< Cosmic Shadow 2018 >

すばるHSCによって発見された最遠red quasar候補の分析

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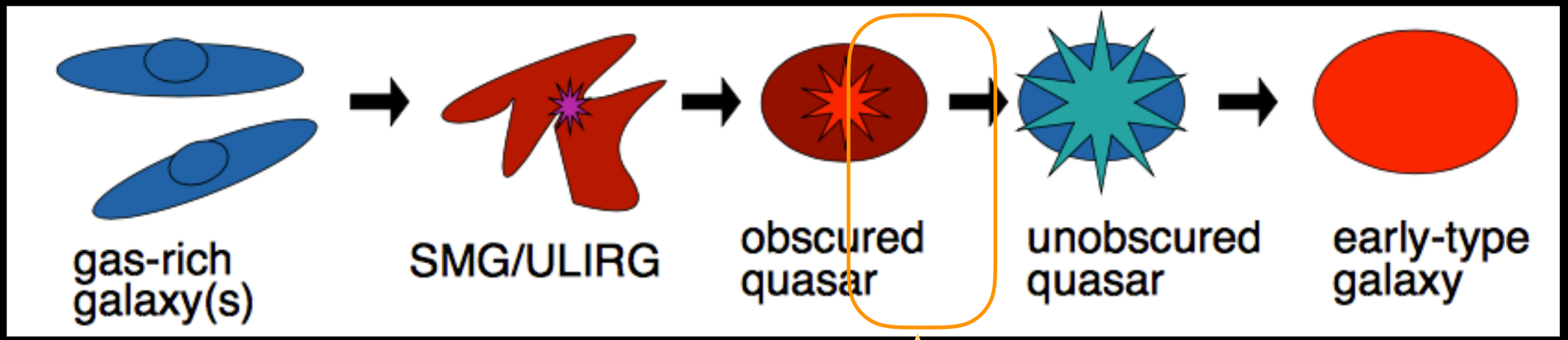
Red quasar

- Red quasars might be in the phase of transition from hidden accretion(obscured BH growing phase) to unobscured radiation (traditional quasar), i.e. “blowout" phase



Alexander & Hickox 2012

- This population is a useful probe to understand the formation and evolution of quasars and their host galaxies

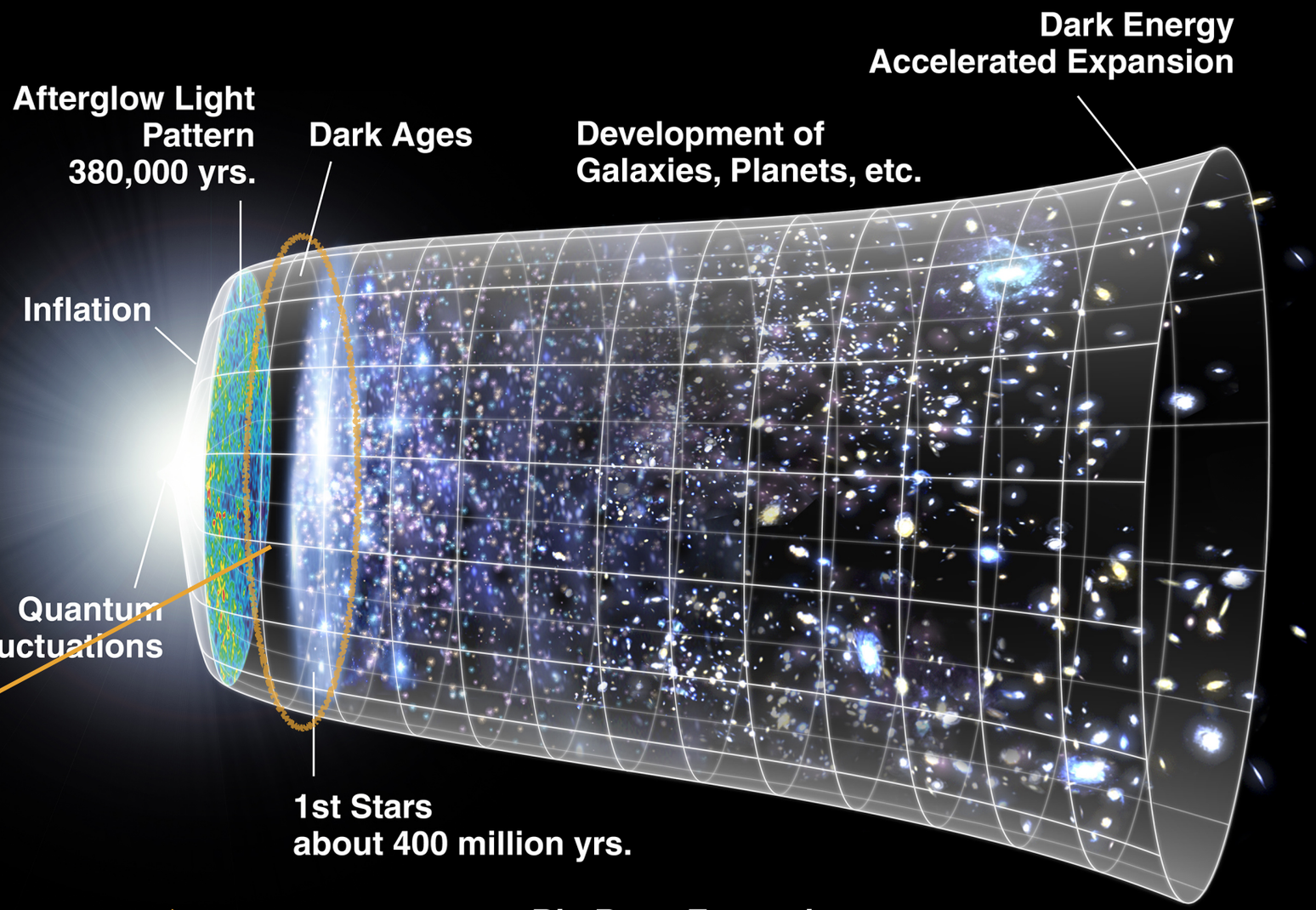
Definition (Glikman et al. 2012)

- At least one broad emission line in the spectrum ($v \geq 1000$ $\mathrm{km\,s^{-1}}$)
- $E(B\text{-}V) \geq 0.1$

SHELLQs project

… **S**ubaru **H**igh-z **E**xploration of **L**ow-**L**uminosity **Q**uasar**s** project,
based on the Subaru Hyper Suprime-Cam (HSC) SSP survey

- More than 80 new high-z ($z > 5.7$) quasars have been discovered by SHELLQs



Cosmic reionization
$z \sim$ 6-10
(Cosmic age：about 0.5 ~ 1 billion year)

https://ja.wikipedia.org/wiki/宇宙の年表

SHELLQs project

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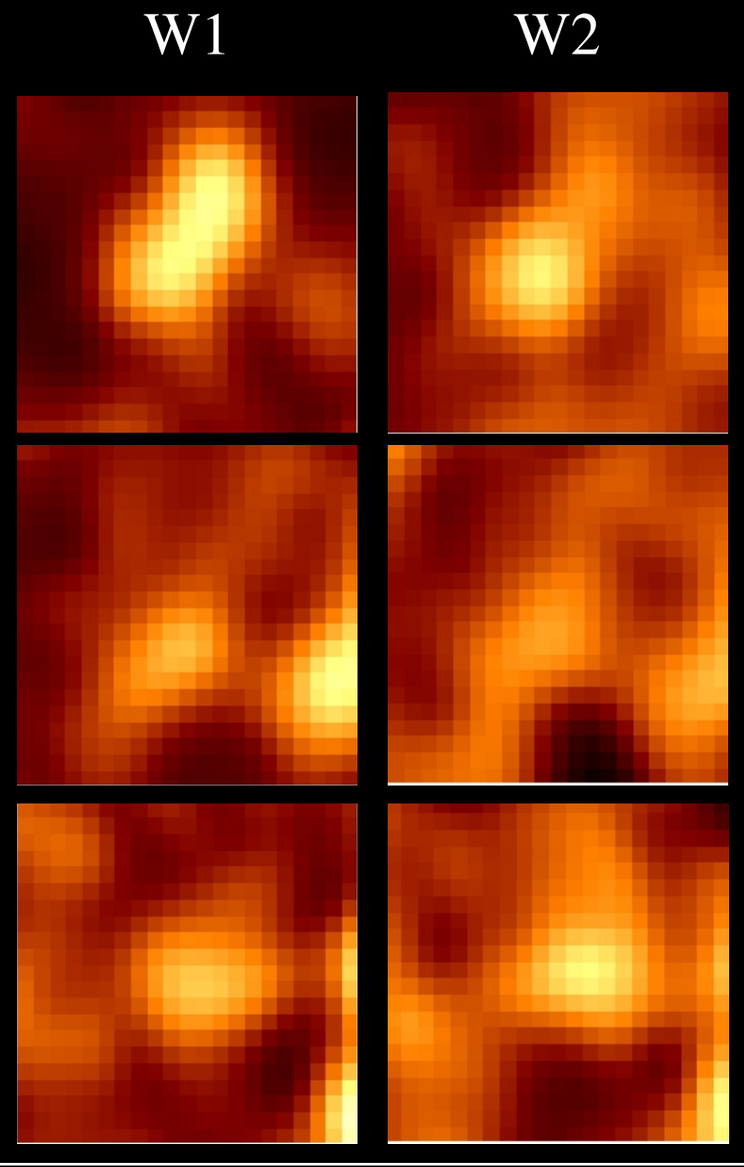
⇩

