基于梦飞望远镜和天关卫星的恒星耀发观测及研究

张敬华・云南大学

2025.05.26 北京 @ 天关卫星时代的恒星X射线耀发研讨会

Photometric Telescope Survey

Monochromatic documentary

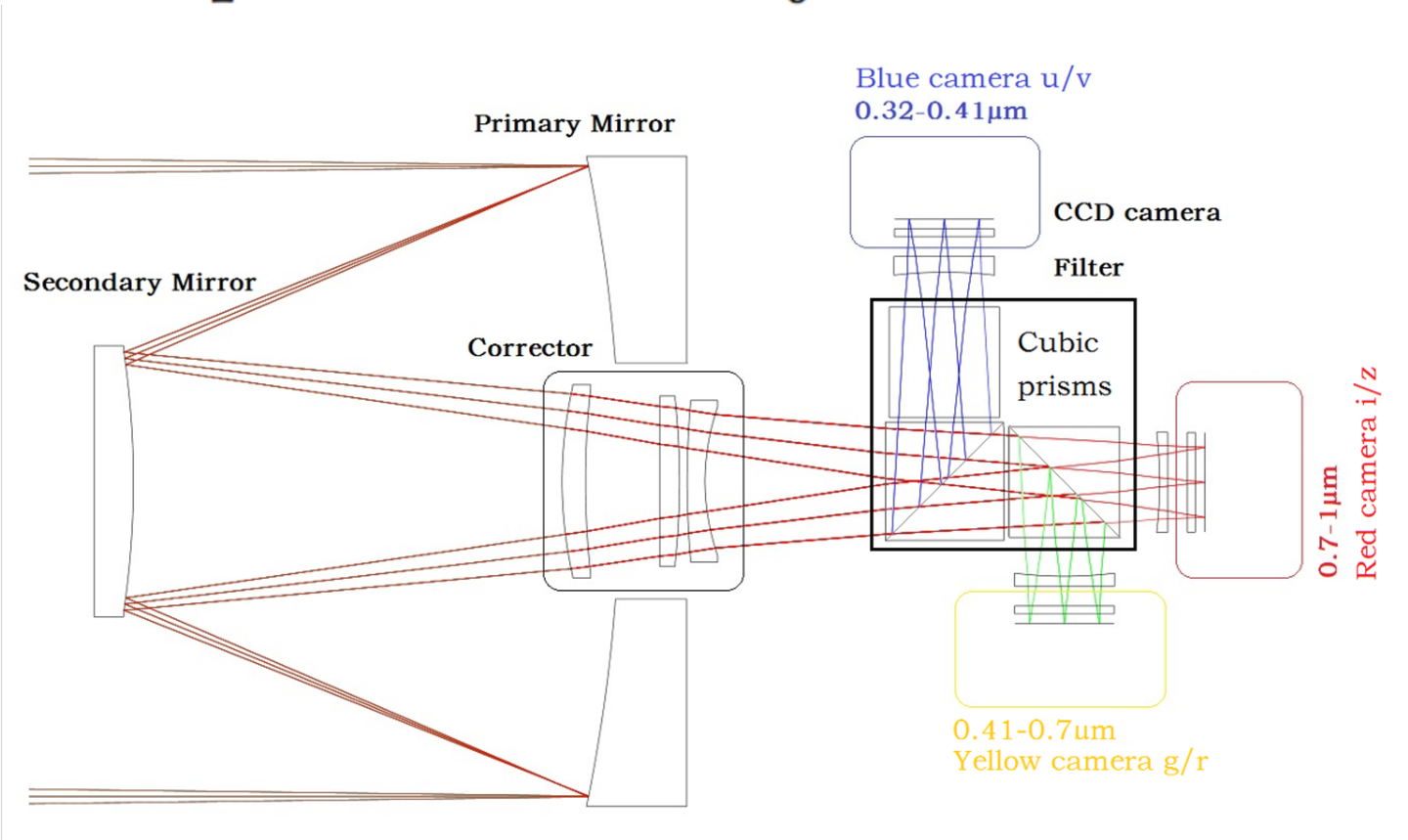
Full-colour documentary

Mephisto Features

Light-Path

wide-field multi-channel

$$\text{Mephisto} = \text{Survey} + \text{Real Color}$$

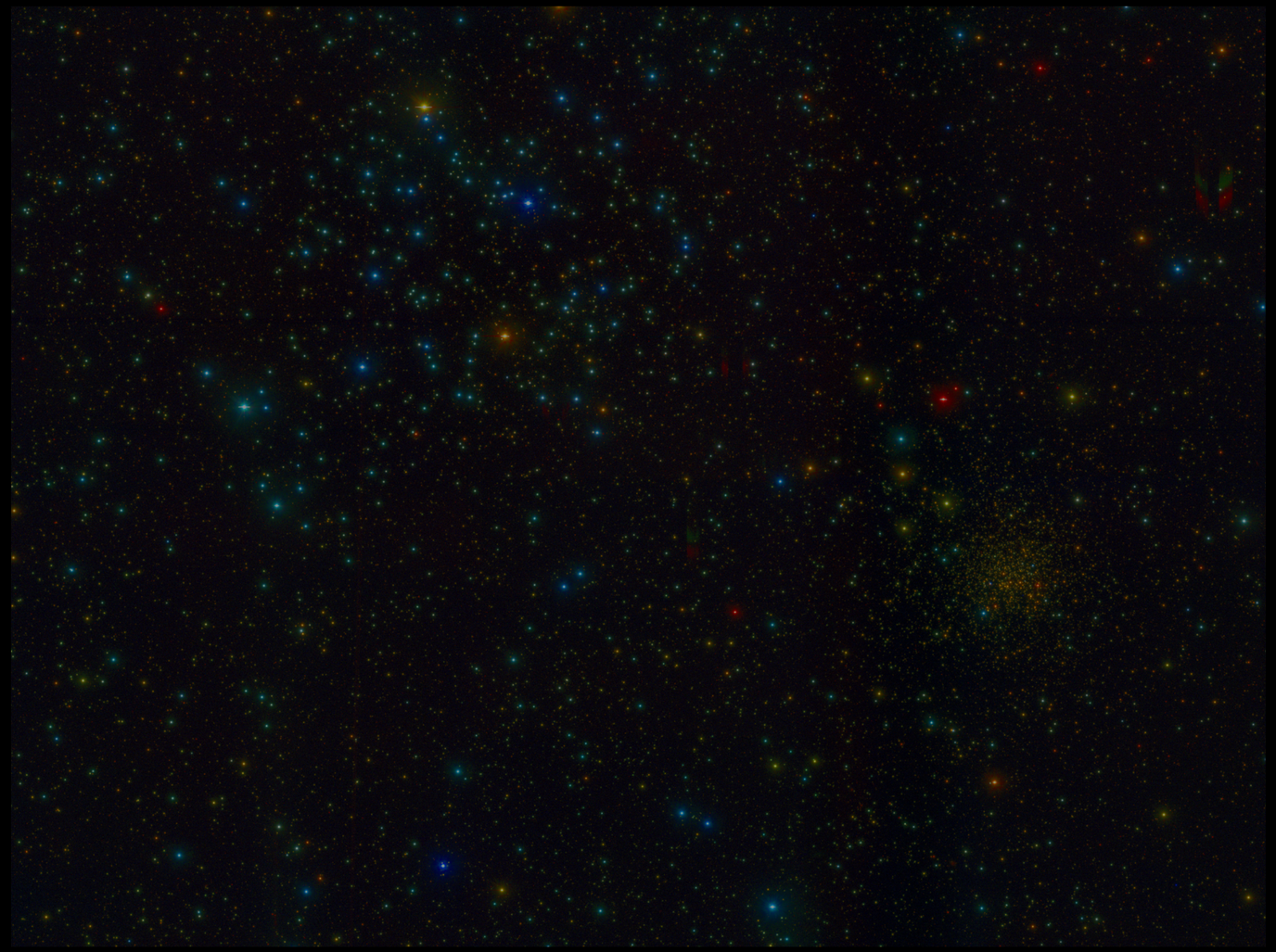


- Ritchey-Chretien (RC) system with correctors → Large aperture & FoV + Room for 3 cameras
- Film-coated cubic prisms for beam-splitting → Three-channels of high image-quality (full FoV)

