

# CHARACTERIZING SPECTRAL CHANNELS OF VISIBLE EMISSION LINE CORONAGRAPH OF ADITYA-L 1

Presented by – Arpit Kumar Shrivastav<sup>1,2,3</sup>

Contributors : Ritesh Patel<sup>1,2</sup>, A. Megha<sup>1</sup>, Vaibhav Pant<sup>2</sup>, M. Vishnu<sup>1</sup>,  
K. Sankarasubramanian<sup>1,4,5</sup> and Dipankar Banerjee<sup>1,2,4</sup>

<sup>1</sup>Indian Institute of Astrophysics, Bangalore, India, <sup>2</sup>Aryabhata Research Institute of Observational Sciences, Nainital, India,  
<sup>3</sup>Department of Physics, Indian Institute of Science, Bangalore, India, <sup>4</sup>Center of Excellence in Space Science, IISER Kolkata, Kolkata,  
India, <sup>5</sup>UR Rao Satellite Centre, Bangalore, India

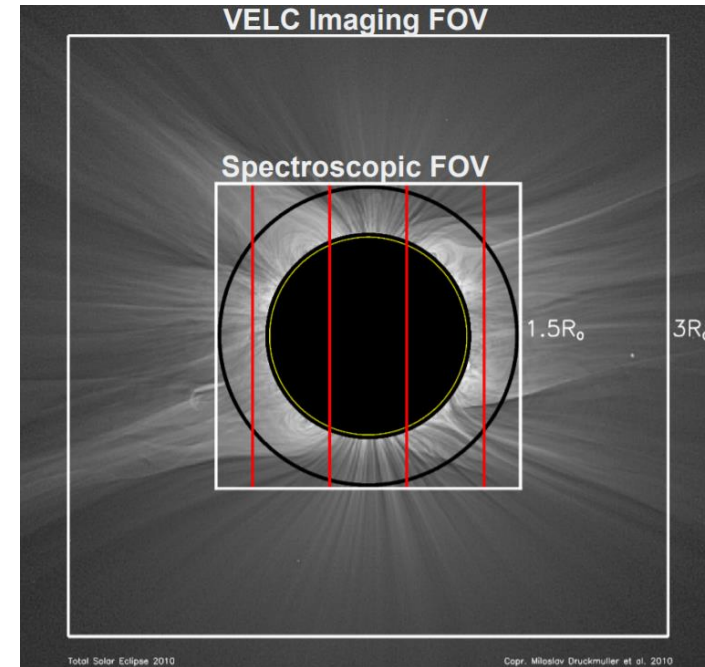
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# Motivation & Quick Introduction

Beforehand :

- Optimizing the slit width
- Understanding the performance of the instrument in different temperature ranges
- SNR requirement in Different Coronal conditions



Total Solar Eclipse 2010, Copr. Miloslov Druckmuller et.al. 2010

Plan the observations

Wavelength Channel (Å)	Characteristic Temperature (logT)	Pixel size (μm)	Pixel Scale (arcsec/pixel)
5303	6.30	6.5	1.25
7892	6.10	6.5	1.25
10747	6.22	25	4.8