We aim to reveal whether red quasars prevail in the early universe using this sample

WISE (**W**ide-field **I**nfrared **S**urvey **E**xplorer)

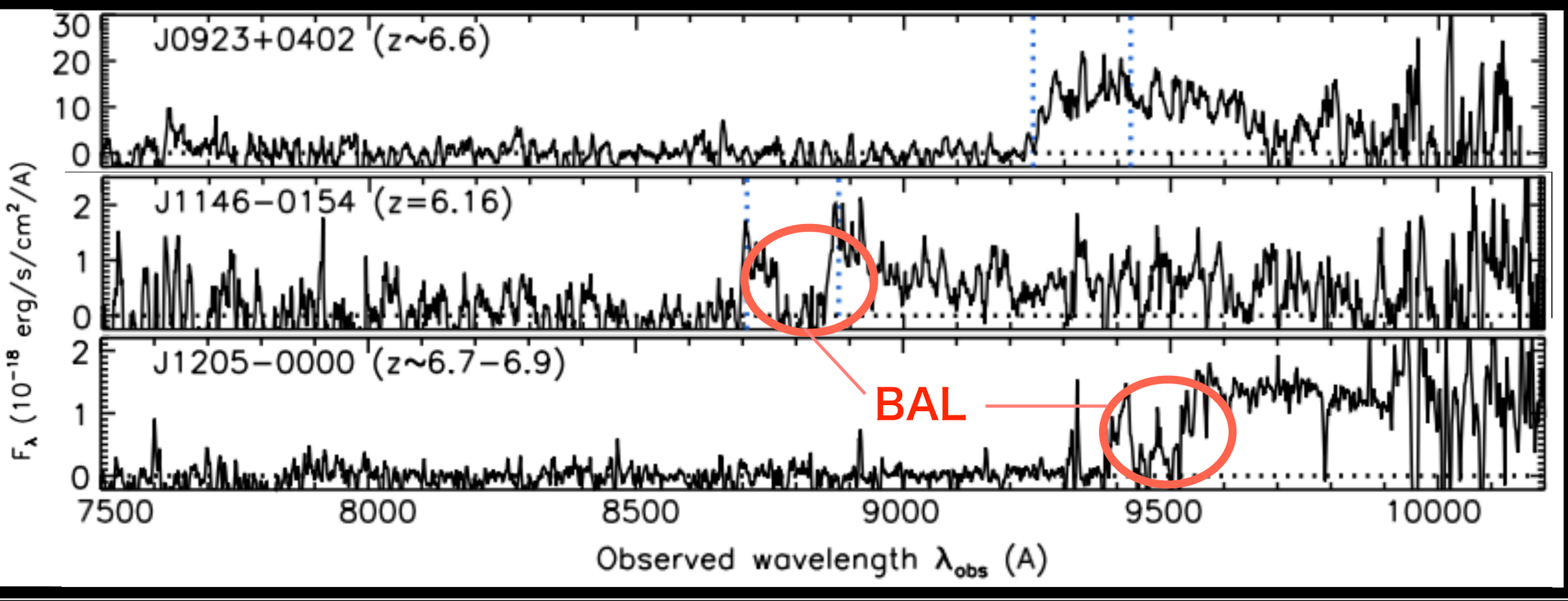
- WISE performed an all-sky astronomical survey in the 3.4 (*W1*), 4.6 (*W2*), 12 (*W3*) and 22 (*W4*) μm bands

Of the ~80 quasars discovered by SHELLQs,
3 were detected by WISE



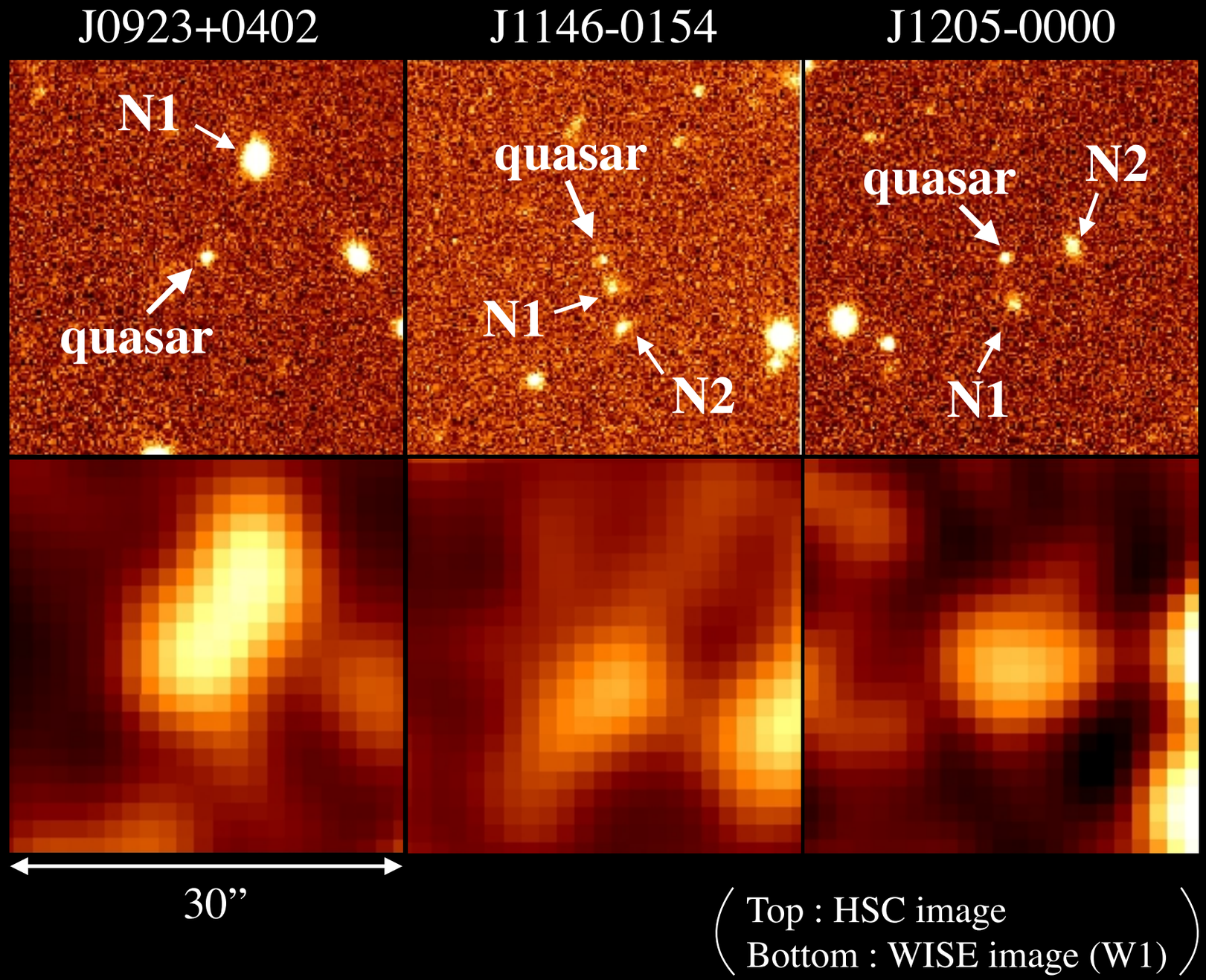
Properties of the 3 candidates from SHELLQs

	z_{AB} (mag)	M_{1450} (mag)	Redshift	AllWISE catalog magnitude	
				W1(AB mag)	W2(AB mag)
J0923+0402	22.64 ± 0.02	−26.18 ± 0.14	6.60	19.06 ± 0.07	19.20 ± 0.16
J1146-0154	23.60 ± 0.06	−23.43 ± 0.07	6.16	20.04 ± 0.16	20.16 ± 0.38
J1205-0000	>25.92	−24.56 ± 0.04	6.75	19.98 ± 0.15	19.65 ± 0.23