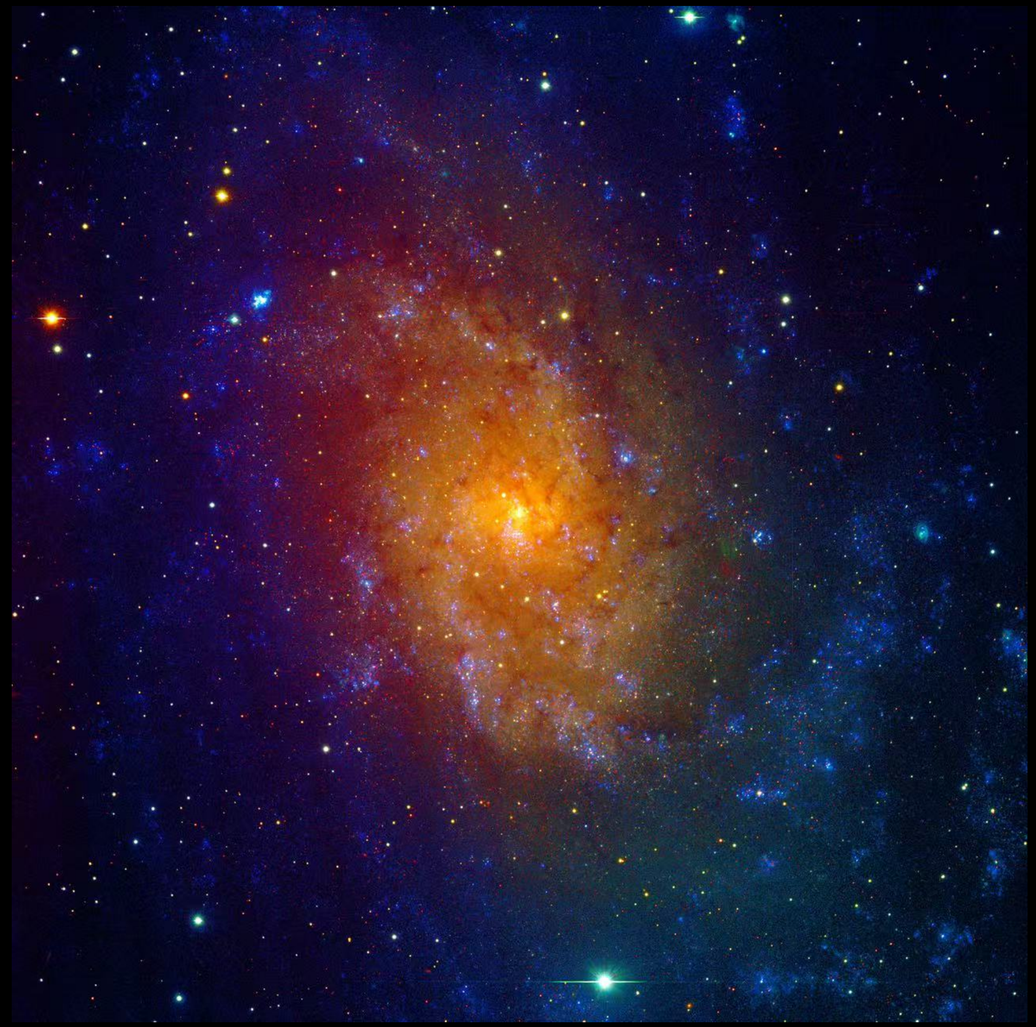
Mephisto Features

Real-color

M35 & NGC2158



M33

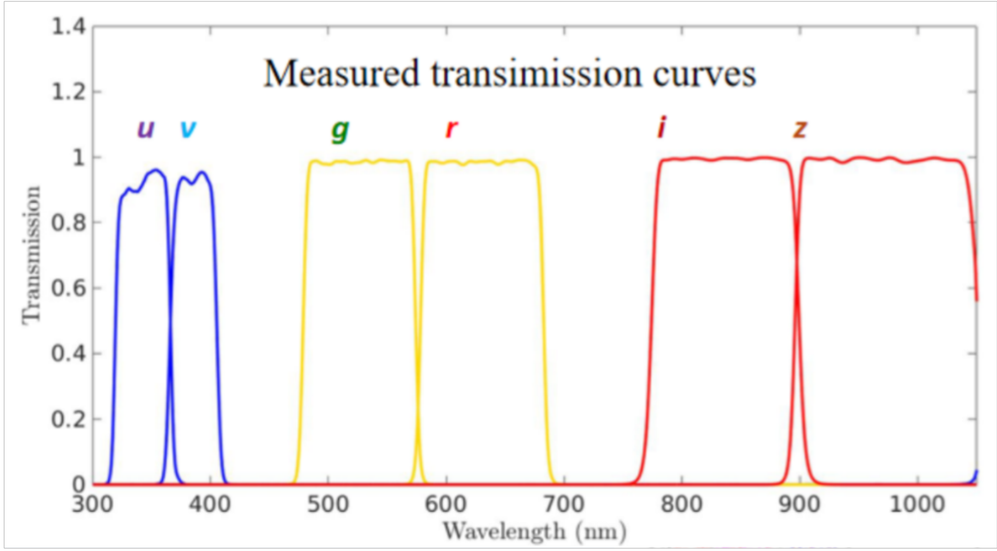


Mephisto Features

Filter System

- Optimized for stellar and galactic astrophysics, allowing precise parameter determinations($T_{\rm eff}$, log g, [Fe/H]) for stars and stellar populations.

	For G dwarfs with [Fe/H] in			
Δ(v − g)/Δ[Fe/H] (mag/dex)	[−1.0,+0.5]	[−2.0,−1.0]	[−3.0,−2.0]	[−3.0,−4.0]
	0.27 (0.04)	0.15 (0.07)	0.07 (0.15)	0.02 (0.5)
	For G Giants			
Δ(v − g)/Δ[Fe/H] (mag/dex)	[−1.0,+0.5]	[−2.0,−1.0]	[−3.0,−2.0]	[−3.0,−4.0]
	0.32 (0.03)	0.13 (0.08)	0.05 (0.2)	0.03 (0.3)
	For stars of Teff = 5800 K and [Fe/H] = 0.0			
Δ(u − v)/Δlog(g) (mag/dex)	log(g)< 4.0		log(g)> 4.0	
	0.23 (0.04)		0.07 (0.15)	



Channel	Filters	Wavelength coverage (central wavelength) (nm)	Average Efficiency
Blue	u	320-365 (342)	~90%
	v	365-405 (385)	~93%
Yellow	g	480-580 (530)	~99%
	r	580-680 (630)	~98%
Red	i	775-900 (837)	~99%
	z	900-1050 (975)	~99%

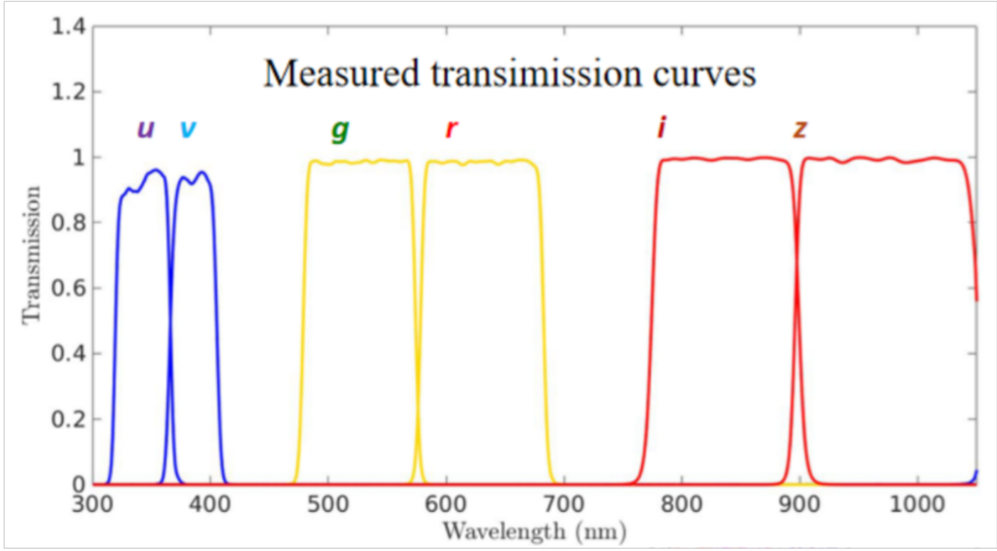
Mephisto Features

Filter System

- Optimized for stellar and galactic astrophysics, allowing precise parameter determinations($T_{\rm eff}$, log g, [Fe/H]) for stars and stellar populations.

Survey	Area	Cadence
Mephisto-W	27000 deg^2	~ Month
Mephisto-D	N*1800 deg^2	> Day
Mephisto-H	N*180 deg^2	> Hour
Mephisto-M	N*18 deg^2	> Minute

Mephisto survey for transients and variables



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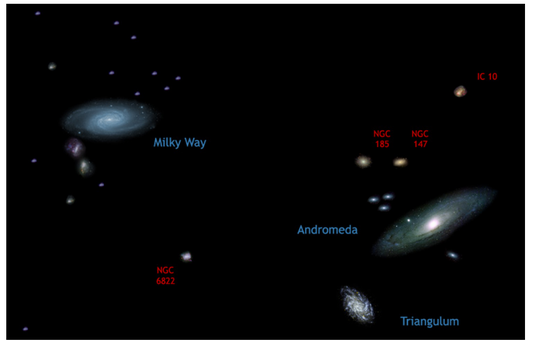
	z	900-1050 (975)	~99%

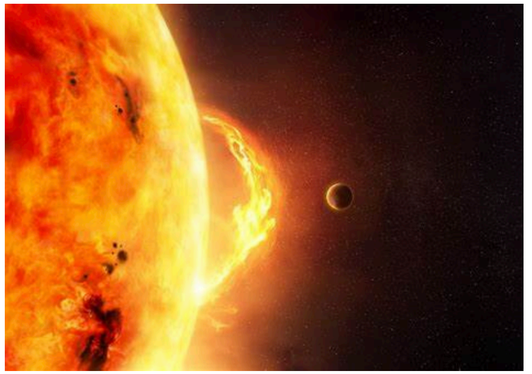
- **Galaxy**: How to reveal the properties, structure, and integrated history of the Milky Way galaxy population based on billions of star samples?

- **Nearby Galaxy**: The fine structure, population properties, and distance of large sample nearby galaxies

