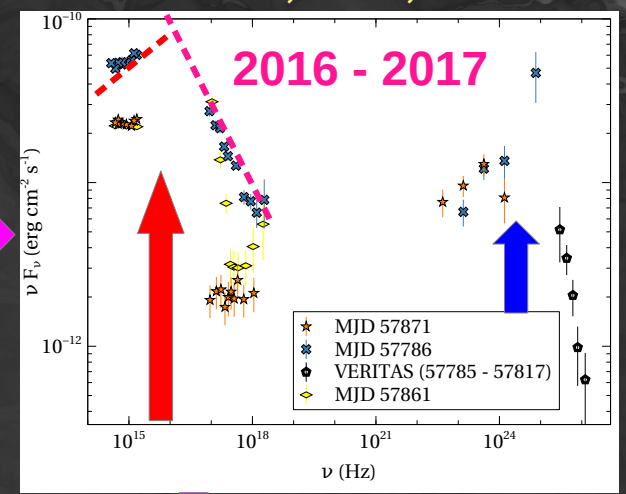
Kushwaha+, 2013, MNRAS



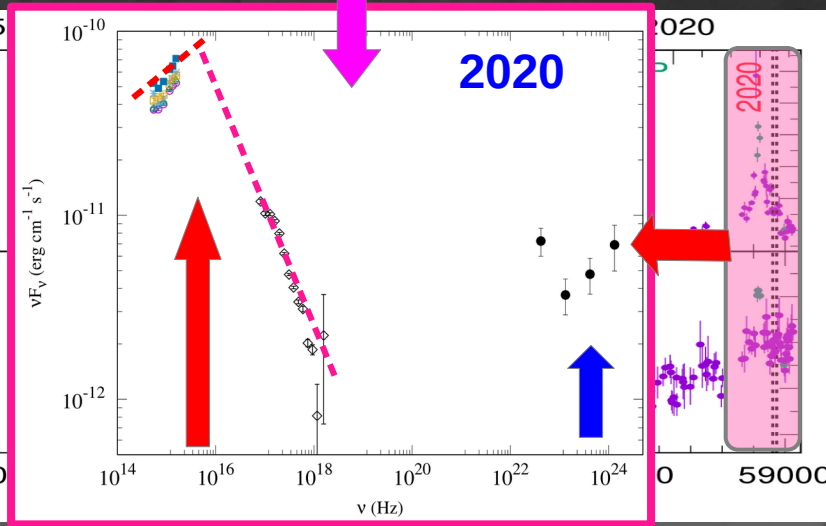
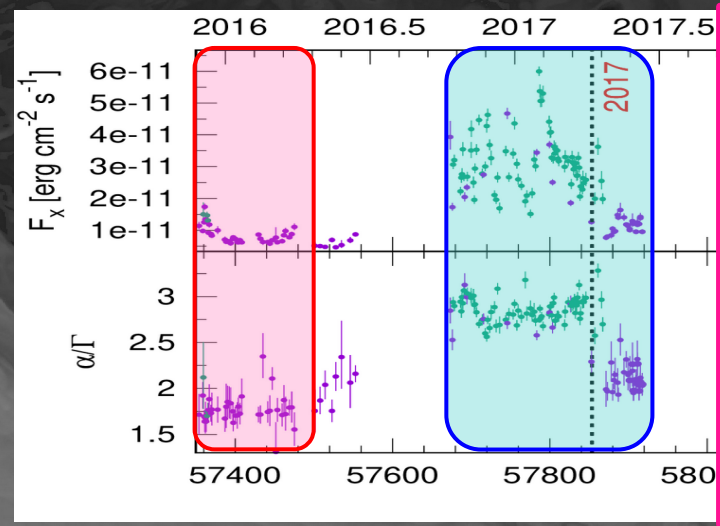
Kushwaha+, 2018a, MNRAS