Possible flux contamination checked with the HSC image

- nearby objects can contribute to WISE flux



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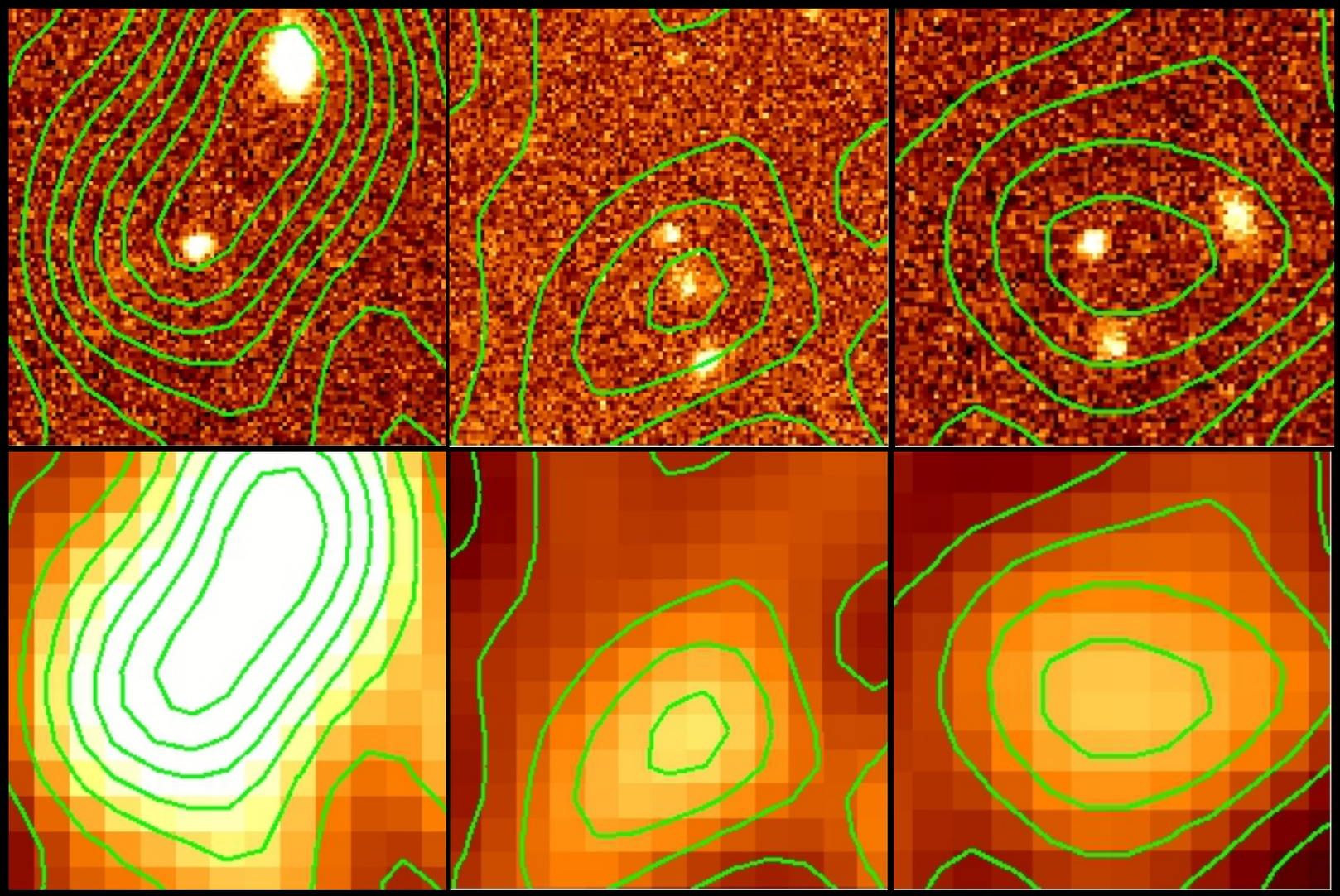
J0923+0402 J1146-0154 J1205-0000



(Top : HSC image
Bottom : WISE image (W1))

Possible flux contamination checked with the HSC image

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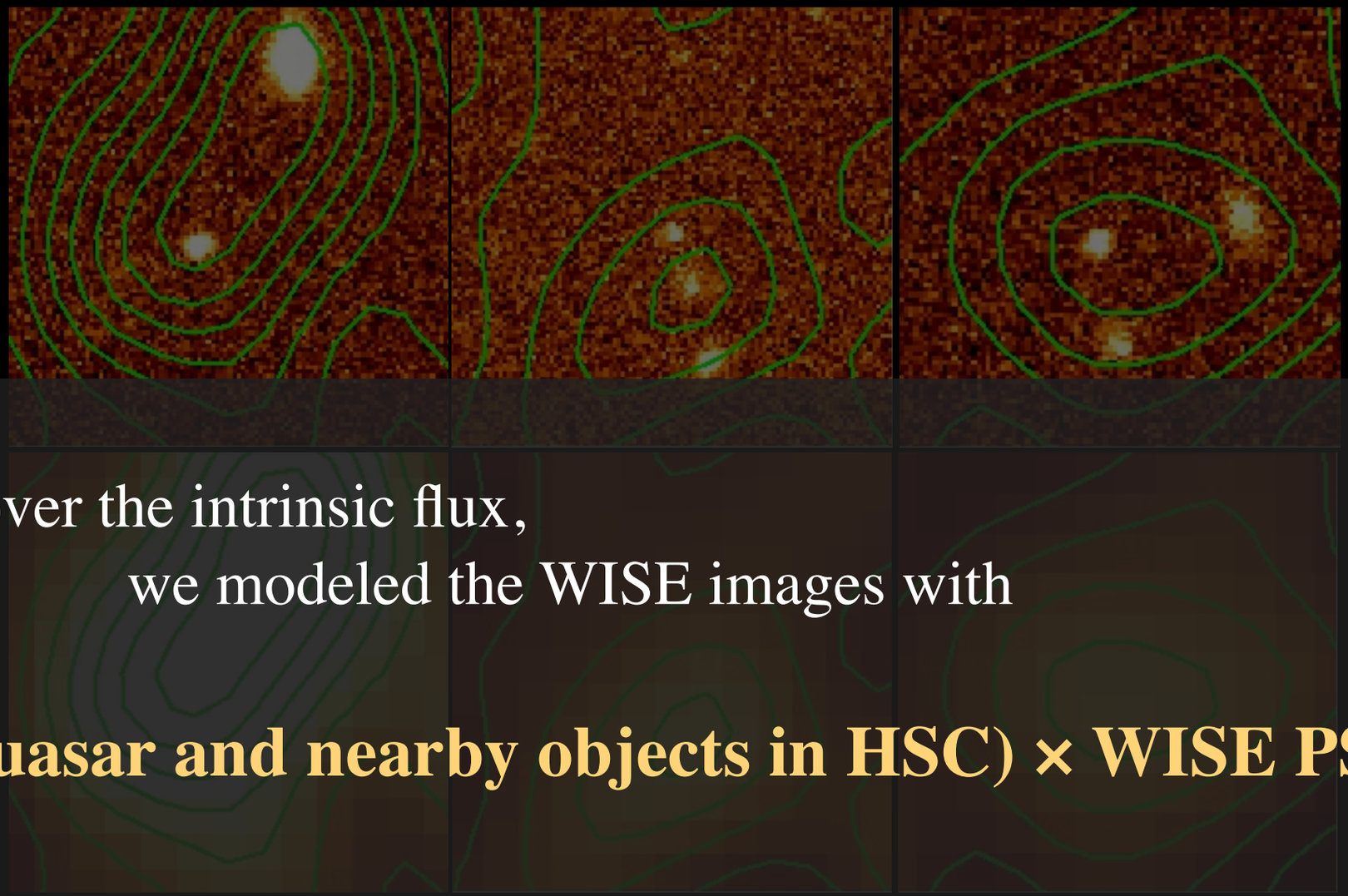
J0923+0402 J1146-0154 J1205-0000