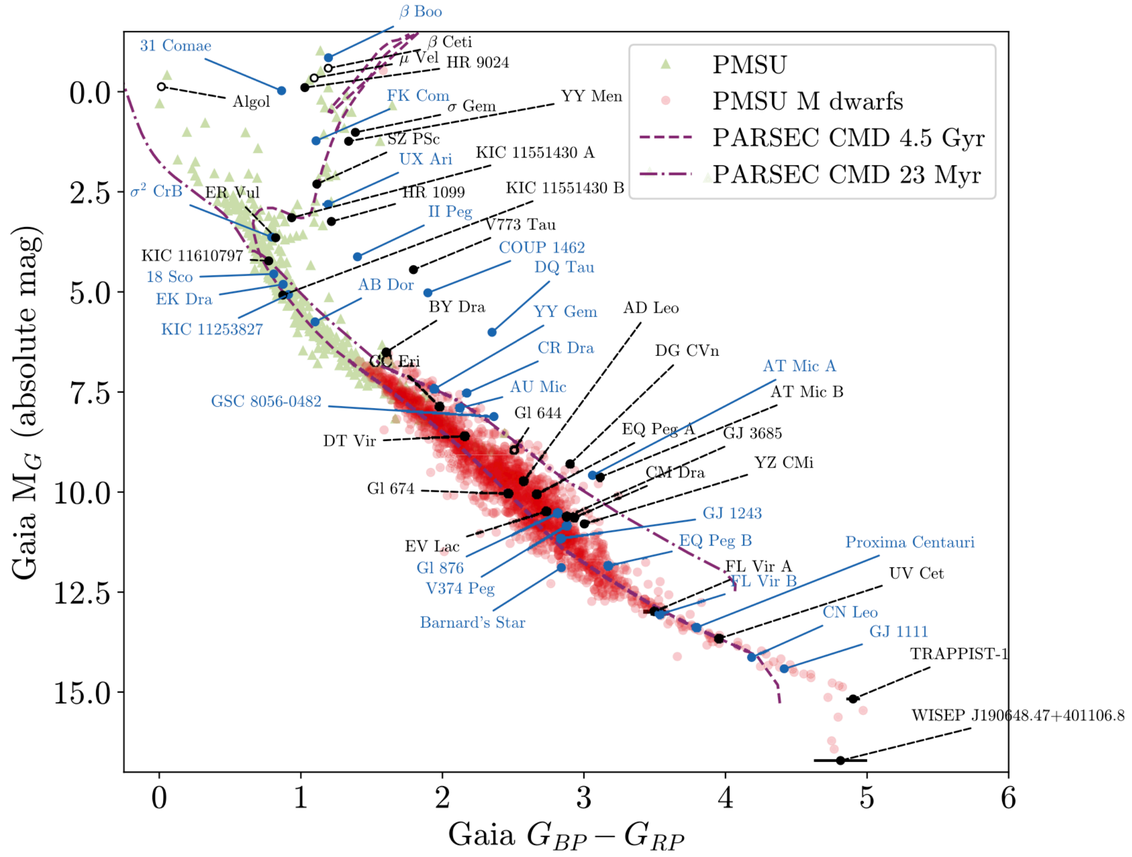


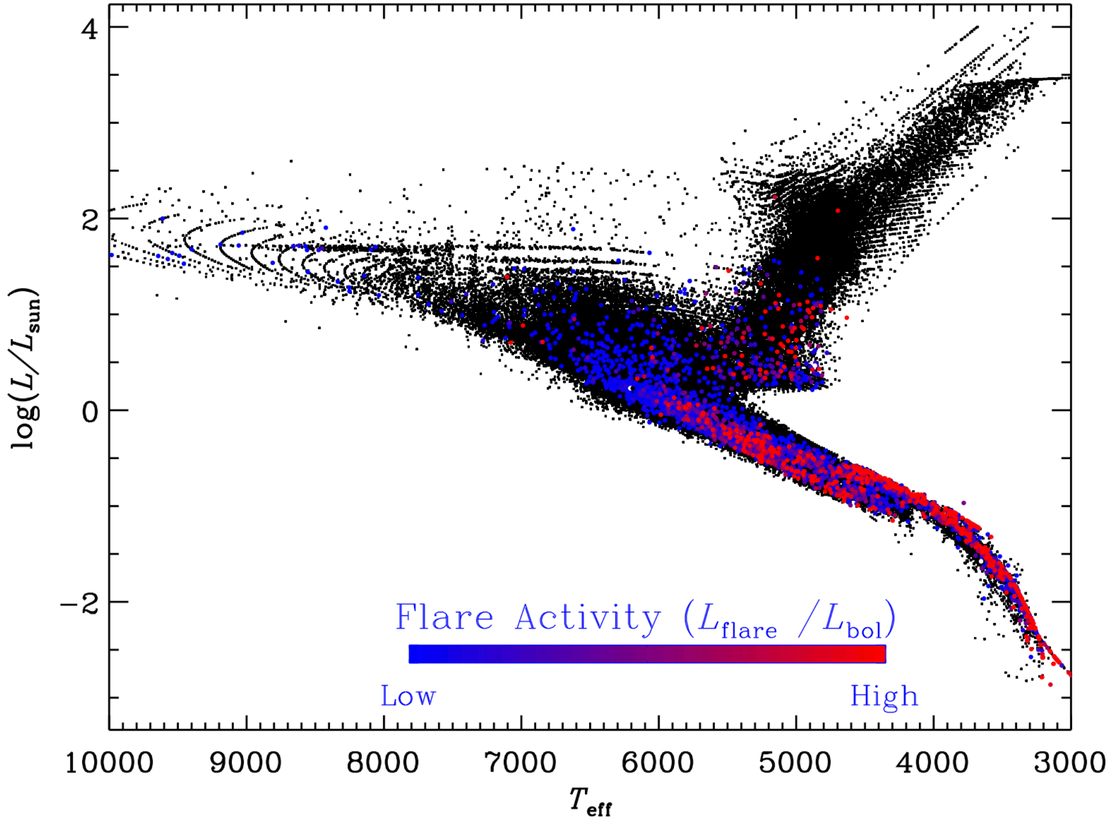
- **Transients Survey**: the statistical properties of different types of transient sources related to the properties of the host galaxy and their limitations on physical origins

- **Multiwavelength observation of Transients**: the explosion processes and radiation mechanisms of temporary sources such as supernovae, gamma bursts, and stellar flares?



Background

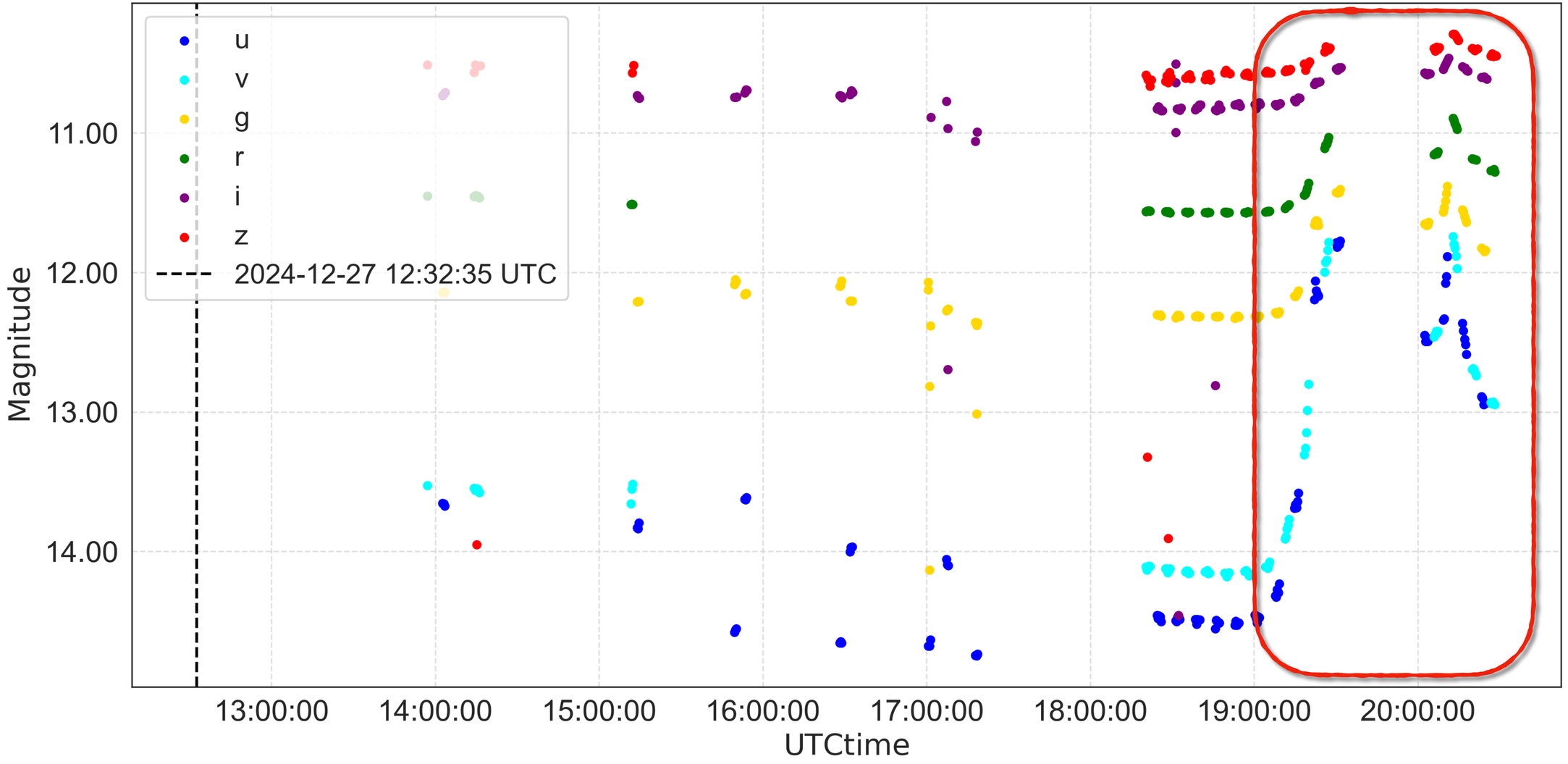




- **Origin of flare radiation and temporal evolution?**
- **Relationship of radiation intensity and stellar physical properties?**

