Swift observations of 2I/Borisov

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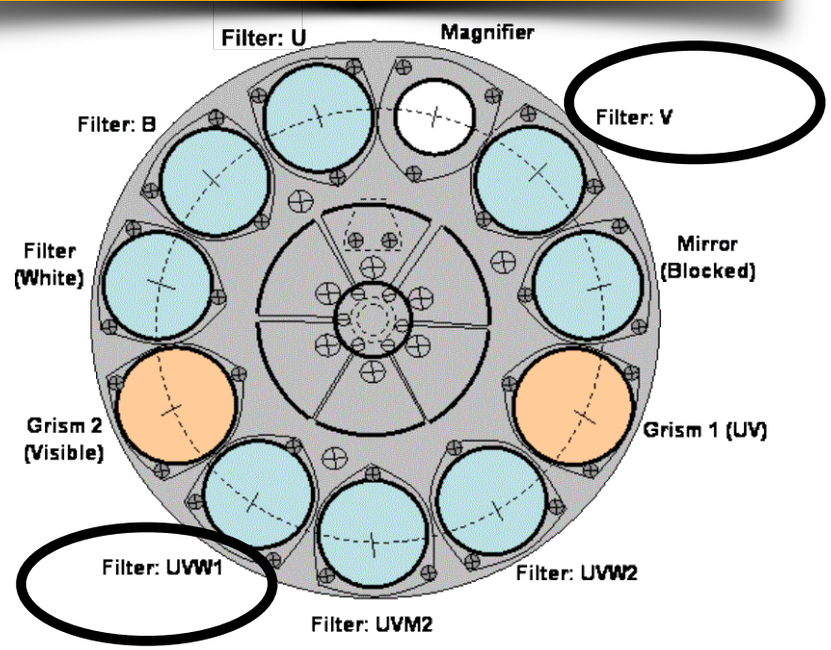
UVOT/Swift

UVOT:
Telescope aperture: 30cm
FoV: 17 by 17 arcmin
Plate scale: 1 arcsec/pixel for lenticular filters
Waverange: 1600-8000A
Colors: figure below