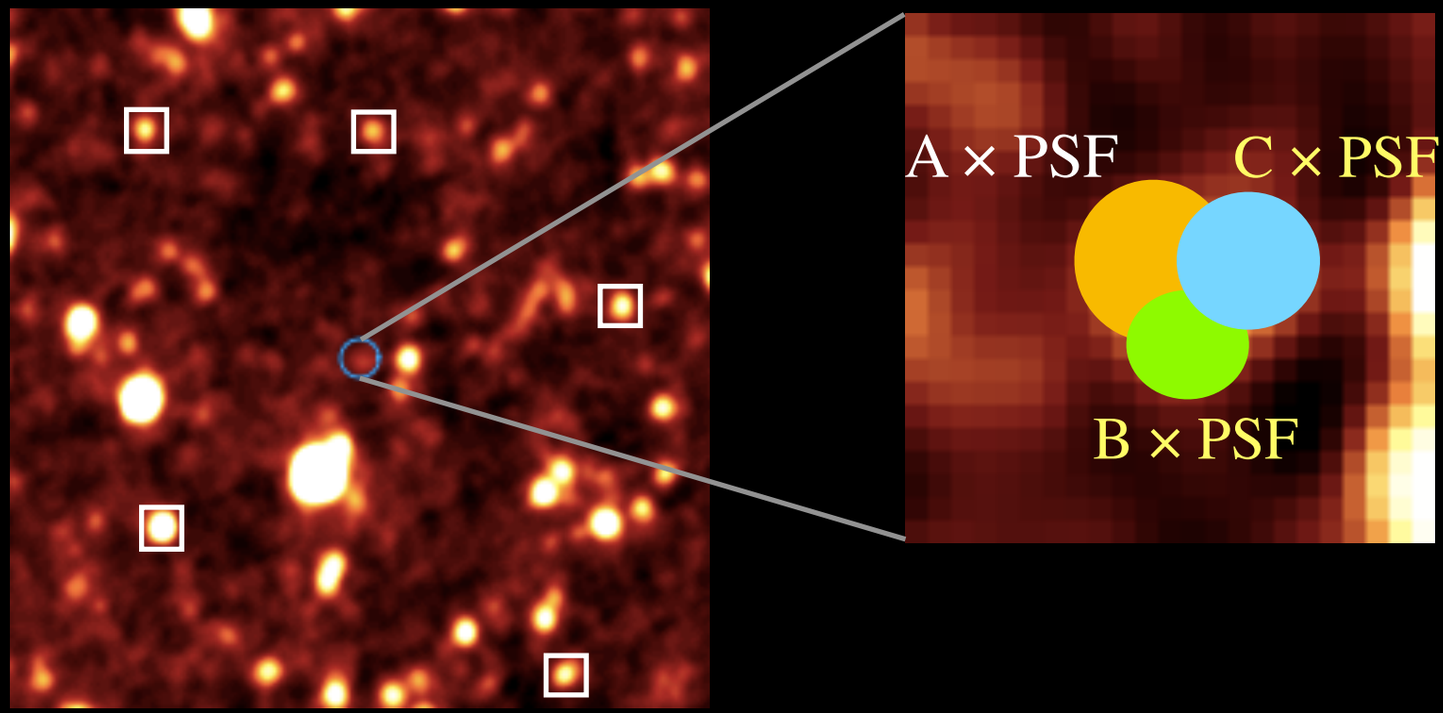


To recover the intrinsic flux,
we modeled the WISE images with

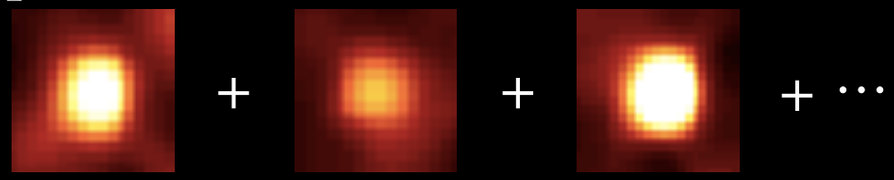
(quasar and nearby objects in HSC) × WISE PSF

(Top : HSC image
Bottom : WISE image (W1))

PSF estimation & Modeling objects



point sources



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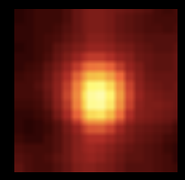
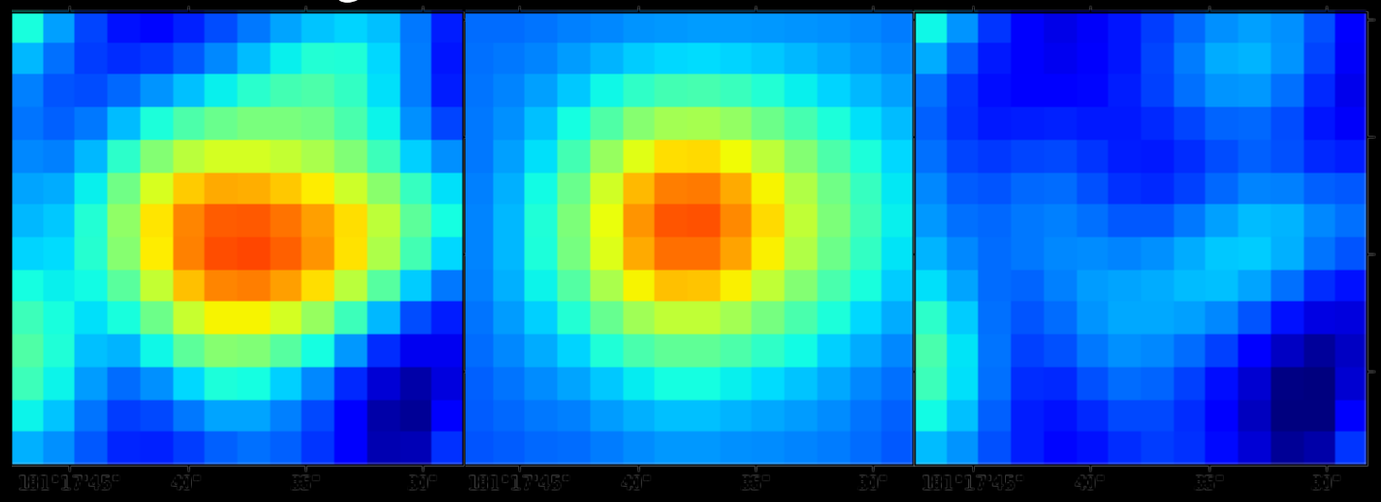