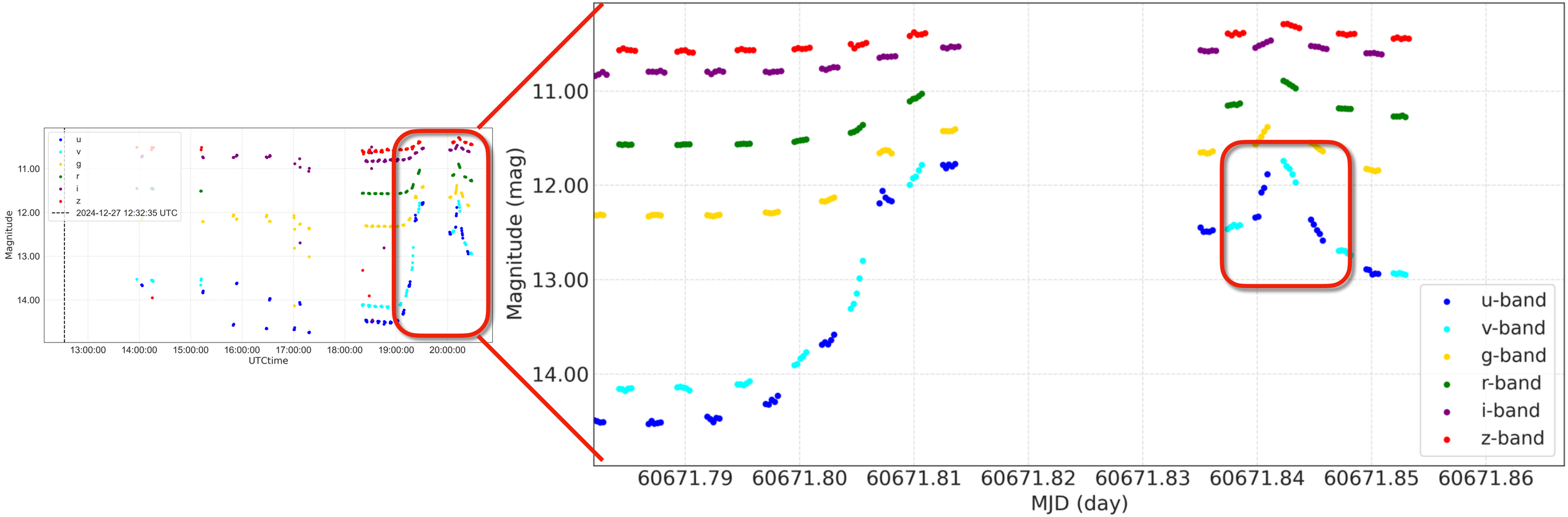
Observation

V830 Tau



Observation

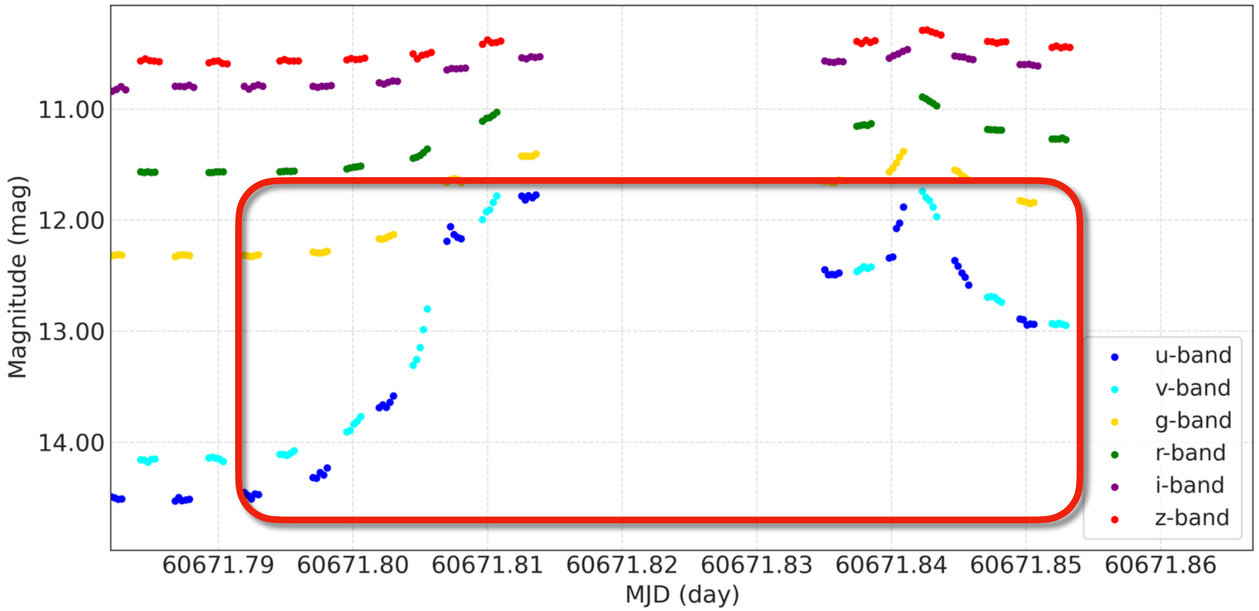
V830 Tau

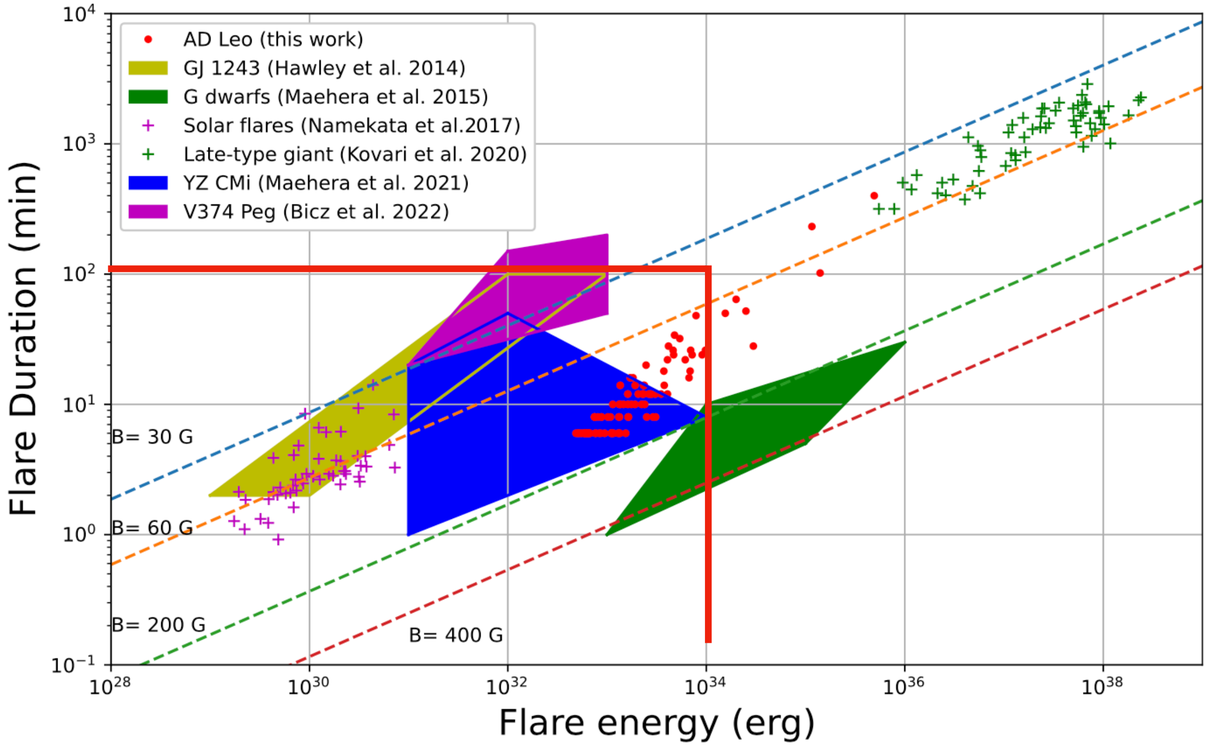


$\Delta Mag\_u > 3$

Observation

V830 Tau





Duration >> 2 hours

Super flare

Observation

V830 Tau

Science

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RESEARCH ARTICLE | STELLAR PHYSICS

Sun-like stars produce superflares roughly once per century

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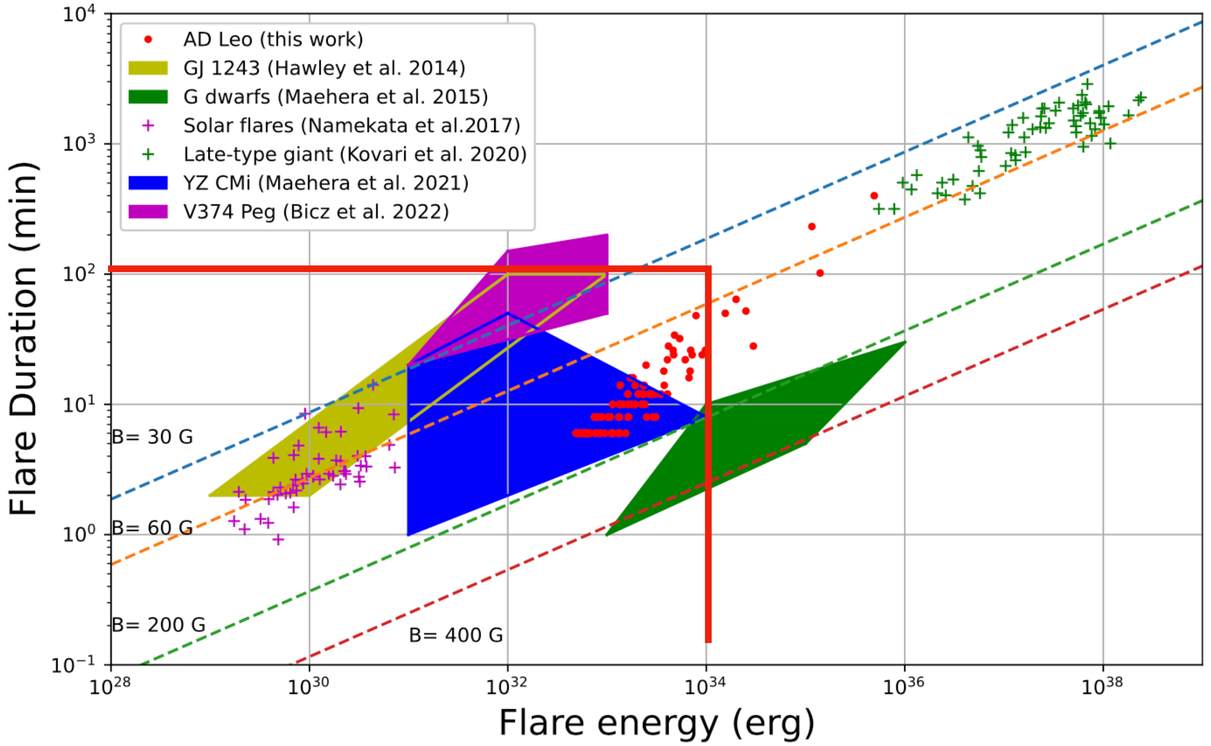
2,677 3 CHECK ACCESS

Editor's summary

Solar flares are bright, transient, multiwavelength emissions from active regions on the Sun. The most intense directly observed solar flares release energies of about 10^{32} erg. It is unclear whether the Sun can produce more intense flares than that or how often they might occur. Vasilyev *et al*. investigated brightness measurements of 56,000 Sun-like stars observed by the Kepler space telescope. They identified almost 3000 bright stellar flares with energies of about 10^{34} to 10^{35} erg, which are called superflares. The occurrence rate is about one superflare per star per century. If the Sun behaves like the stars in this sample, then it could produce superflares at a similar rate. —Keith T. Smith



Super flare

Observation

V830 Tau

1 2022AAS...24040613J 2022/06
The Magnetic Field Variability of CI Tau and V830 Tau
Johns-Krull, Christopher; Prato, Lisa; Stahl, Asa *and 4 more*

2 2021ApJ...920...22S 2021/10 cited: 2
Chandra X-Ray Observations of V830 Tau: A T Tauri Star Hosting an Evanescent Planet
Skinner, Stephen L.; Güdel, Manuel

3 2020A&A...642A.133D 2020/10 cited: 34
The GAPS Programme at TNG. XXVII. Reassessment of a young planetary system with HARPS-N: is the hot Jupiter V830 Tau b really there?
Damasso, M.; Lanza, A. F.; Benatti, S. *and 41 more*

4 2020yCat..36420133D 2020/08
VizieR Online Data Catalog: V830 Tau VI light curves and RV curves (Damasso+, 2020)
Damasso, M.; Lanza, A. F.; Benatti, S. *and 41 more*

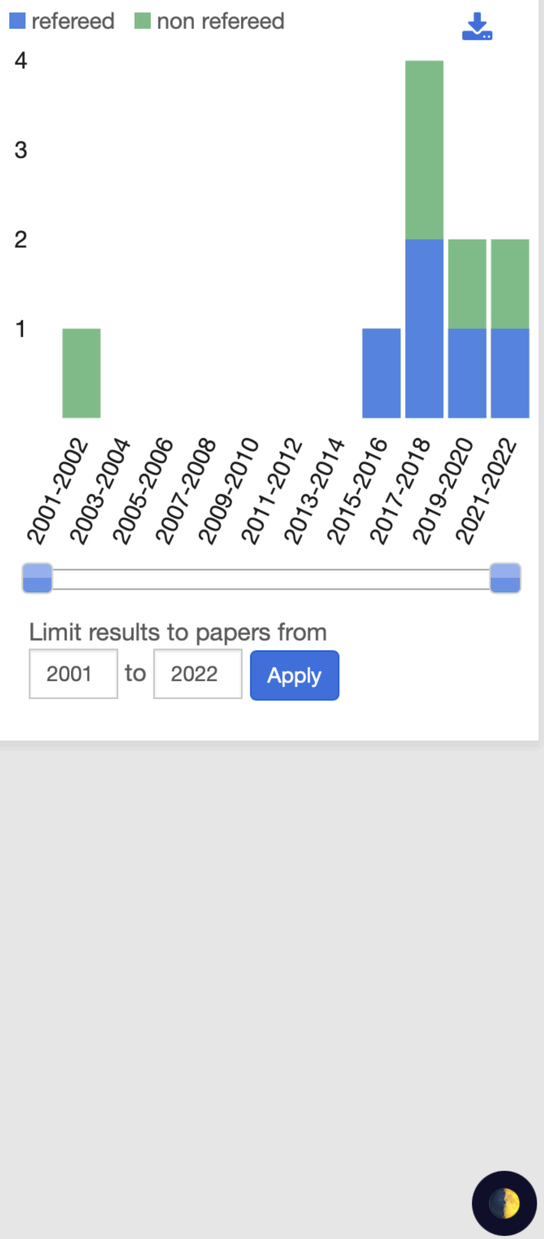
5 2018cxo..prop.5327S 2018/09
V830 Tau: An X-ray Bright T Tauri Star Hosting a Hot Jupiter
Skinner, Stephen

6 2017A&A...602A..39V 2017/06 cited: 52
Predicting radio emission from the newborn hot Jupiter V830 Tauri b and its host star
Vidotto, A. A.; Donati, J. -F.