Kushwaha+, 2018b, MNRAS



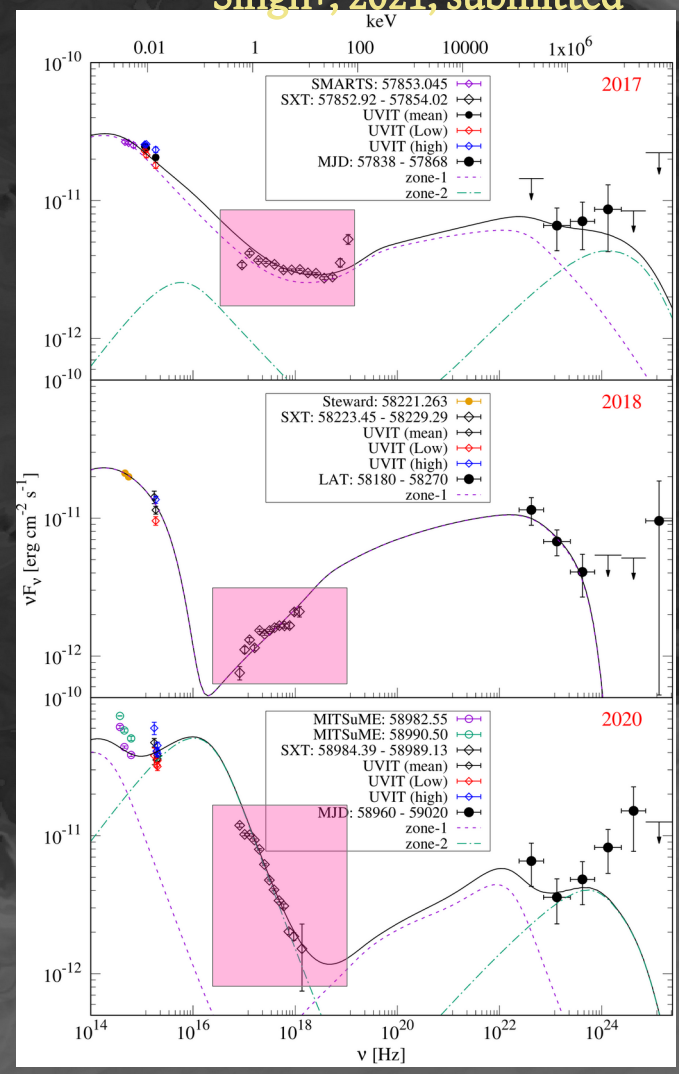
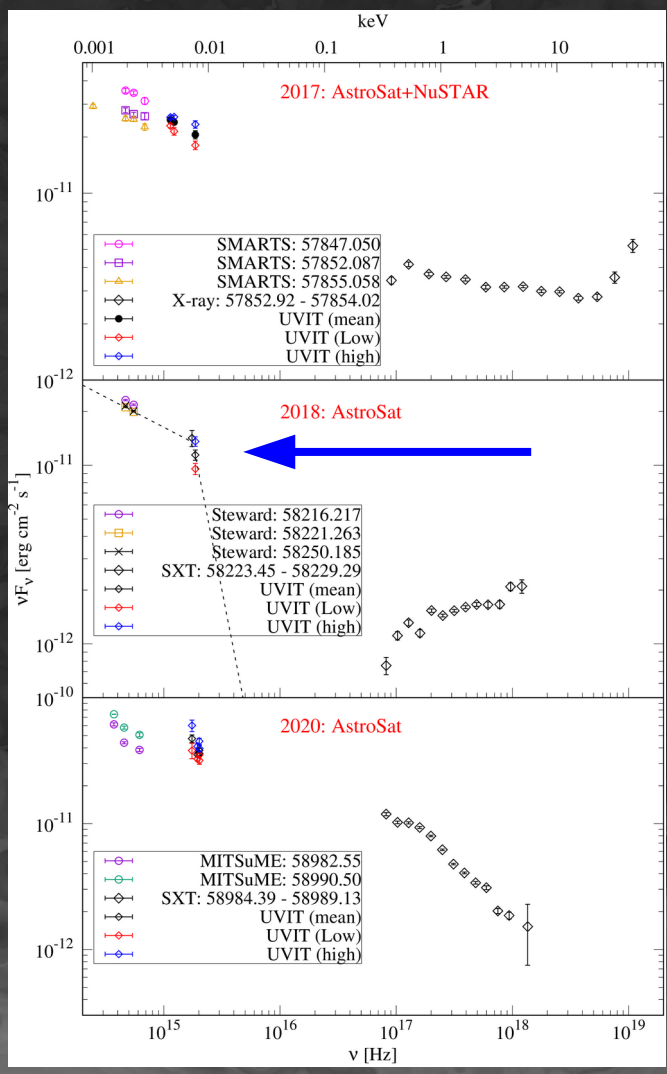
Power-law spectrum  
in different energy  
bands



# OJ 287: AstroSat Observations

- **2018:** Spectral **steepening/cutoff** in optical-UV spectrum
- **2017 & 2020:** **hardened** optical-UV & MeV-GeV spectra, **softer** X-ray
- **2018:** one-zone leptonic  
 → **Synchrotron**, **Synchrotron self-Compton (SSC)**, **External Compton-250 K thermal field**
- **2020:** 2-zone leptonic  
 → 2<sup>nd</sup> zone: **HBL**  
 → **HBL: Synchrotron (X-ray) & SSC (MeV-GeV hardening)**
- **2017:** 2-zone leptonic  
 → **X-ray: HBL/Synchrotron?**  
 → **X-ray: Mainly Synchrotron**  
 → **MeV-GeV: HBL**

Singh+, 2021, submitted



# Summary: AstroSat View of OJ 287

- **OJ 287:** continuous activity in phases, each **spectrally distinct** vis-a-vis the **preceding one**
- **AstroSat:** Three pointings: **2017, 2018, & 2020**, different flux & **spectrally distinct**
- **2018:** **Lowest** X-ray flux & **Hard X-ray** spectrum,  
→ **cutoff** in optical-UV  
→ **Broadband SED:** *one-zone leptonic scenario* – **Synchrotron** (optical-UV), **SSC** (X-ray), **EC-IR** (MeV-GeV)
- **2020:** **Highest** X-ray flux & **Extremely soft** X-ray spectrum  
→ **Hardened UV** and **MeV-GeV**  
→ **Broadband SED:** *Two-zone leptonic scenario* – **additional HBL component:** **Synchrotron** (optical-UV + X-ray), **SSC** (MeV-GeV hardening)
- **2017:** **Intermediate** X-ray flux & spectrum  
→ **optical-UV** & **MeV-GeV** relatively **harder** too  
→ **X-ray spectrum:** *Primarily Synchrotron*  
→ **Broadband SED** – *2-zone model*

# Thanks !!

**Poster-ID: #1417 (Indico), Presenter-Forum Number: 281**