Normalized mean of ~10 nearby point sources

Reproduced the WISE images with multiple PSFs

WISE image　　model　　residual

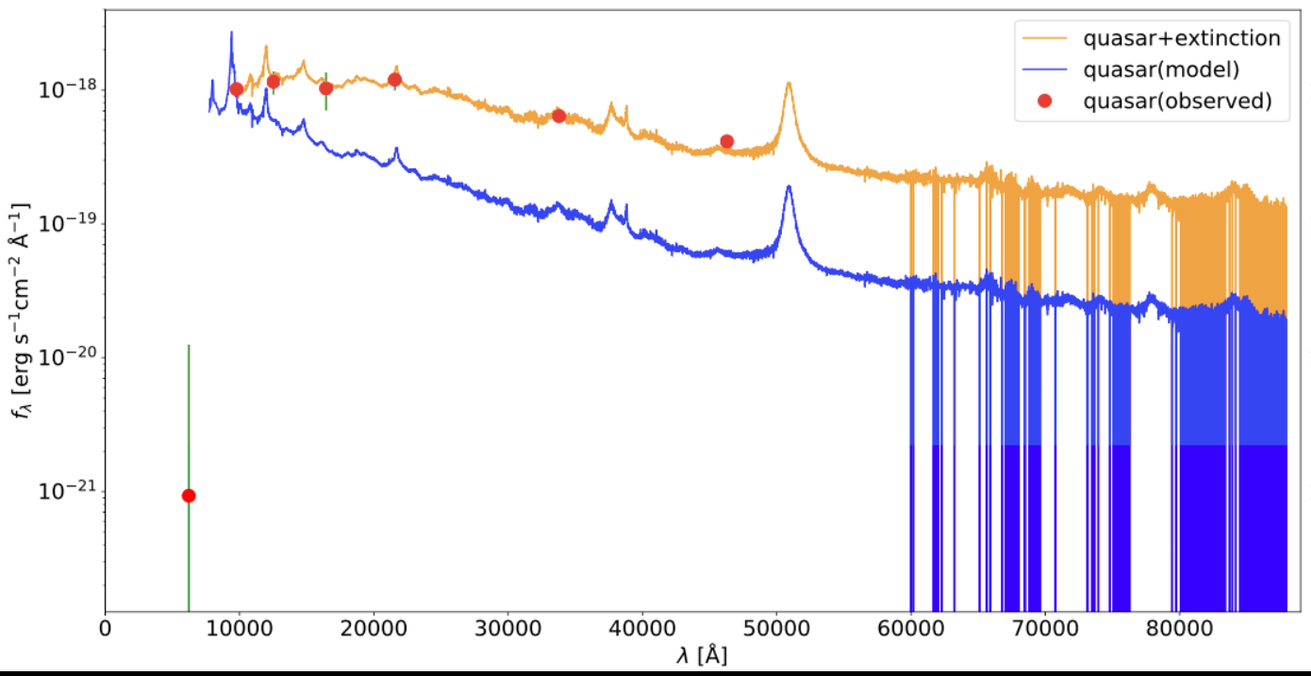


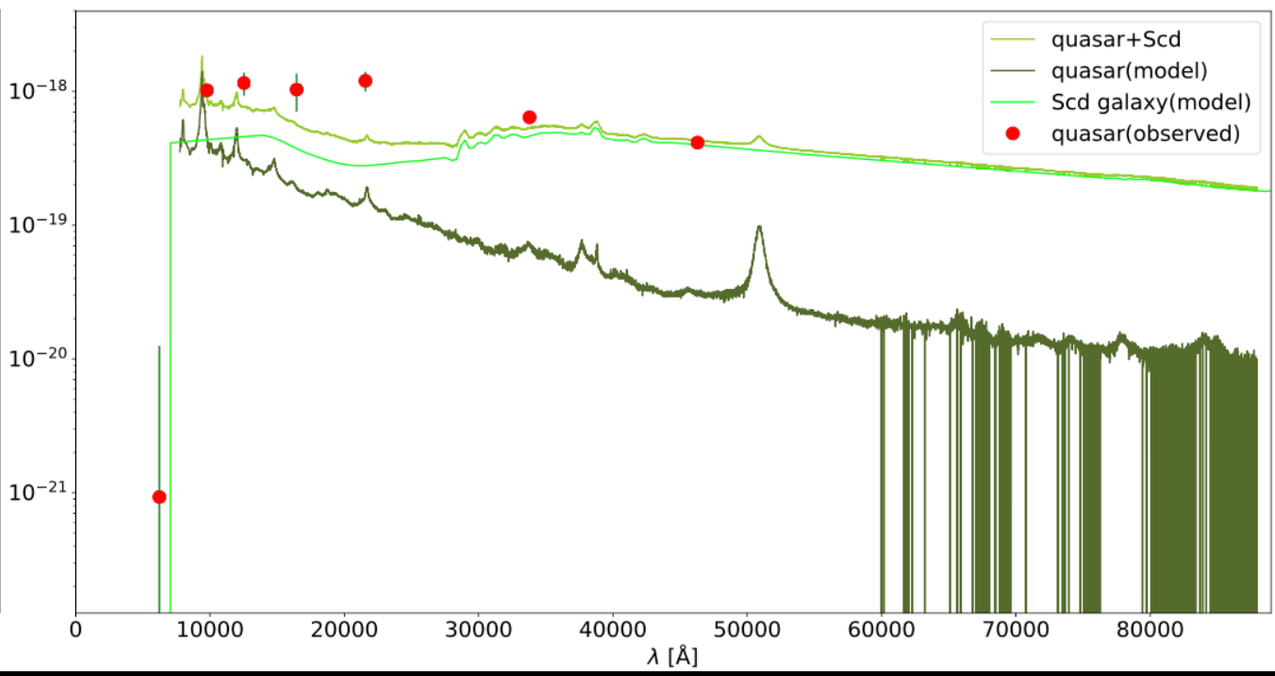
intrinsic WISE flux of quasar
||
A × PSF

Broad band SED fitting

SED models

- Left : quasar (Selsing et al. 2016) + SMC extinction (Pei 1992)
- Right : quasar (Selsing et al. 2016) + galaxy (Coleman et al. 1980)

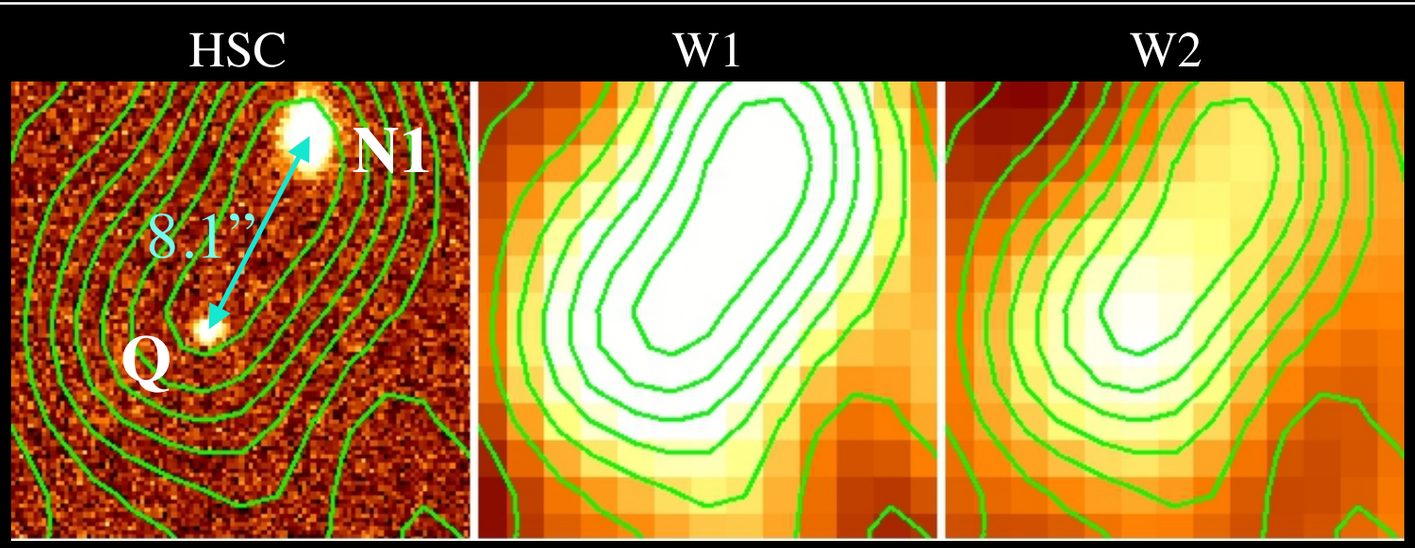




Compared reduced chi square values

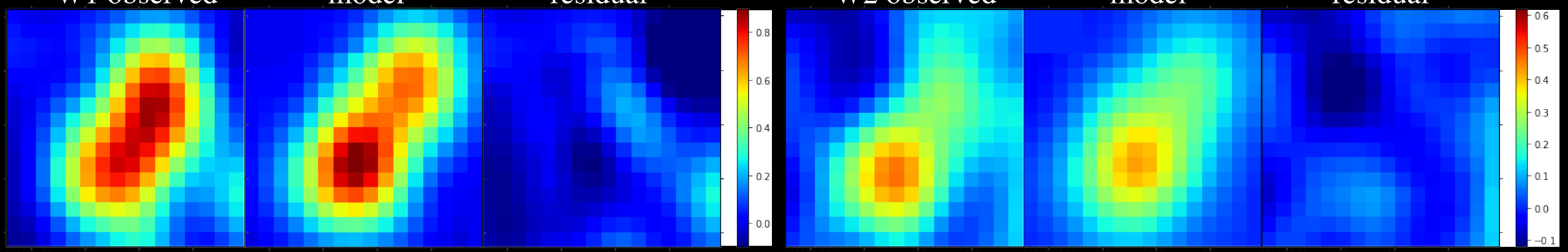
Checked *E(B -V)*

Investigated if the absolute magnitude (M_{1450}) and star formation rate (SFR) of quasar hosts are reasonable