7 2017reph.conf50001B 2017/05
Radio Observations of V830 Tau
Bower, Geoffrey

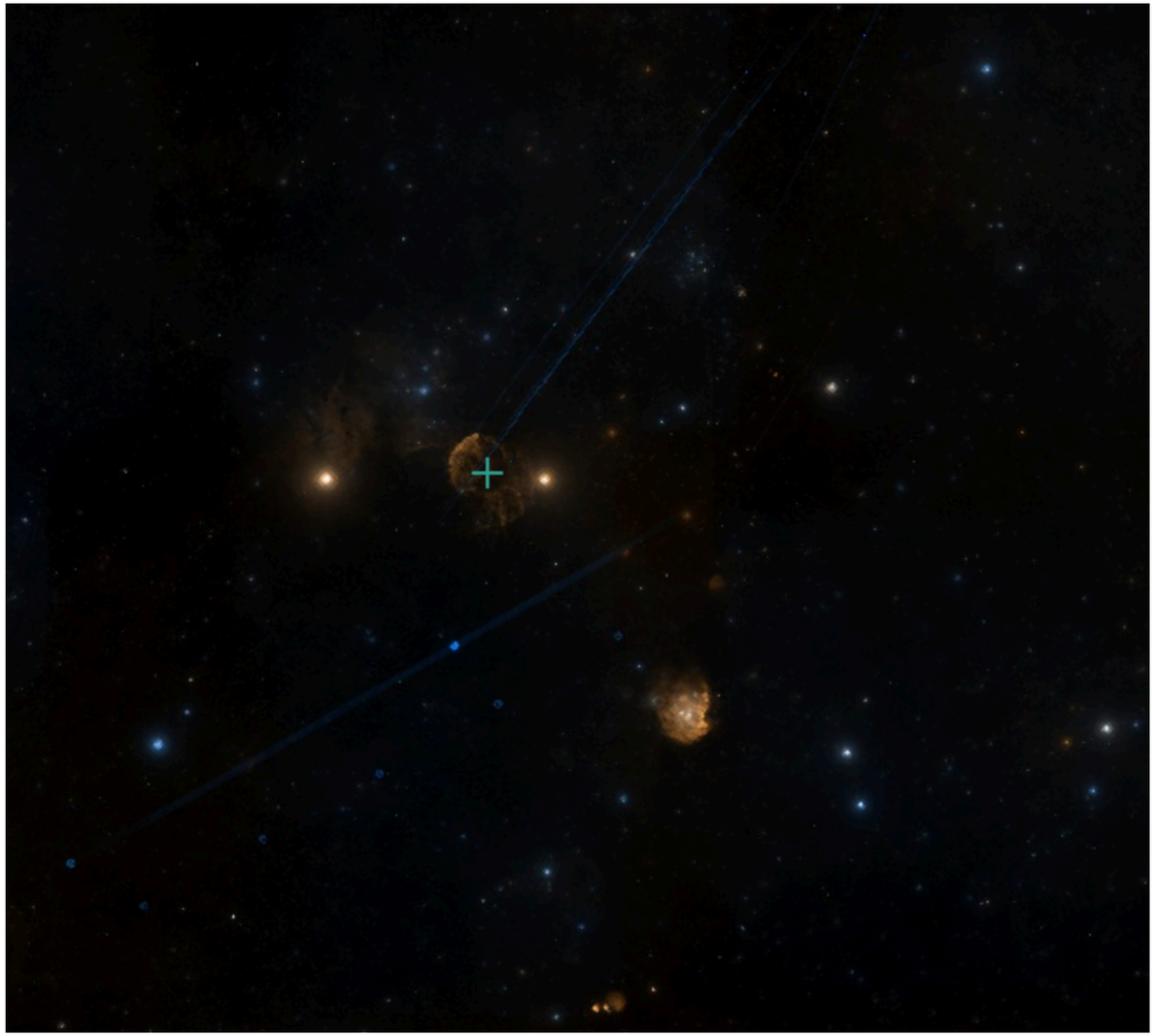
8 2017MNRAS.465.3343D 2017/03 cited: 56
The hot Jupiter of the magnetically active weak-line T Tauri star V830 Tau
Donati, J. -F.; Yu, L.; Moutou, C. *and 16 more*

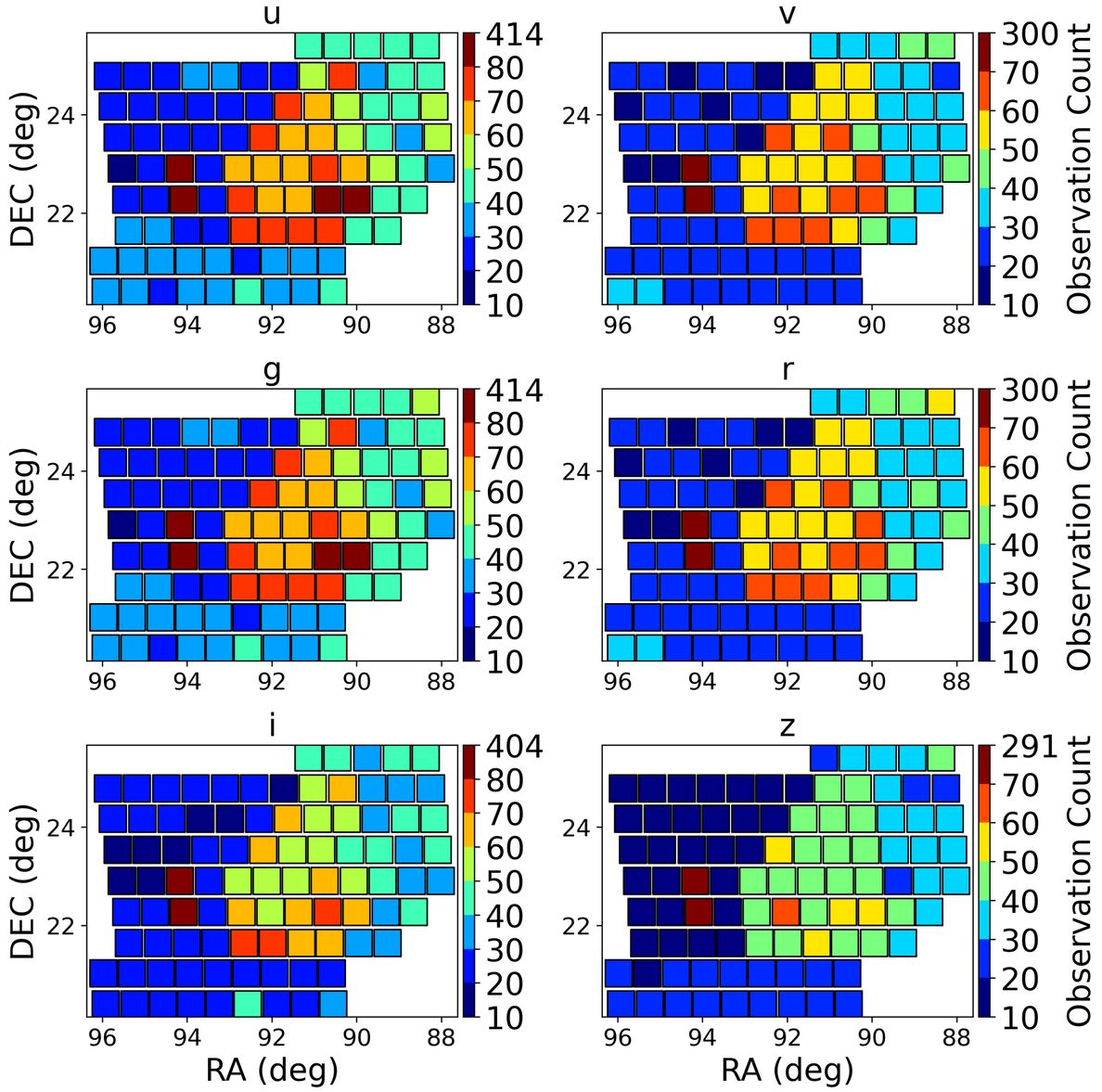
9 2015MNRAS.453.3706D 2015/11 cited: 56
Magnetic activity and hot Jupiters of young Suns: the weak-line T Tauri stars V819 Tau and V830 Tau
Donati, J. -F.; Hébrard, F.; Hussain, G. A. J. *and 19 more*