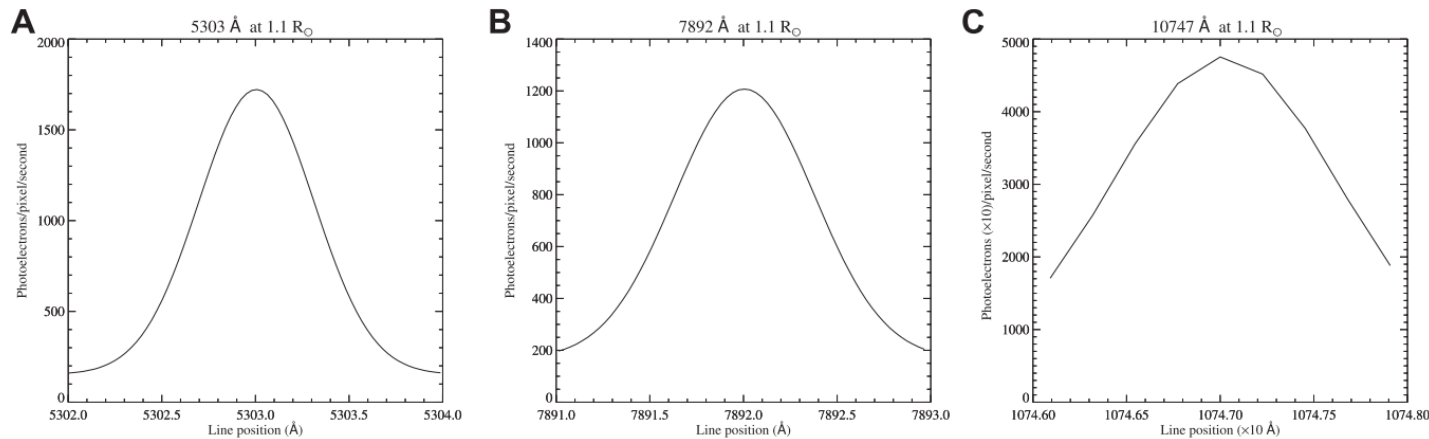
(Allen, 1973)

# Strategy

Inputs to **Chianti** :  
Density, Temperature,  
Emission measure,  $\text{FWHM}_{\text{instr}}$

Output: Synthetic spectra  
Intensities  
(photons  $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1} \text{\AA}^{-1}$ )

Conversion to  
Photoelectrons  
(Including Instrument &  
telescope Specifications)



Final Spectra

Scatter Intensity

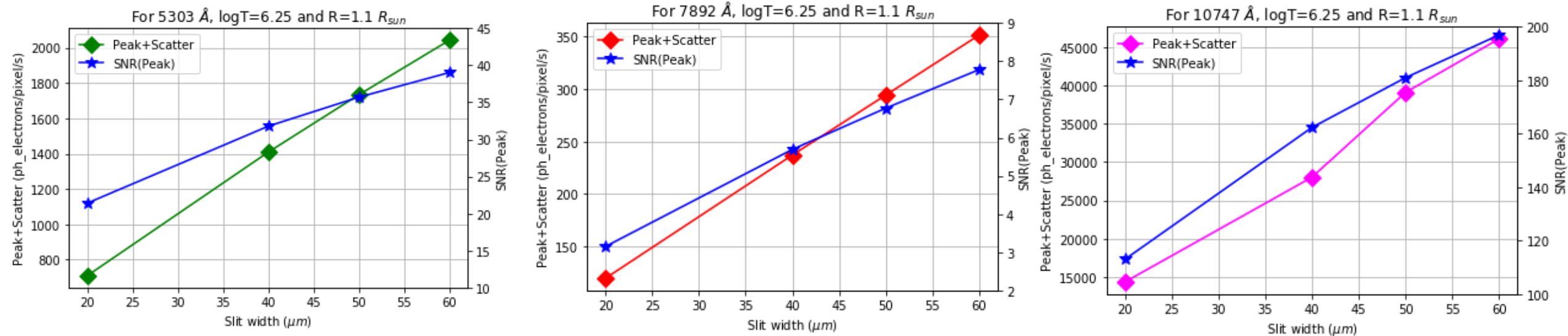
Synthetic spectra for VELC at 1.1  $R_{\odot}$  for (A) 5303 Å, (B) 7892 Å, and (C) 10747 Å for 50  $\mu\text{m}$  slit width at their respective line formation ( Patel et. al. 2021)