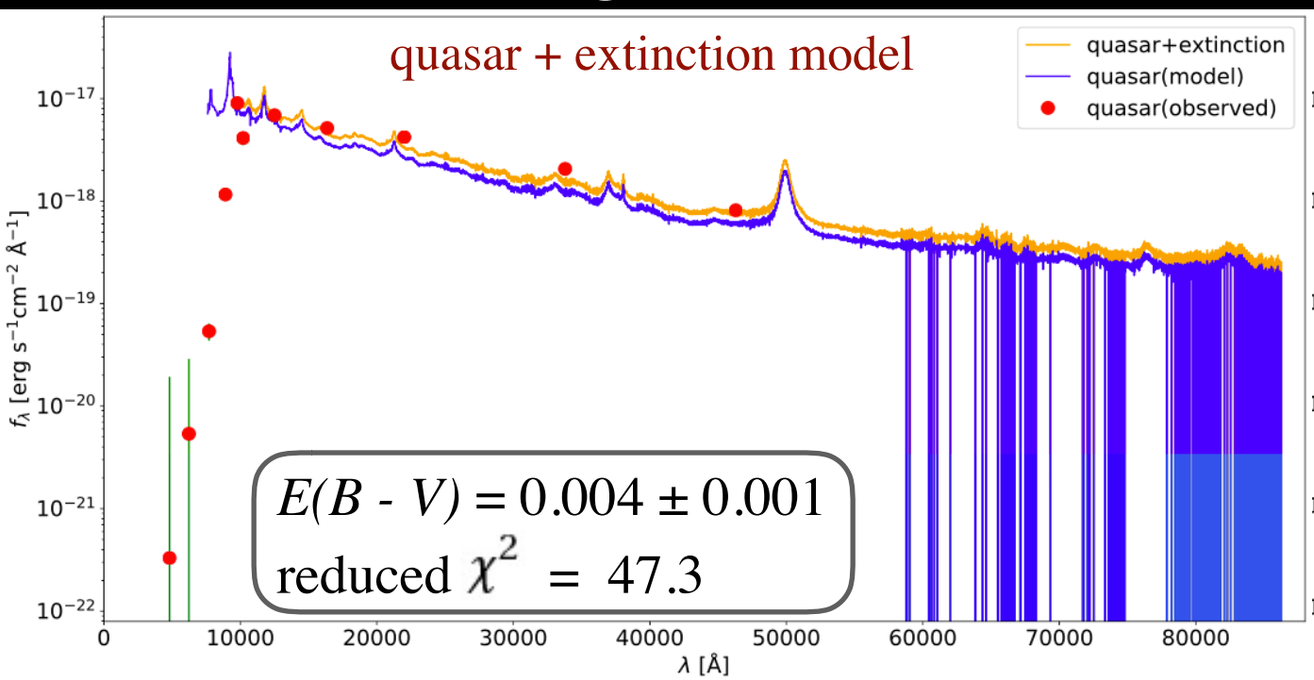


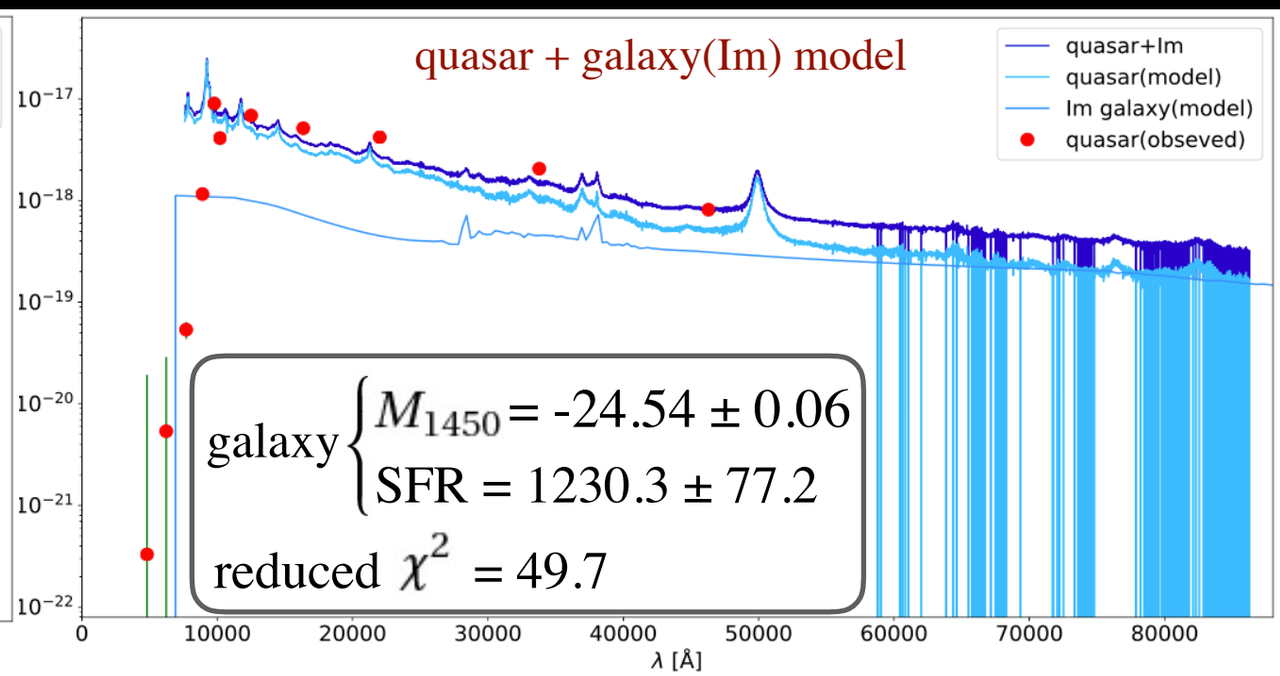
	decomposed flux fraction	
	quasar	N1
W1	59 ± 0.2%	41 ± 0.2%
W2	70 ± 2%	30 ± 2%