Observation

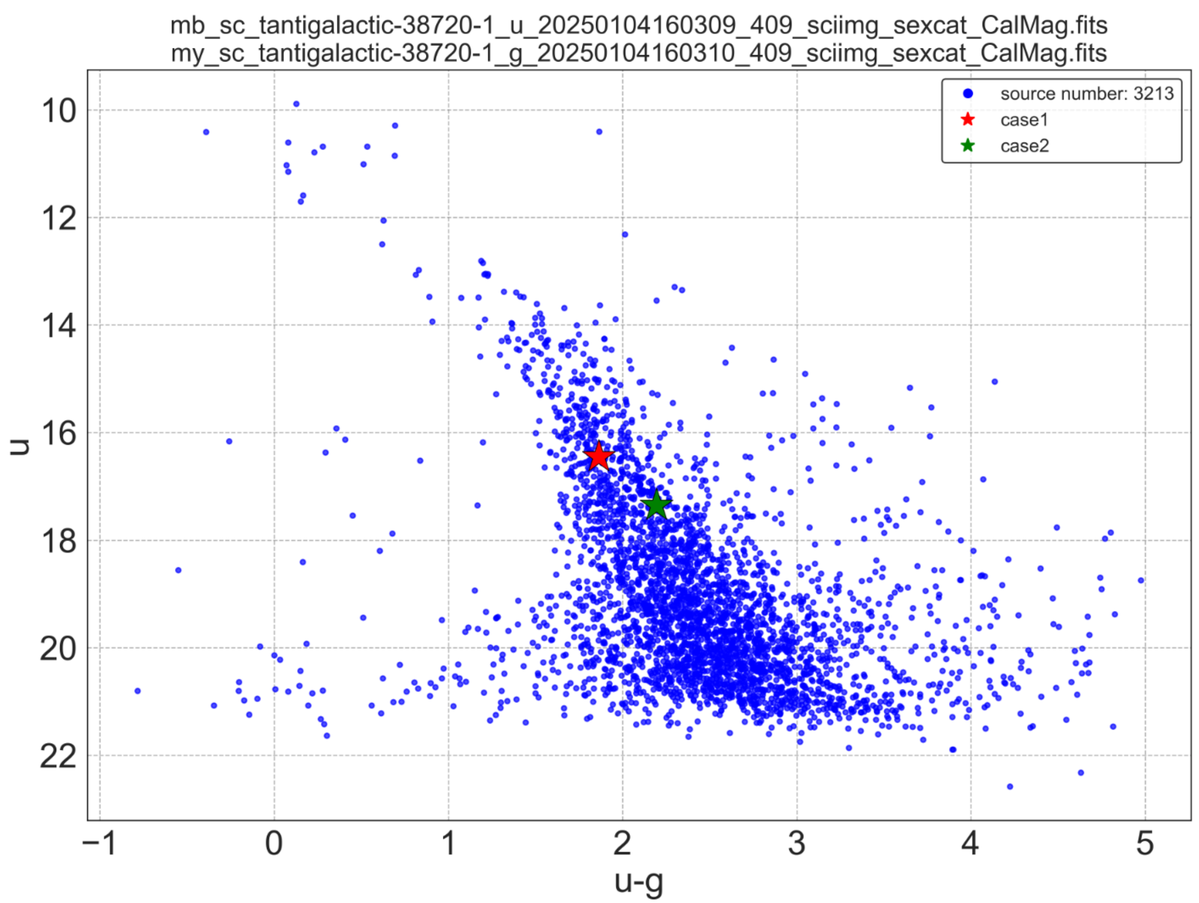
Anti-galactic Field

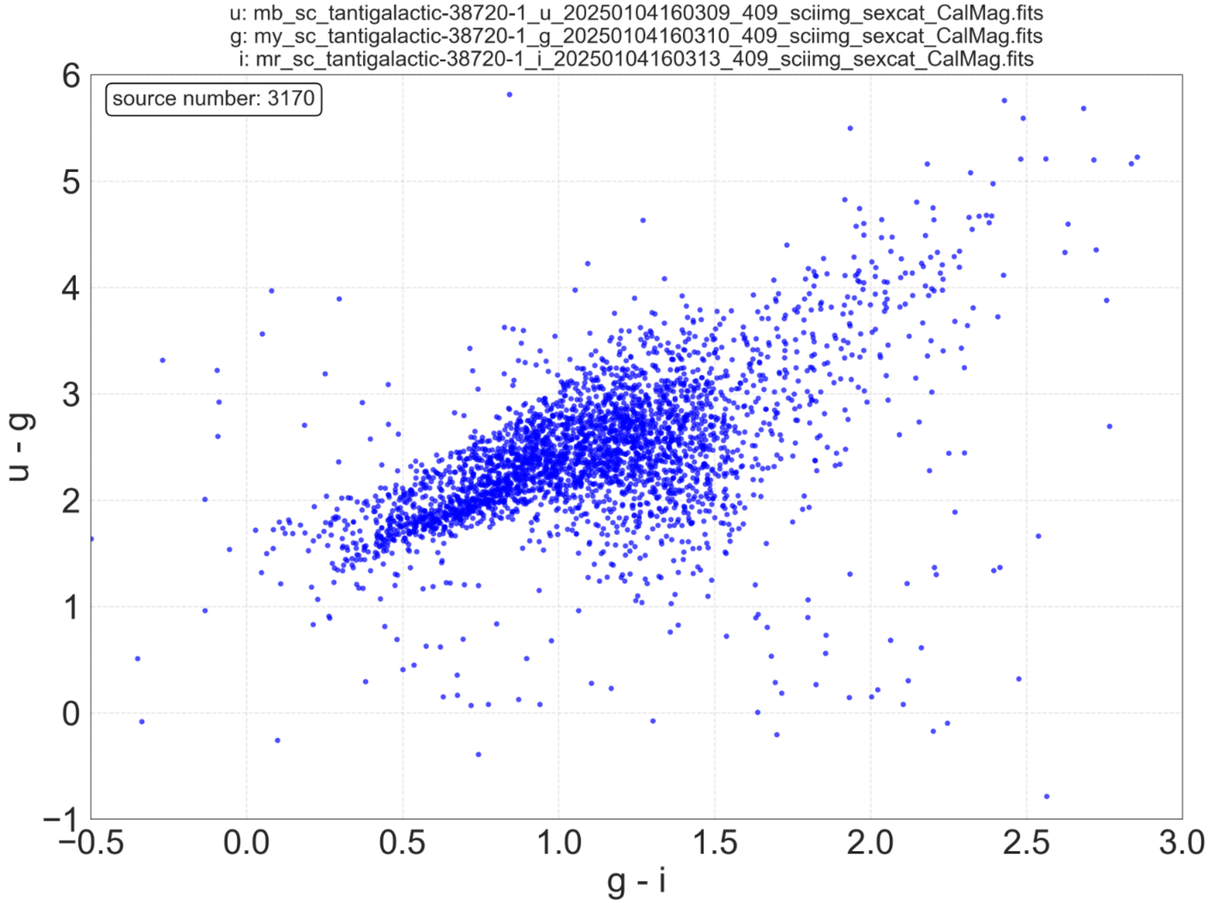




Observation

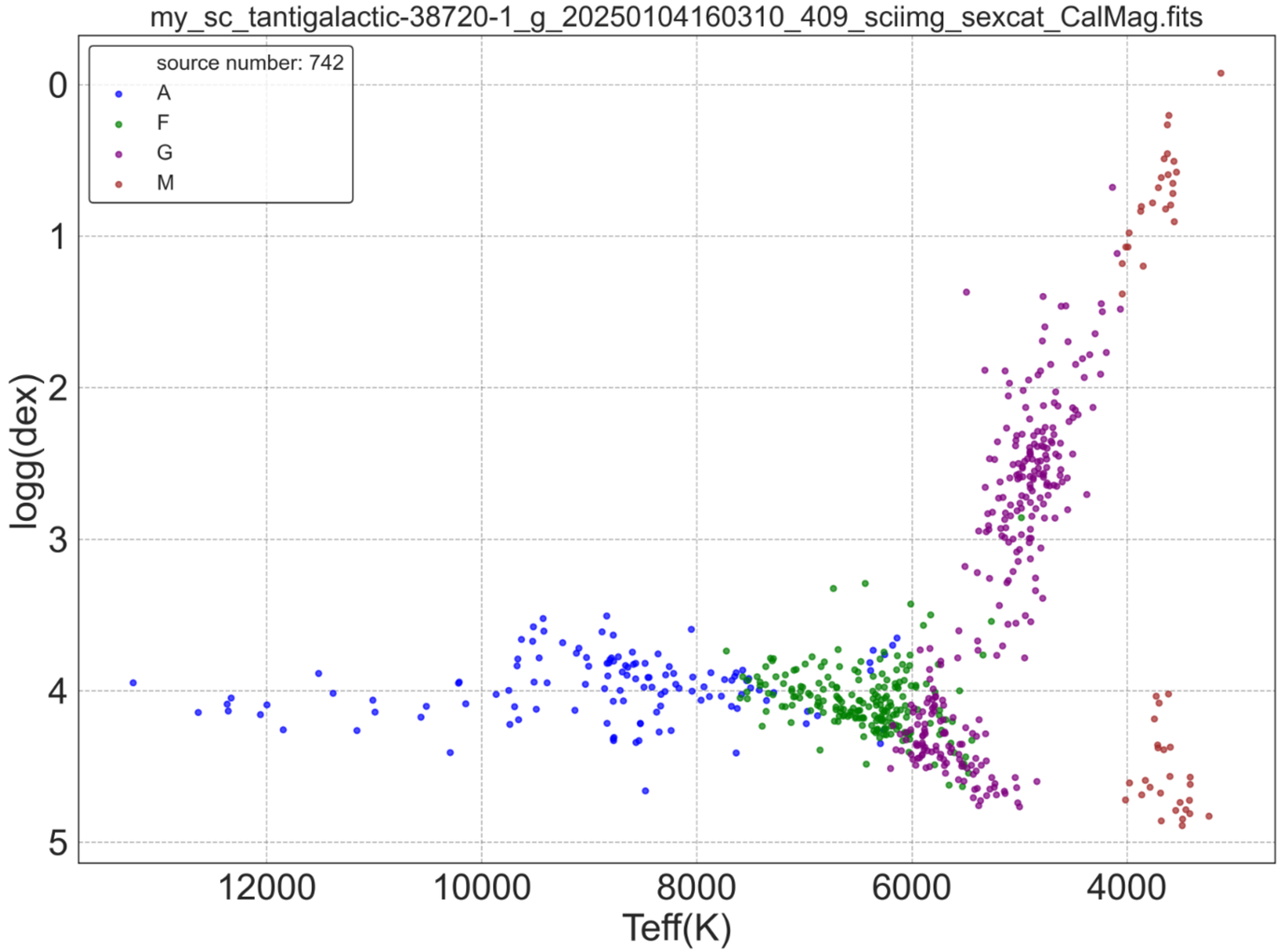
Anti-galactic Field





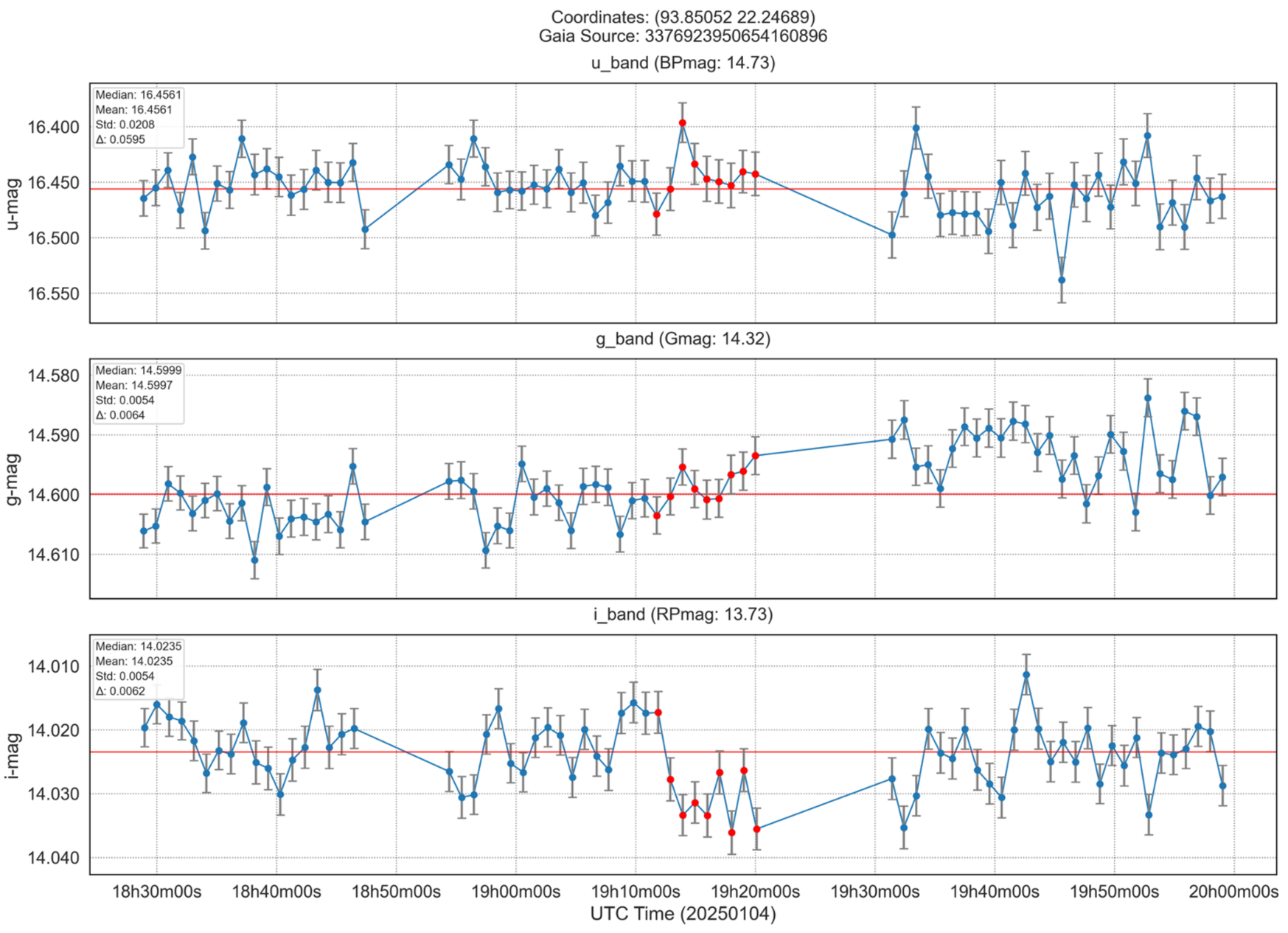
Observation

Anti-galactic field



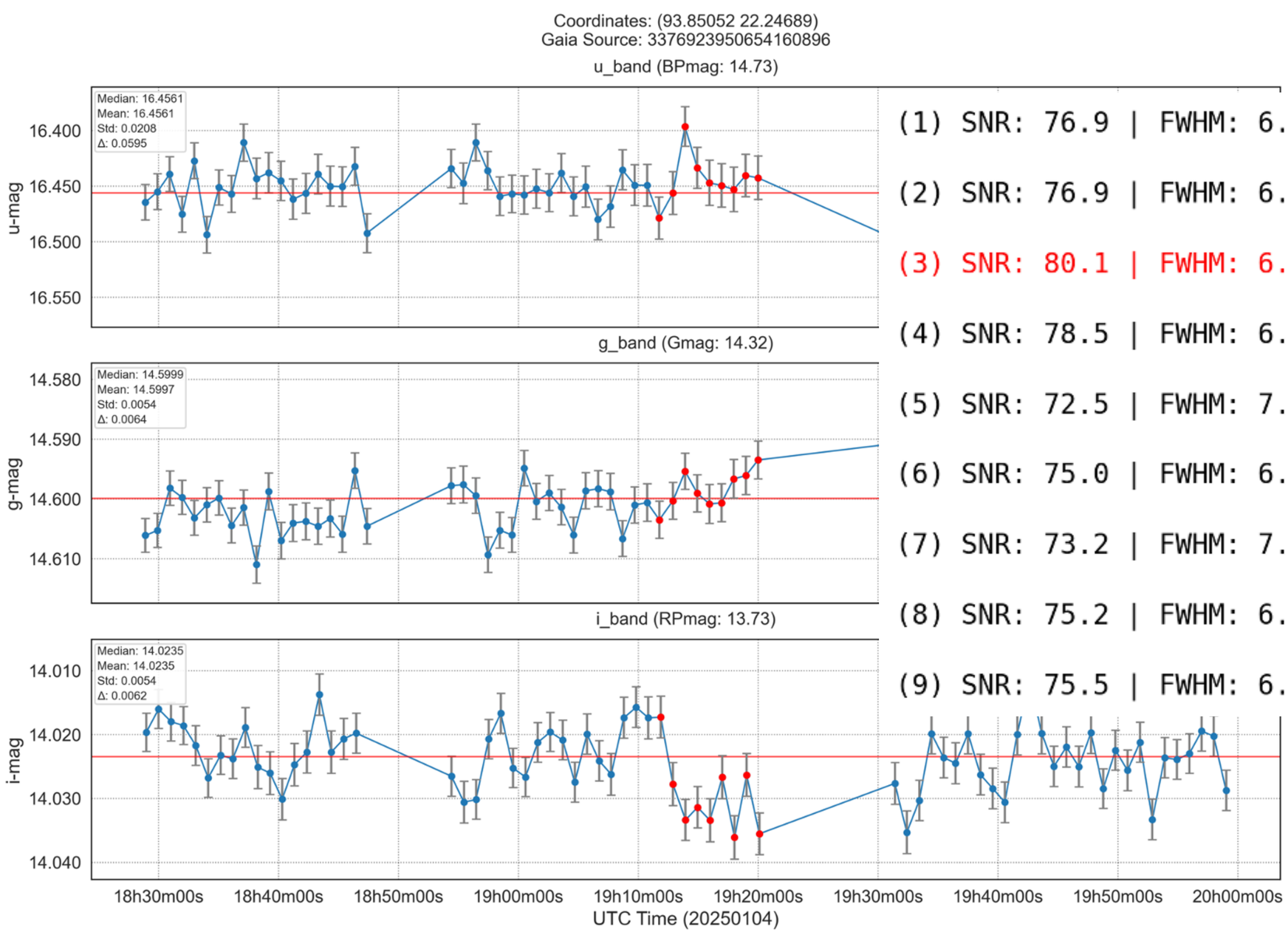
Observation

Anti-galactic Field



Observation

Anti-galactic Field