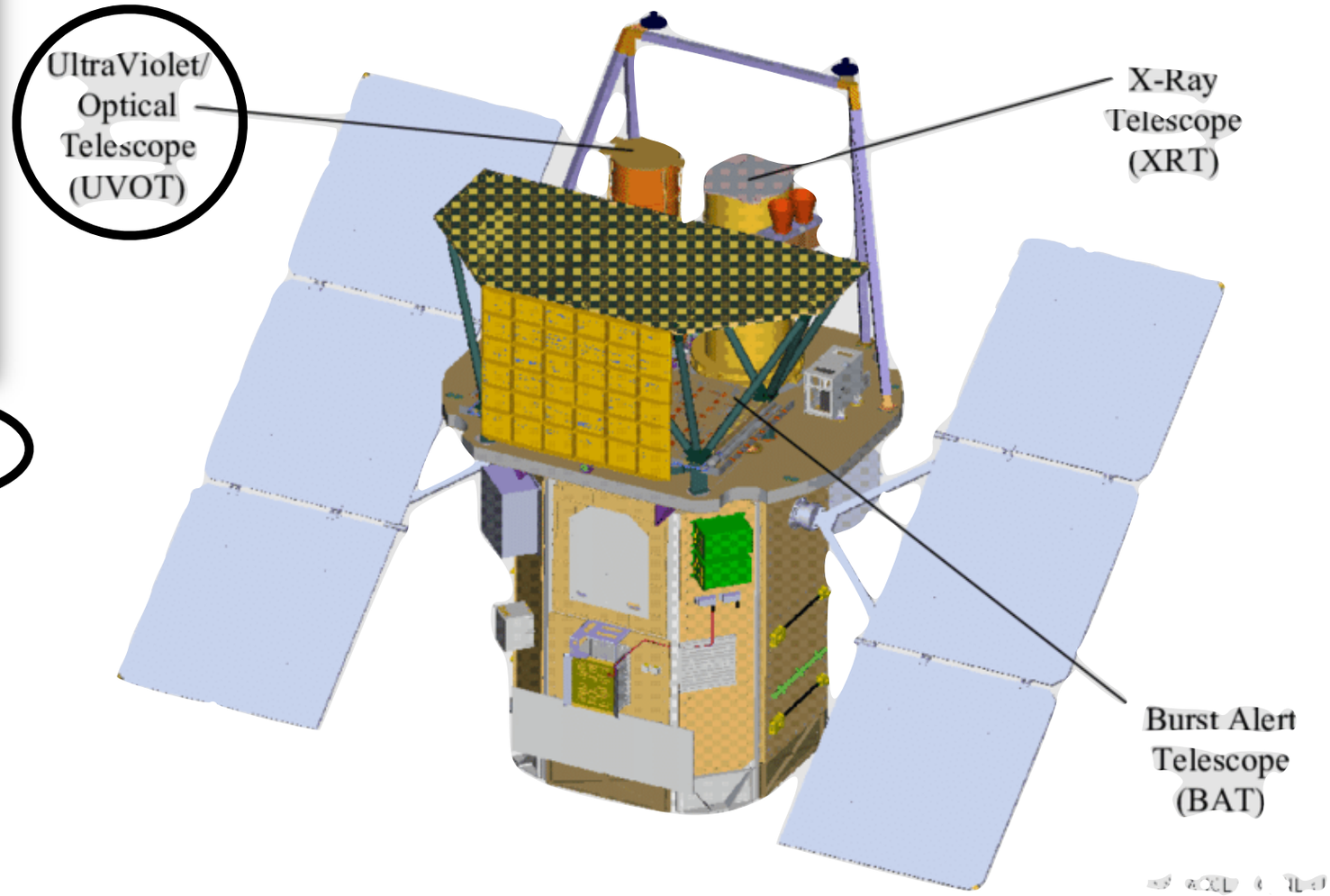