# Slit Width Optimization

At  $[1.1, 1.2, 1.3, 1.4, 1.5] R_{sun}$

- $\log(\text{EM}) = [27, 26.3, 25.8, 25.36, \text{and } 25] \text{ cm}^5$
- $\log(\text{ne}) = [8.2, 7.85, 7.6, 7.38, \text{and } 7.2] \text{ cm}^3$

(Baumbach, 1937; Allen, 1973)

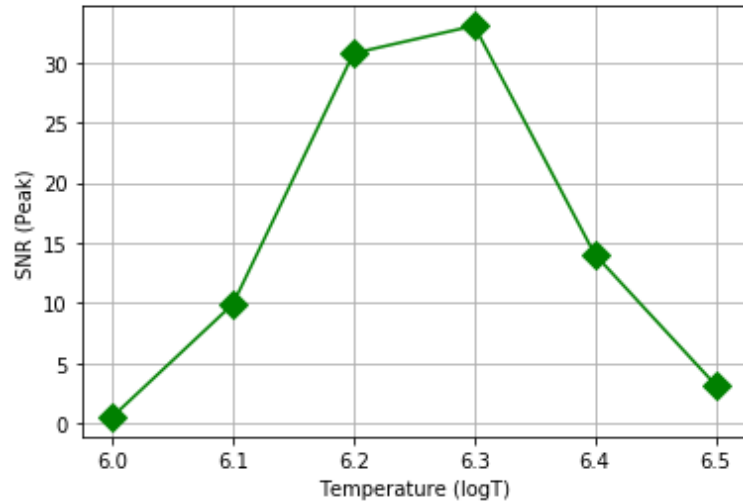


Variation of Synthetic Intensity (Peak+Scatter) & SNR with Slit width for all three channels

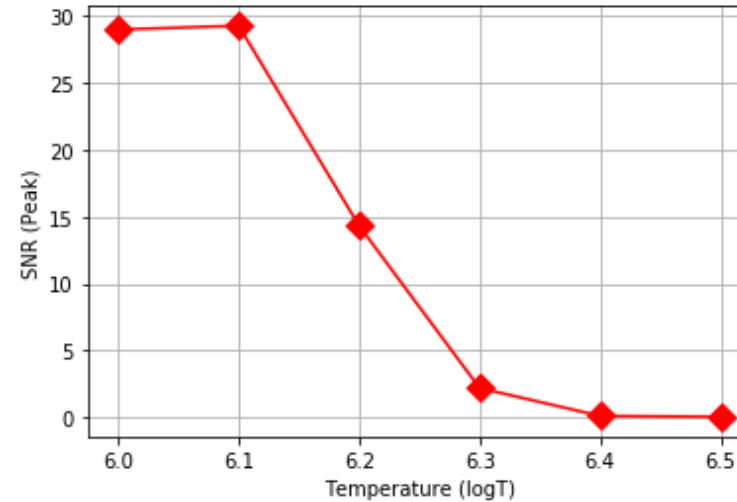
- Visible Spectral Channel, full well capacity of ~30,000 electrons
- IR detector, full well capacity of ~30,300 electrons in the high-gain mode (Singh et al., 2019).
- Spectropolarimeter mode, a fixed exposure time of 500 ms.
- A slit width of 60 μm, the incident photons count to ~23,033 electrons at 1.1 R<sub>sun</sub>, ~77% of the full well capacity.