(1) SNR: 76.9 | FWHM: 6.2 (2.6") | E: 0.01 | MAG: 16.48

(2) SNR: 76.9 | FWHM: 6.8 (2.9") | E: 0.10 | MAG: 16.46

(3) SNR: 80.1 | FWHM: 6.1 (2.6") | E: 0.08 | MAG: 16.40

(4) SNR: 78.5 | FWHM: 6.2 (2.6") | E: 0.06 | MAG: 16.43

(5) SNR: 72.5 | FWHM: 7.3 (3.1") | E: 0.05 | MAG: 16.45

(6) SNR: 75.0 | FWHM: 6.7 (2.9") | E: 0.04 | MAG: 16.45

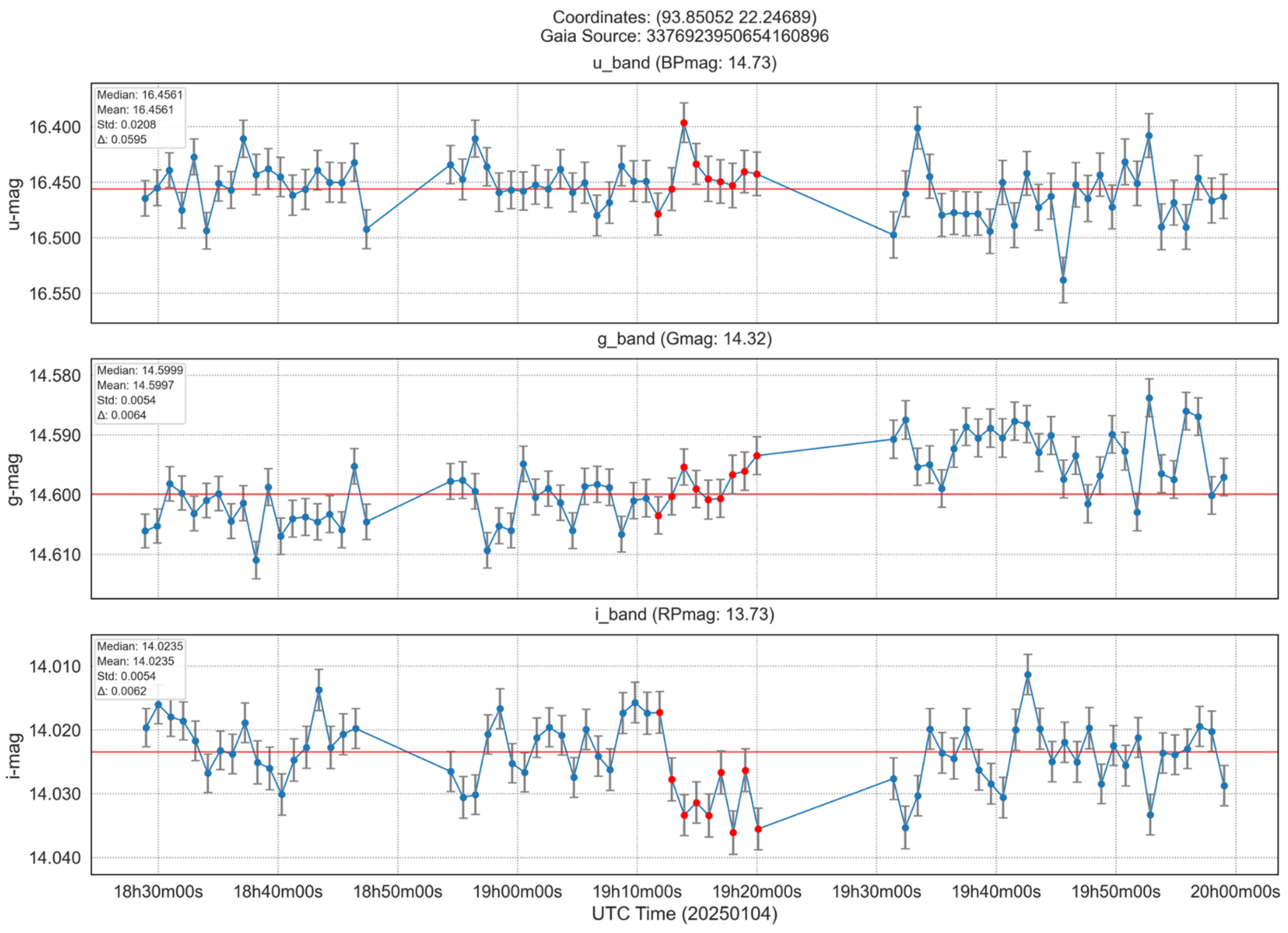
(7) SNR: 73.2 | FWHM: 7.2 (3.1") | E: 0.05 | MAG: 16.45