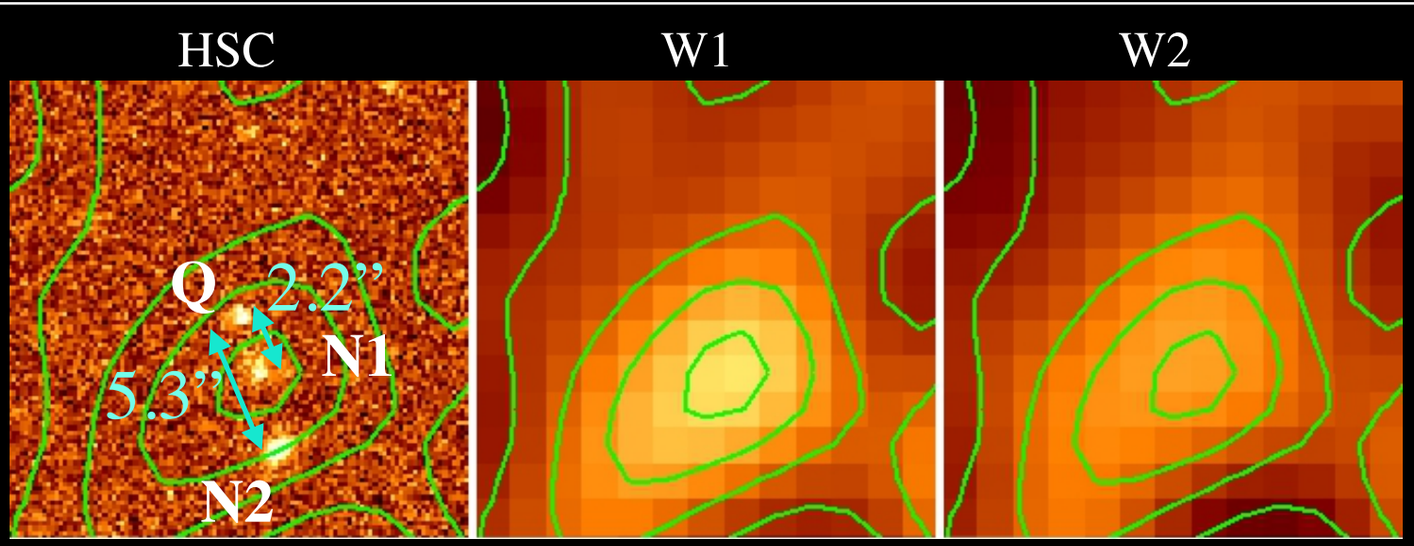
Reproduced the object by PSF



Broadband SED fitting

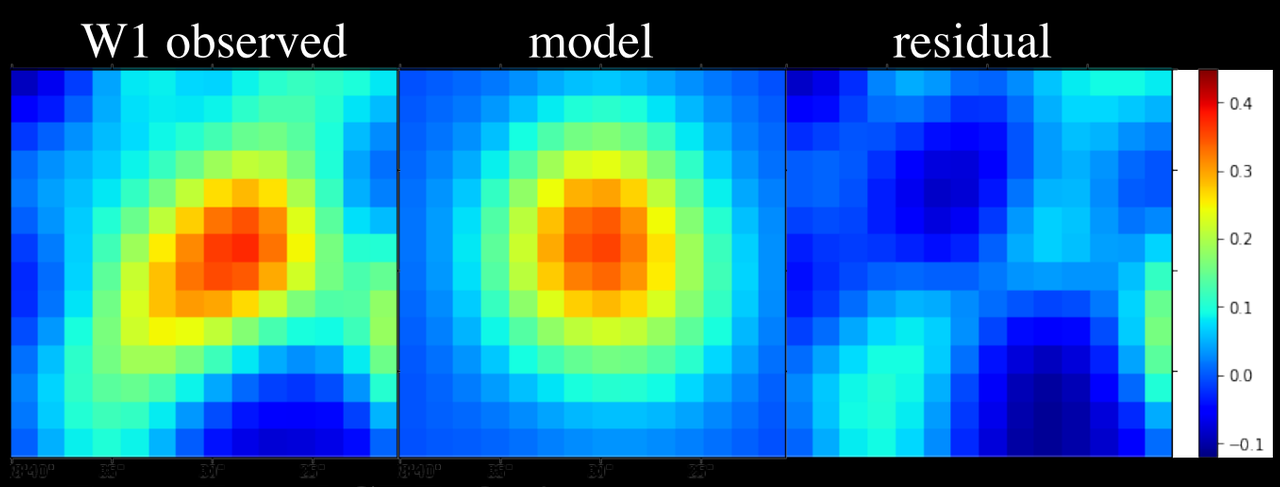




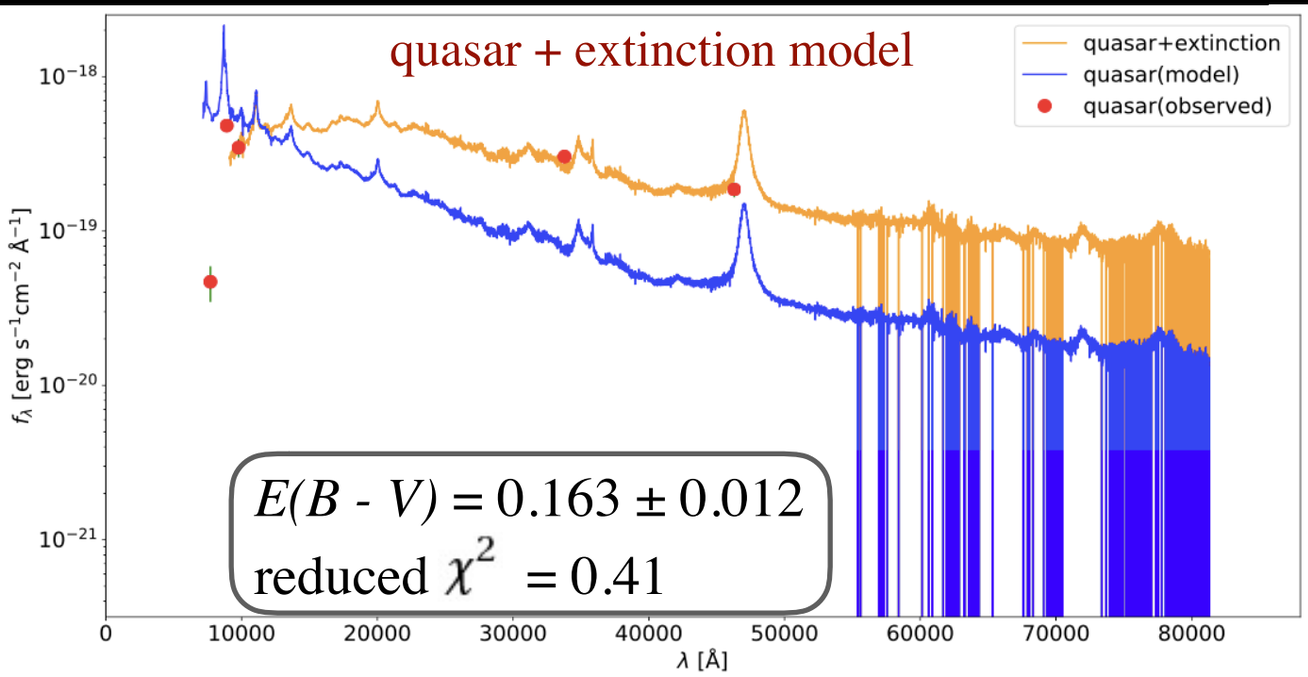


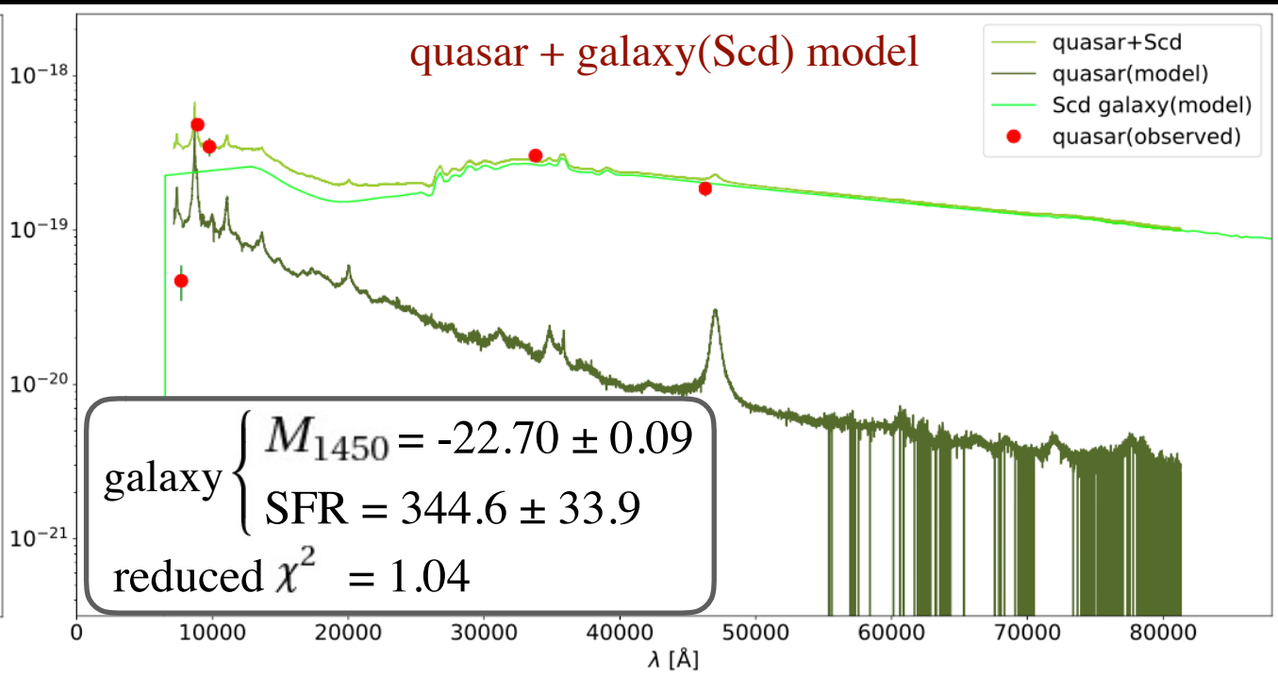
	decomposed flux fraction		
	quasar	nearby:1	nearby:2
W1	31 ± 2%	47 ± 7%	22 ± 5%
W2	51 ± 1%	49 ± 2%	0.5 ± 0.4%

Reproduced the object by PSF

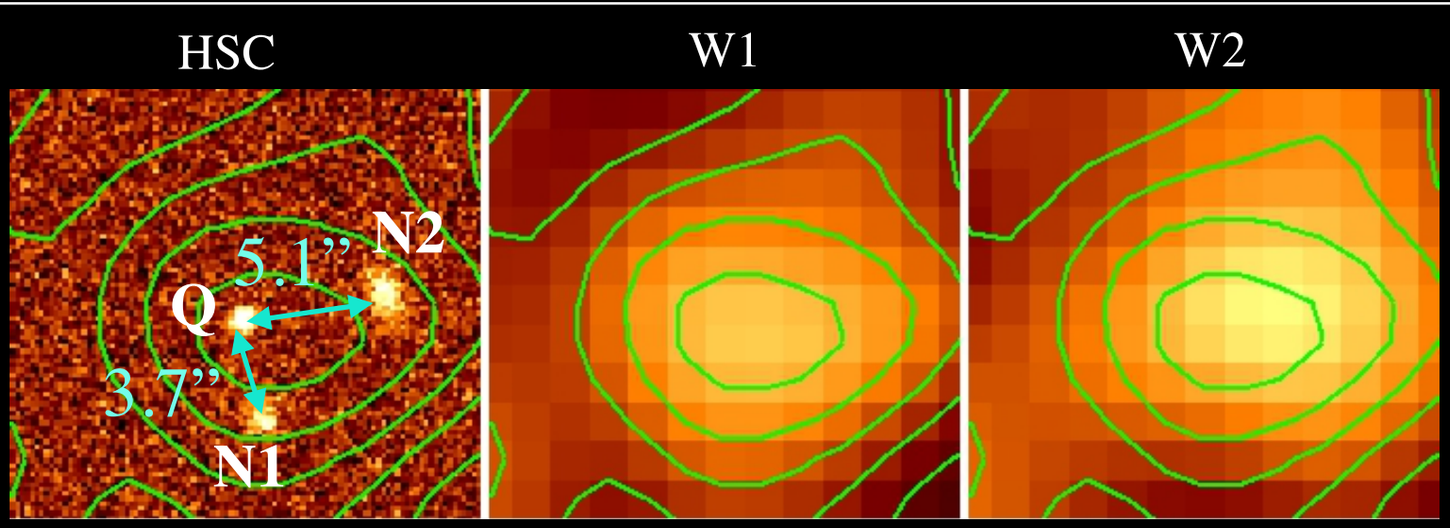


Broadband SED fitting



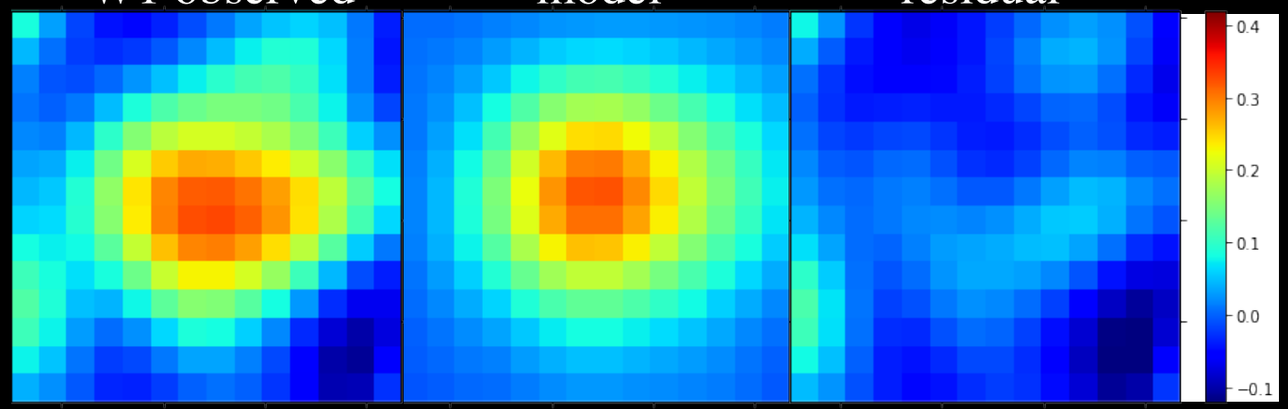


Possible red quasar !