# SNR vs Temperature

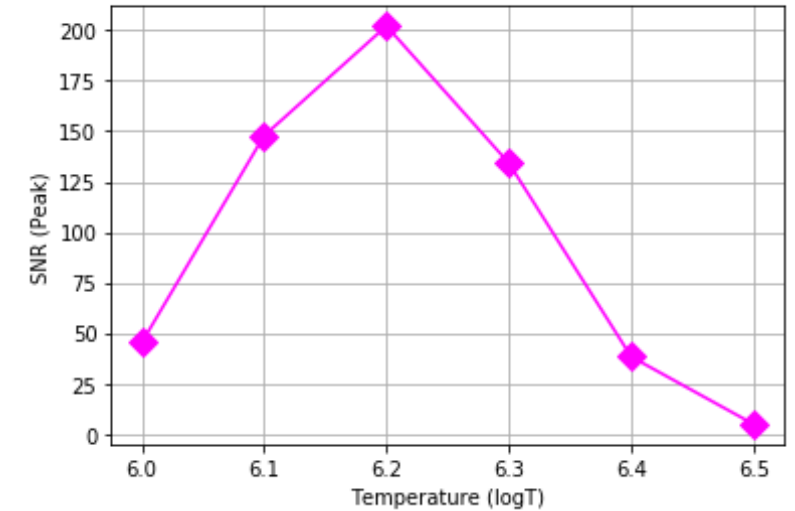
For 5303 Å, at R=1.1 R<sub>sun</sub>



For 7892 Å, at R=1.1 R<sub>sun</sub>



For 10747 Å, at R=1.1 R<sub>sun</sub>



## Variation of SNR(Peak) with temperature for all three spectral channels

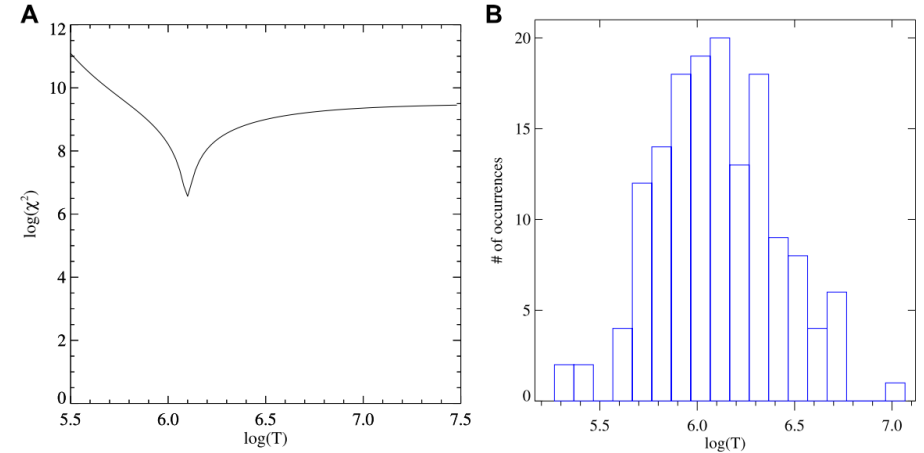
- The three channels show maximum SNR corresponding to different temperatures.
- The 7,892 Å channel shows good SNR for relatively cool plasma.
- Combined study will be helpful in investigating plasma over a wide range of temperatures.
- In 5303 and 7892 Å, The SNR becomes  $\leq 5$  for few cases.