(8) SNR: 75.2 | FWHM: 6.7 (2.9") | E: 0.11 | MAG: 16.44

(9) SNR: 75.5 | FWHM: 6.4 (2.7") | E: 0.09 | MAG: 16.44

Observation

Anti-galactic Field



Gaia DR3
Astropysical params:

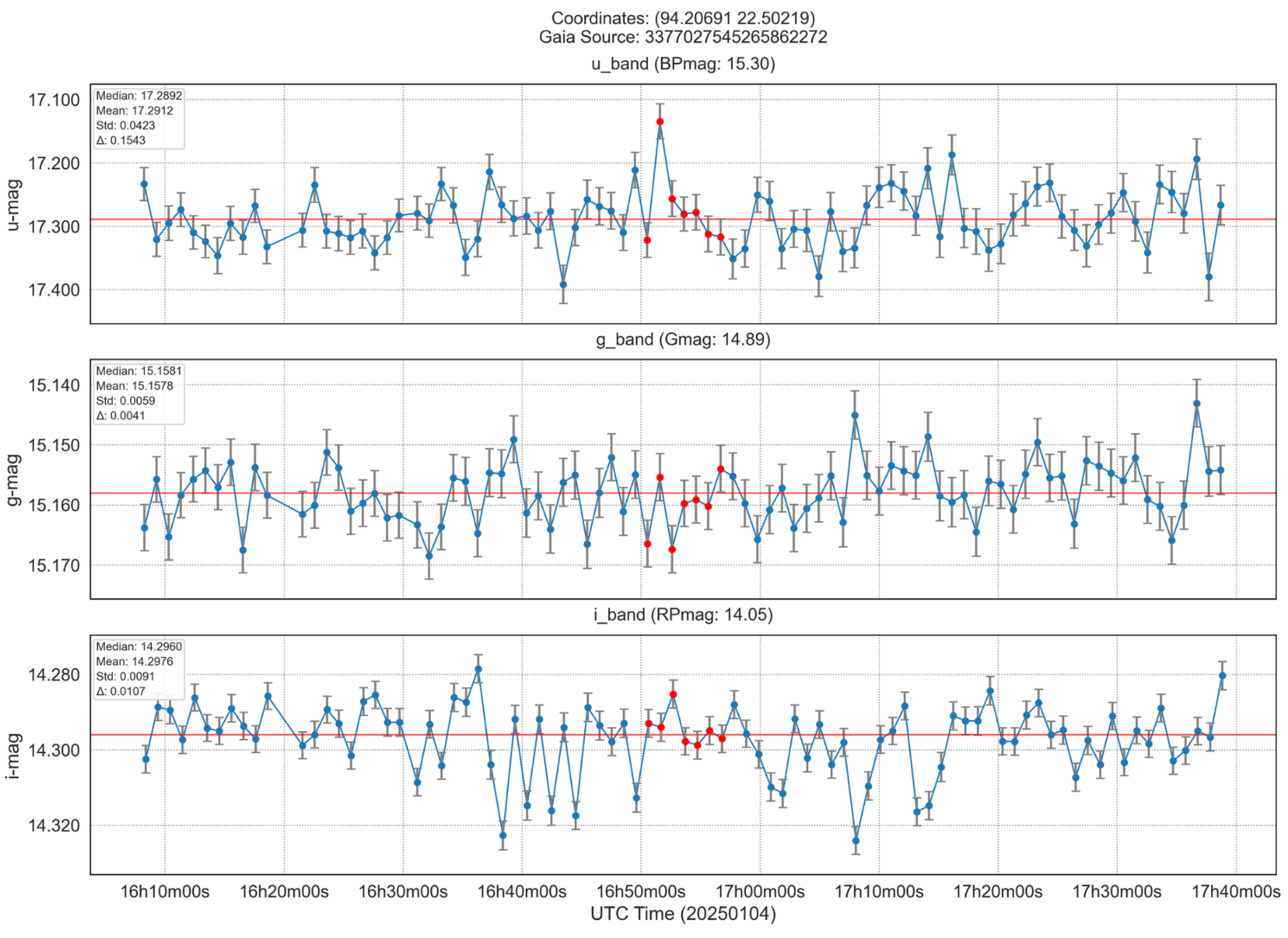
$$Teff: 6743.84^{+27.9}_{-27.6}$$

$$\log g: 4.3113^{+0.0088}_{-0.0080}$$

$$[Fe/H]: 0.0123^{+0.0181}_{-0.0231}$$

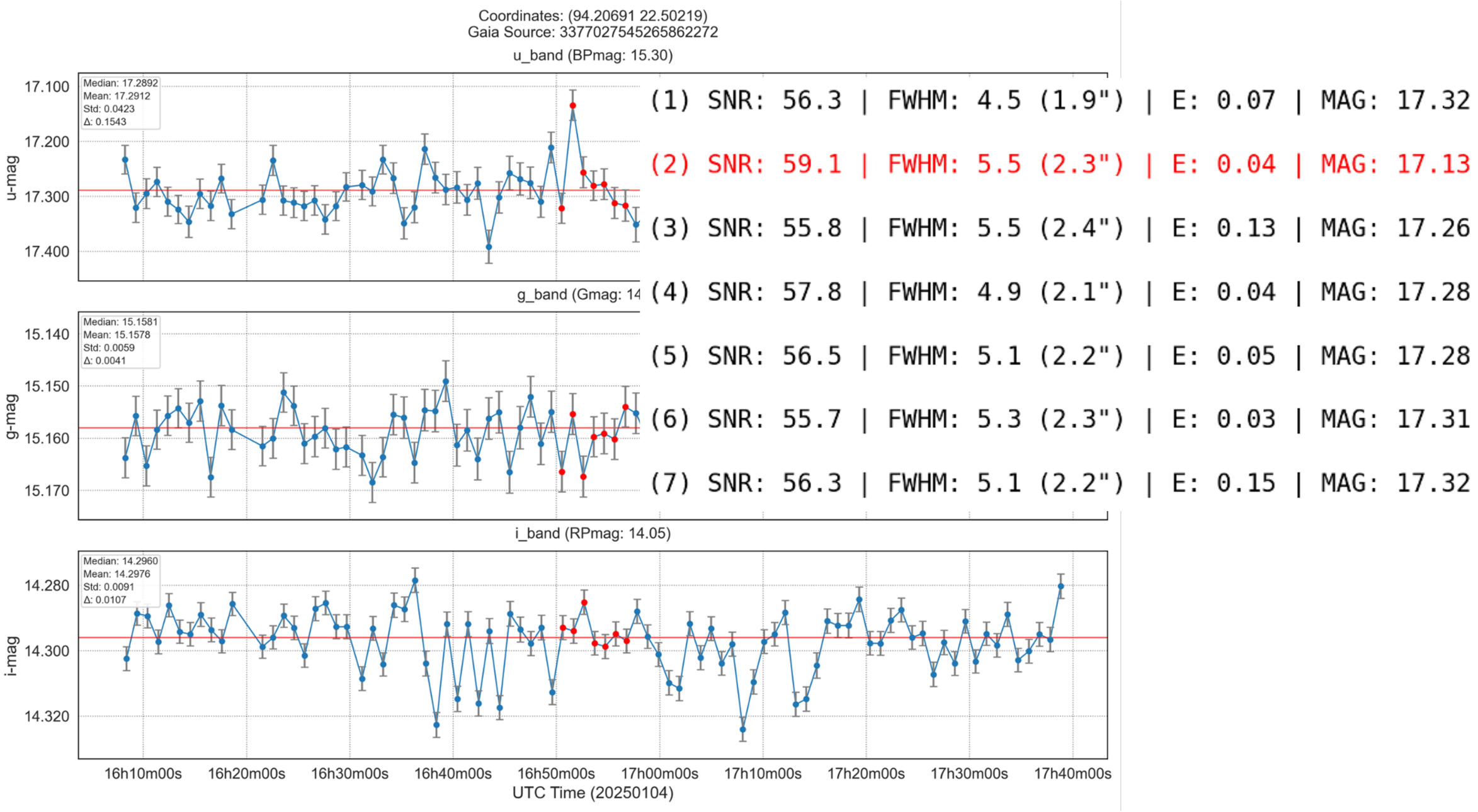
Observation

Anti-galactic Field



Observation

Anti-galactic Field



(1) SNR: 56.3 | FWHM: 4.5 (1.9") | E: 0.07 | MAG: 17.32

(2) SNR: 59.1 | FWHM: 5.5 (2.3") | E: 0.04 | MAG: 17.13

(3) SNR: 55.8 | FWHM: 5.5 (2.4") | E: 0.13 | MAG: 17.26

(4) SNR: 57.8 | FWHM: 4.9 (2.1") | E: 0.04 | MAG: 17.28

(5) SNR: 56.5 | FWHM: 5.1 (2.2") | E: 0.05 | MAG: 17.28

(6) SNR: 55.7 | FWHM: 5.3 (2.3") | E: 0.03 | MAG: 17.31

(7) SNR: 56.3 | FWHM: 5.1 (2.2") | E: 0.15 | MAG: 17.32

Flare Diagnostics with Multiband Observation

Mesurement/data	Physical paramter of flare
Time resolved NUV/optical flux	Temperature、Footpoint area、SED evolution
Balmer jump ratio $F_{peak,u}/F_{peak,v}$	Optical depth at $T \sim 10{,}000K$
X-ray exponential decay constant	Semi-loop length
NUV light curve timing vs. X-ray	Non-thermal vs. thermal interpretation of hard X-ray

Flare Statistics with Wide-Field Survey Data

- ✦ Flare energy、duration、frequency;
- ✦Distributions of these statistics with stellar physical parameters (Teff; mass; age; metallicity);
- ✦Explore their impact on the habitability of exoplants.


Thank You!