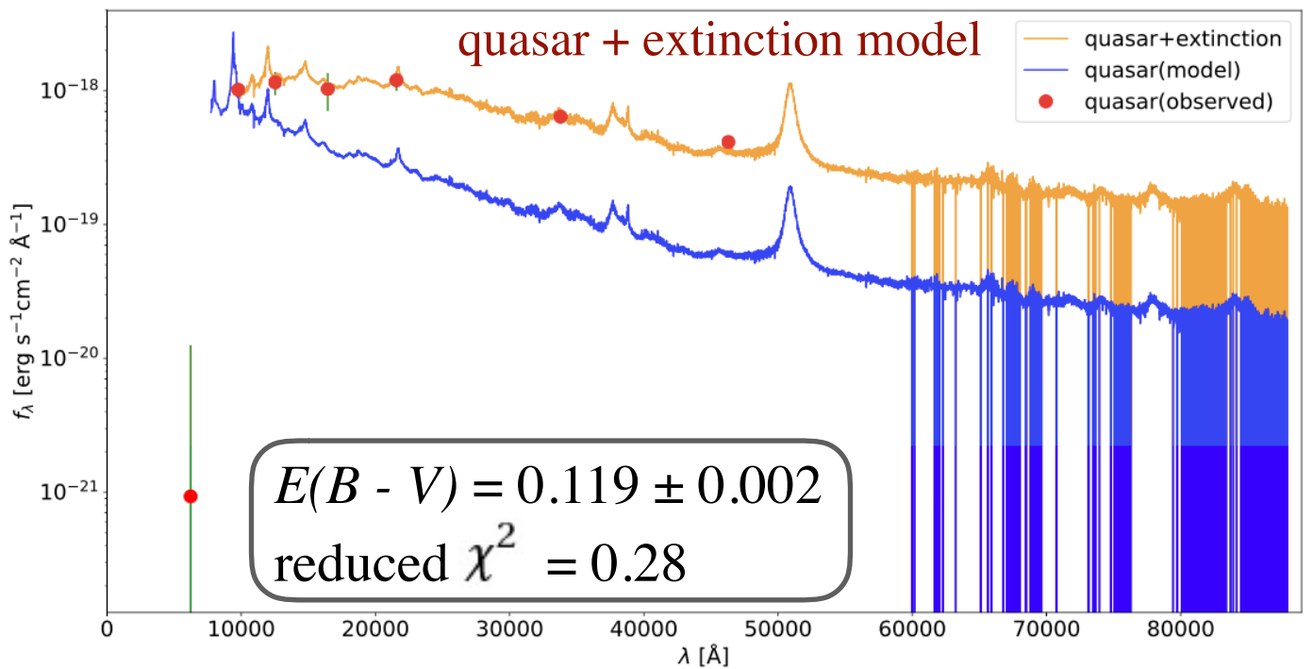


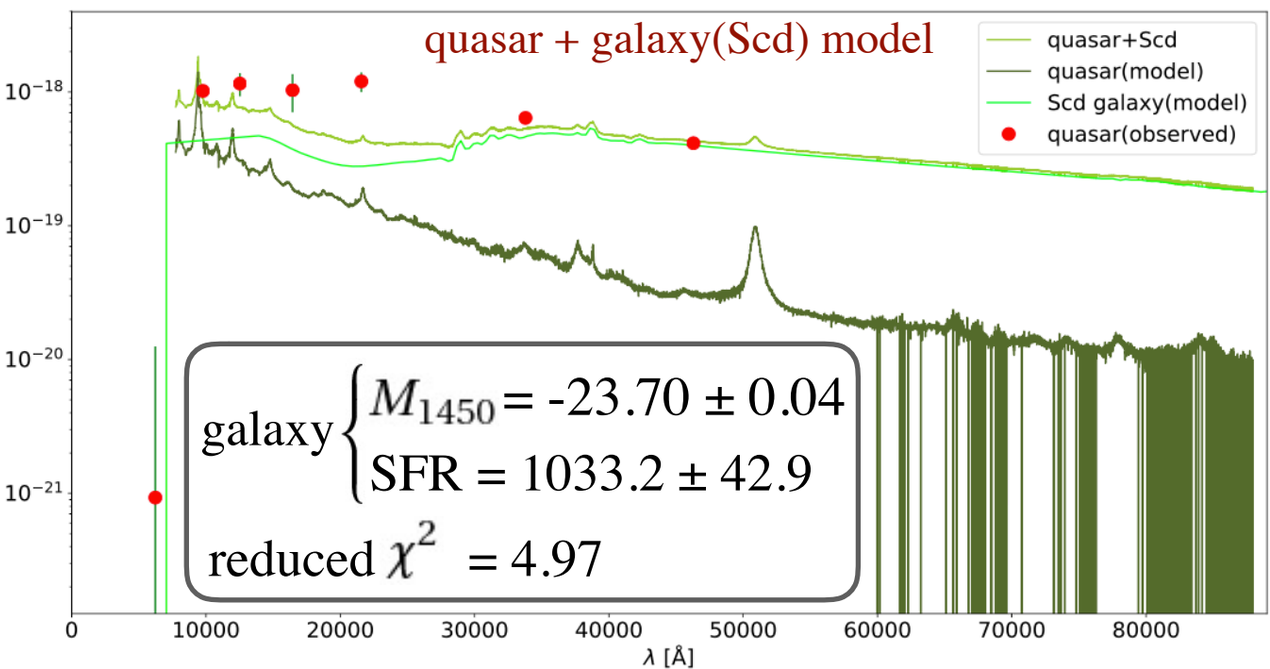
	decomposed flux fraction		
	quasar	nearby:1	nearby:2
W1	70 ± 0.04%	6 ± 0.8%	24 ± 0.8%
W2	57 ± 0.09%	0.3 ± 0.6%	43 ± 0.7%

Reproduced the object by PSF



Broadband SED fitting



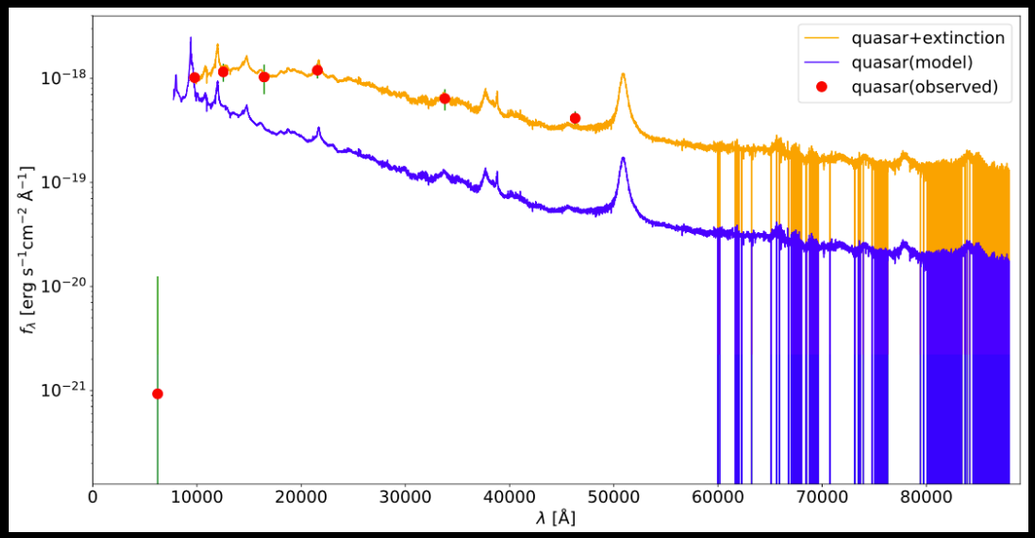


Searching for high-z red quasars

- The red quasar candidates were selected with a combination of the HSC and WISE data
- Reproduced the WISE images with multiple PSFs
- Constructed the broadband SEDs of each candidate and derived the color excess E(B -V)

→ Confirmed that one quasar is most likely a red quasar

Possible red quasar



Future prospects

- What's the interrelation? Red quasar vs. BAL
- We'll conduct the same analysis for more luminous sample