# Effect of Temperature distribution

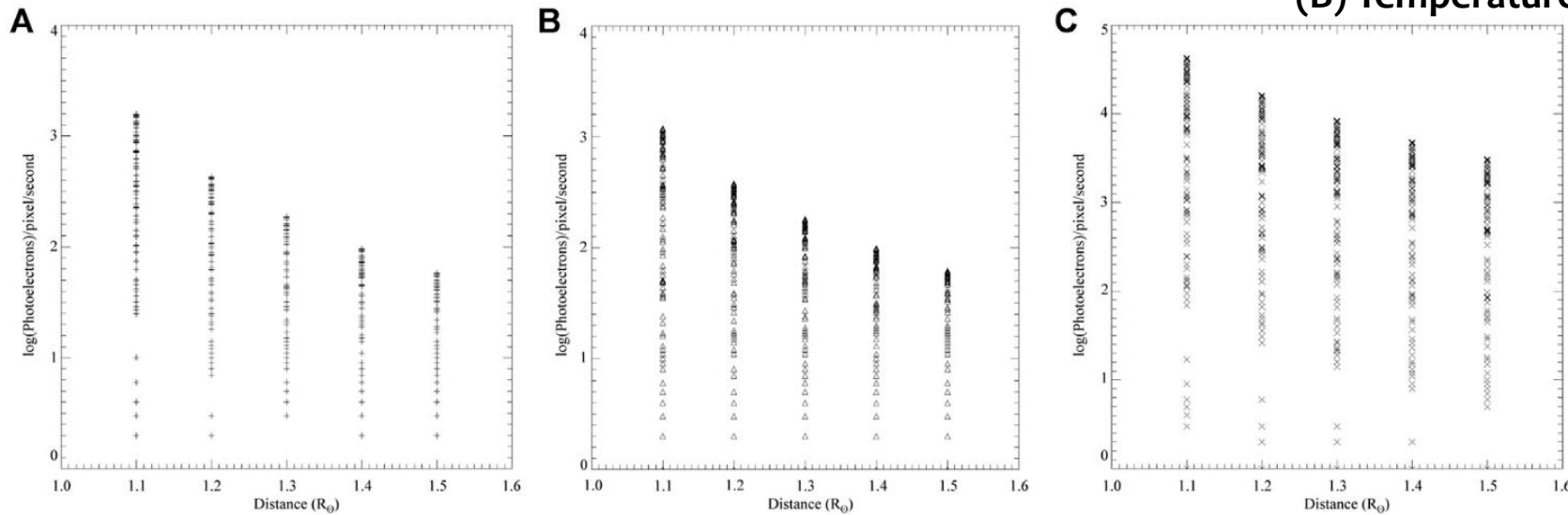
Simulated cases – the isothermal corona with electron density (Baumbach Model)

vs

Scale-Height Density model,  $n_e = n_0 e^{-\left(\frac{r-1.1}{H}\right)}$



(A) Chi-square minimization output as a function of temperature  
(B) Temperature distribution with peak at  $\log(T) = 6.1$

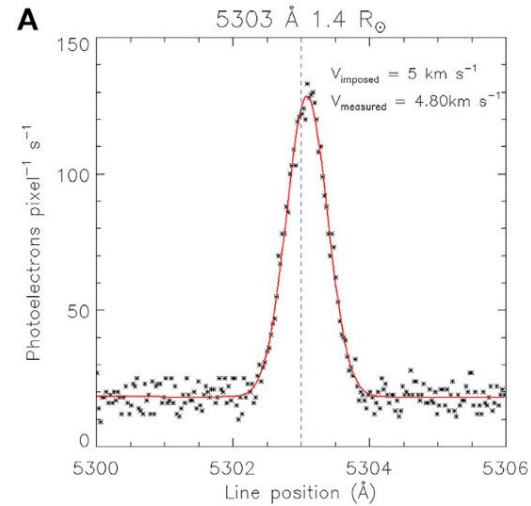


- A cluster of points near the top at each height for all channels.
- Comparison of Counts near peak line formation temperature.