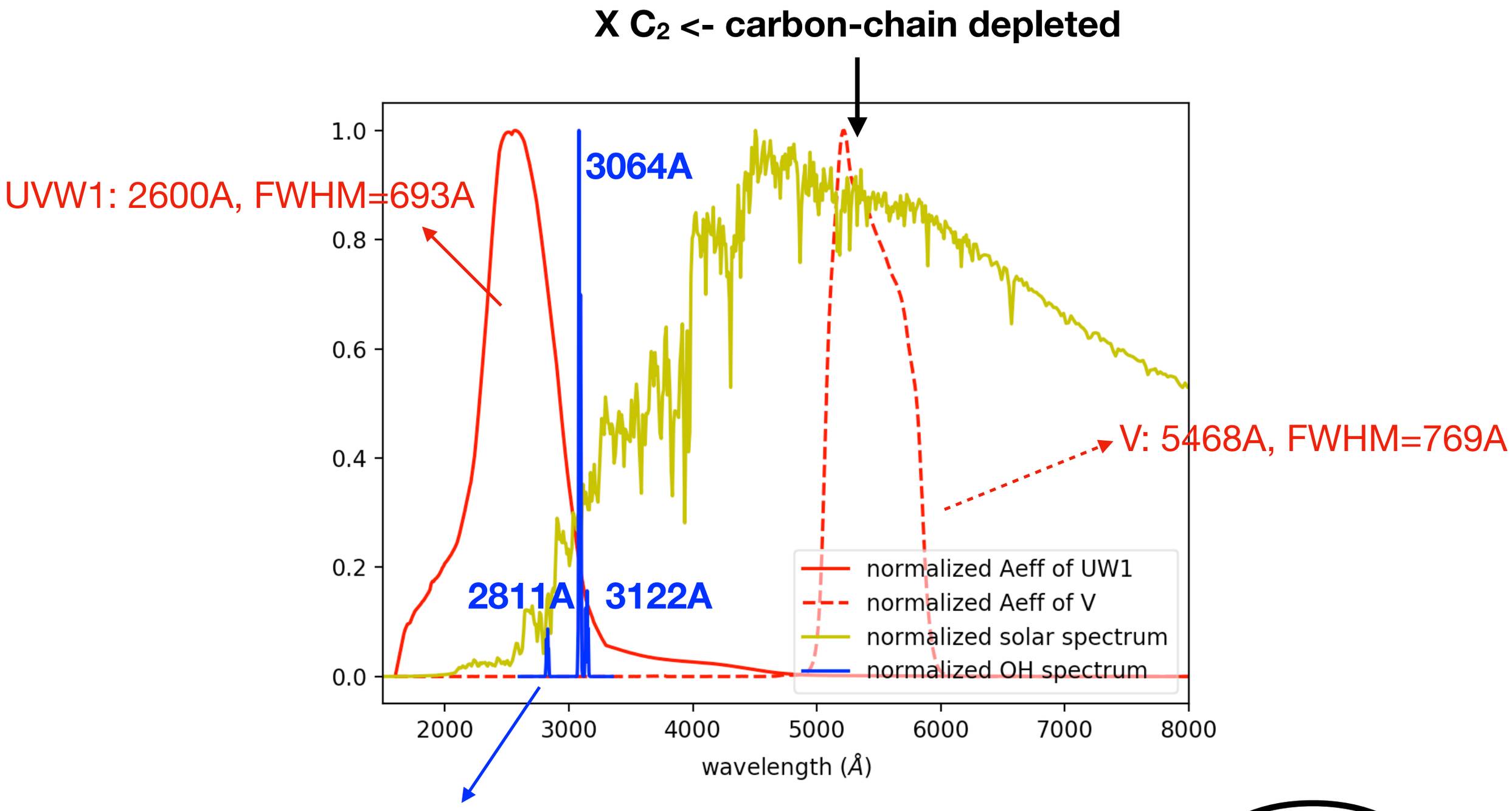