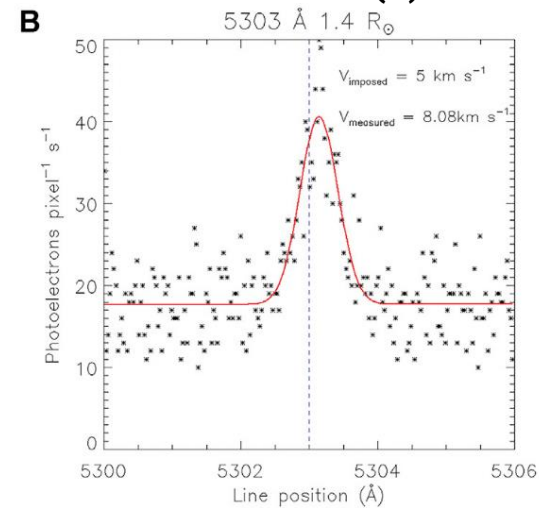
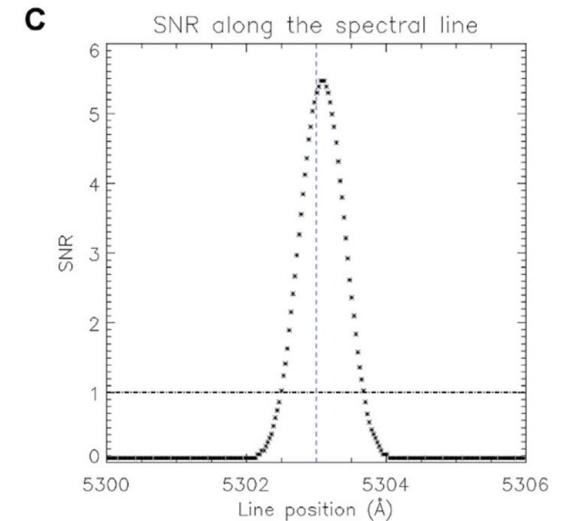
Photoelectron variation using synthetic spectra for VELC at different heights for (A) 5303 Å, (B) 7892 Å, and (C) 10747 Å for 50 μm slit width with temperature distribution.

# SNR Limitation on Doppler Velocity

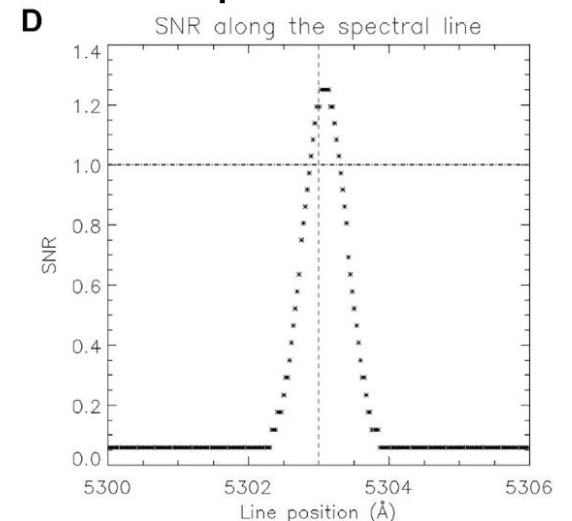
- Quiet-Sun case for 5303Å, A shift of  $\approx 88\text{m}\text{\AA}$
- Gaussian fit after adding random noise (to mimic the near-realistic observation)
- For the SNR at the peak of the spectra is  $\approx 5$ , a reliable Doppler speed is measured in the synthetic data, close to the imposed one.
- For the SNR at the line peak is close to 1, a significant deviation could be seen in the measured Doppler speed.



(A) Synthetic green line with noise and Doppler shift added at  $1.4R_{\text{sun}}$   
 (C) SNR variation within the spectral



(B) Synthetic green line with noise and Doppler shift added line at 20% intensity of (A).



(D) show SNR variation within the spectral line

# Summary & Conclusions

- For slit width of 50  $\mu\text{m}$ , IR Channel detector has a sufficient margin to account for the flaring conditions or intensity enhancement in the coronal structures.
- The slit width needs to be  $\leq 60 \mu\text{m}$ .
- Combined study using all three channels will be helpful in investigating plasma over a wide range of temperatures.
- The maximum contribution will be observed due to the coronal structures contributing at and near the peak temperature for VELC channels.
- An SNR of at least 5 is good enough to measure a Doppler speed as low as  $5 \text{ km s}^{-1}$  using the green channel of VELC.
- Study can be extended for different science case.

## References :

- **Characterizing Spectral Channels of Visible Emission Line Coronagraph of Aditya-L1, Ritesh Patel, A. Megha, Arpit Kumar Shrivastav, Vaibhav Pant, M. Vishnu, K. Sankarasubramanian and Dipankar Banerjee, DOI : 10.3389/fspas.2021.660992**
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