Table 1. Summary of the observing log

	Start Time	End Time	r_h (AU)	dr_h (km/s)	Δ (AU)	S-T-O (°)	UVW1 T_{exp} (s)	V T_{exp} (s)
Sep 27 UT	2019-09-27T03:06:26.000	2019-09-27T14:38:55.000	2.56	-23.54	3.1	17.31	8204.59 (8204.59)	3099.12 (2712.24)
Nov 01 UT	2019-11-01T14:07:07.000	2019-11-02T01:37:46.000	2.17	-14.43	2.42	24.24	7203.27 (5486.77)	3097.79 (1935.43)
Dec 01 UT	2019-12-01T03:17:14.000	2019-12-01T21:16:55.000	2.01	-3.0	2.04	28.12	8147.0 (5071.03)	3091.99 (385.74)

UVW1/V Filter



Fluorescence radiation: OH + solar UV photon —> OH* —> OH + UV photon

H_2O <- OH <- UVW1(total) - <u>UVW1(solar reflection)</u>

[derived by V(total)]

Observation

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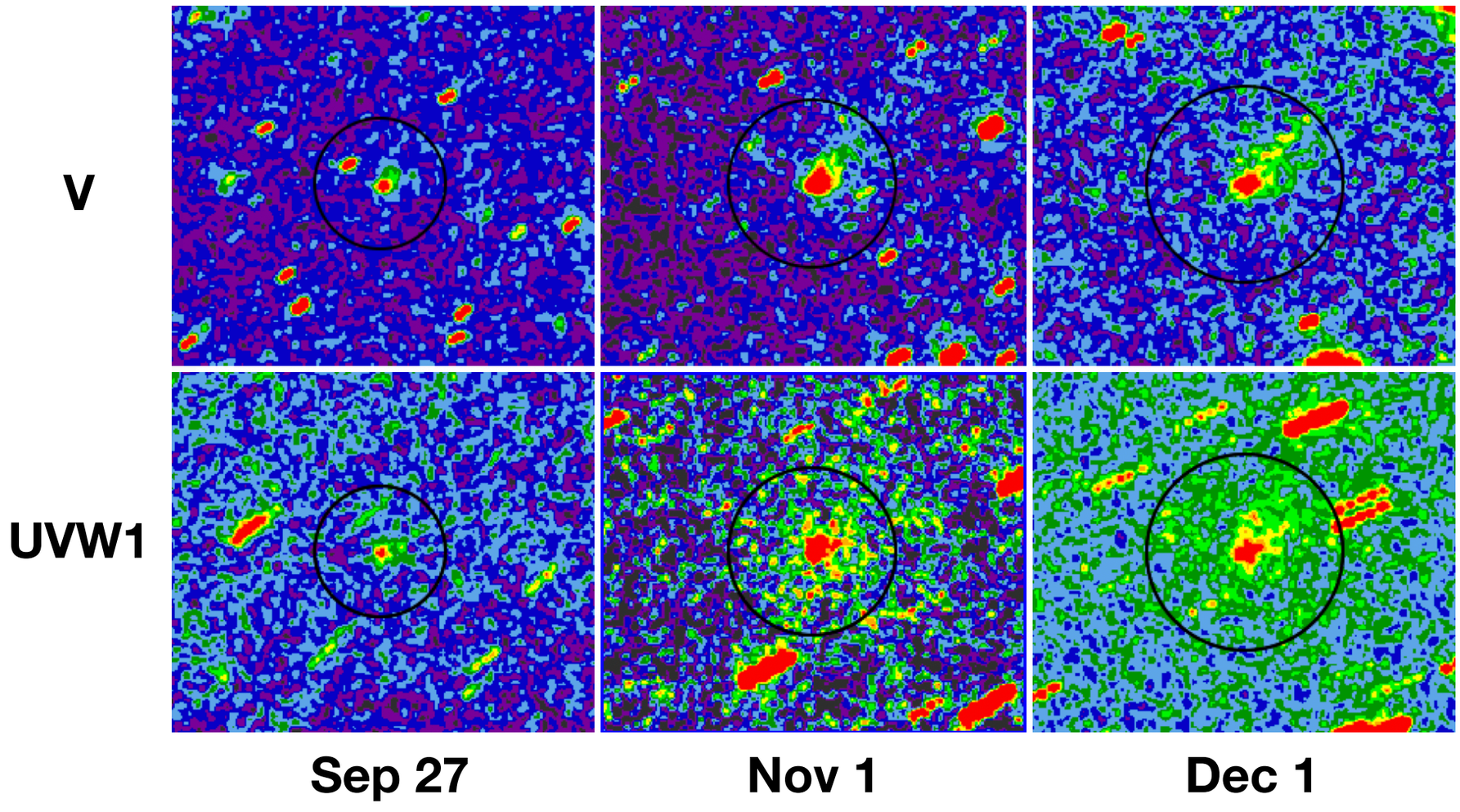
- Carried out every observation by **multiple exposures** to remove smearing
- **Discarded** exposures heavily contaminated by background stars
- Aligned and **co-added** the left exposures to increase SNR



Reduction Procedure

(α=0.093 for un-reddened solar spectrum)

$$\underbrace{C_{\mathrm{OH}}}_{\text{② aperture photometry}} = \underbrace{C_{\mathrm{UVW1}} - \alpha \cdot C_{\mathrm{V}}}_{\text{① subtract V from UVW1 image}}$$

↓

③ $\mathrm{Flux_{OH}} = \beta \cdot C_{\mathrm{OH}}$

β can be estimated by a model of OH spectrum

④ g-factor ↓

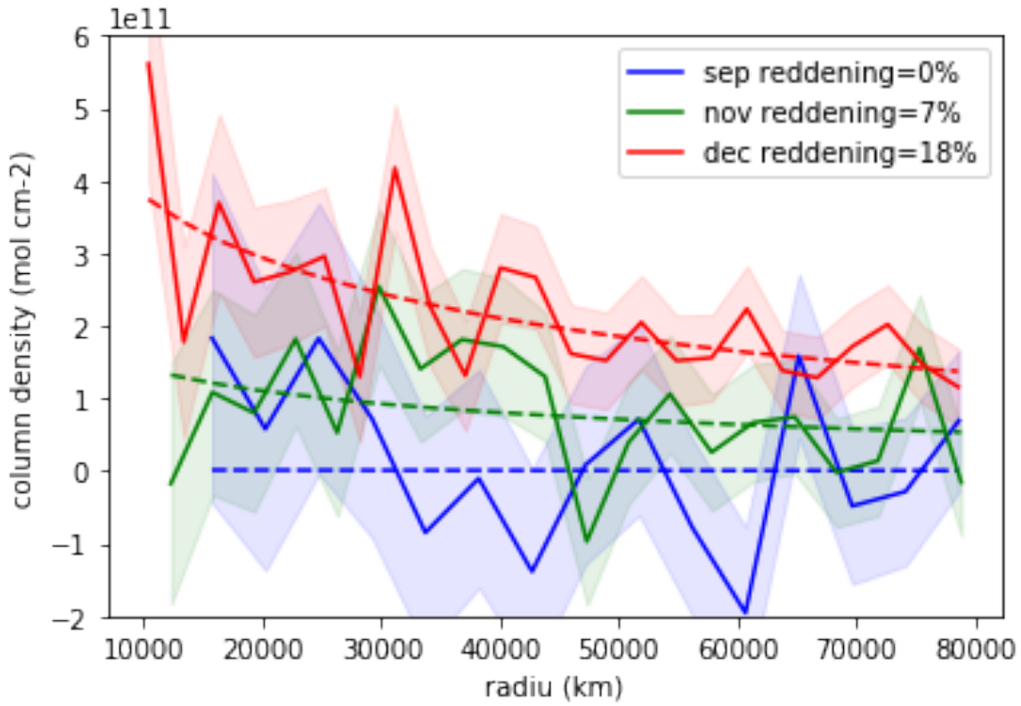
Nmol within the aperture

⑤ got Nmol for a series of annuli within the aperture (80 000km) ↓

column density profile

⑥ adjust reddening (α) to fit vectorial model ↓

water production rate



Results

Midtime	ΔT_{peri} (days)	rFoV (arcsec/km)	Filter	C_{filter} (cts s^{-1})	m_{filter} (mag)	Flux$_{filter}$ (erg s^{-1} cm^{-2})	C_{OH} (cts s^{-1})	reddening (%)
2019-09-27T08:52:40.500	-72.2	36/8.1E+04	V	1.5±0.4	17.4±0.3	(3.7±1.0)E-13	0.0±0.1	0
			UVW1	0.14±0.07	19.7±0.6	(1.4±0.4)E-12		
2019-11-01T19:52:26.500	-36.7	46/8.1E+04	V	7.4±0.6	15.7±0.1	(1.8±0.2)E-12	0.4±0.1	7
			UVW1	1.0±0.1	17.5±0.1	(5.4±0.5)E-12		
2019-12-01T12:17:04.500	-7.0	54/8.0E+04	V	5.1±1.1	16.1±0.2	(1.2±0.3)E-12	1.4±0.1	18
			UVW1	1.7±0.1	16.9±0.1	(2.7±0.6)E-12		

g-factor (erg s^{-1} mol^{-1})	N_{mol} (mol)	Q_{H_2O} (mol s^{-1})	active area (km^2)	active radius (km)	$Af\rho$ (m)	phase cor (0 deg)	$A(0)f\rho$ (m)
3.7E-16	(0.2±7.5)E+30	(0.1±2.5)E+26	0.0±0.4	0.03±0.55	0.46±0.04	0.55	0.84±0.06
5.5E-16	(1.5±0.5)E+31	(4.6±1.5)E+26	0.5±0.2	0.20±0.03	0.49±0.02	0.46	1.05±0.05
5.5E-16	(3.8±0.3)E+31	(1.1±0.1)E+27	1.1±0.1	0.30±0.01	0.41±0.03	0.43	0.95±0.07