EP 250207b is not a collapsar fast X-ray transient. Is it due to a compact object merger?

Jonker et al., arXiv:2508.13039v1

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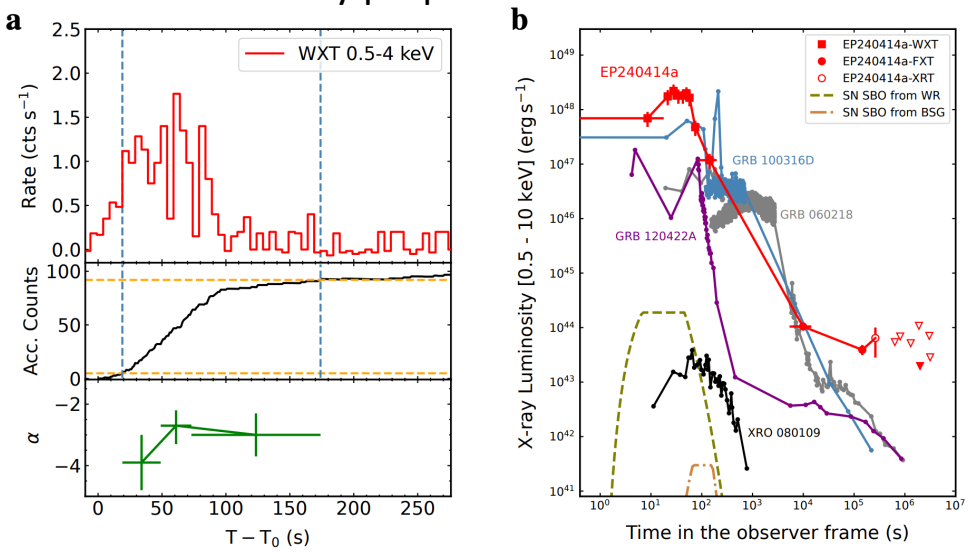
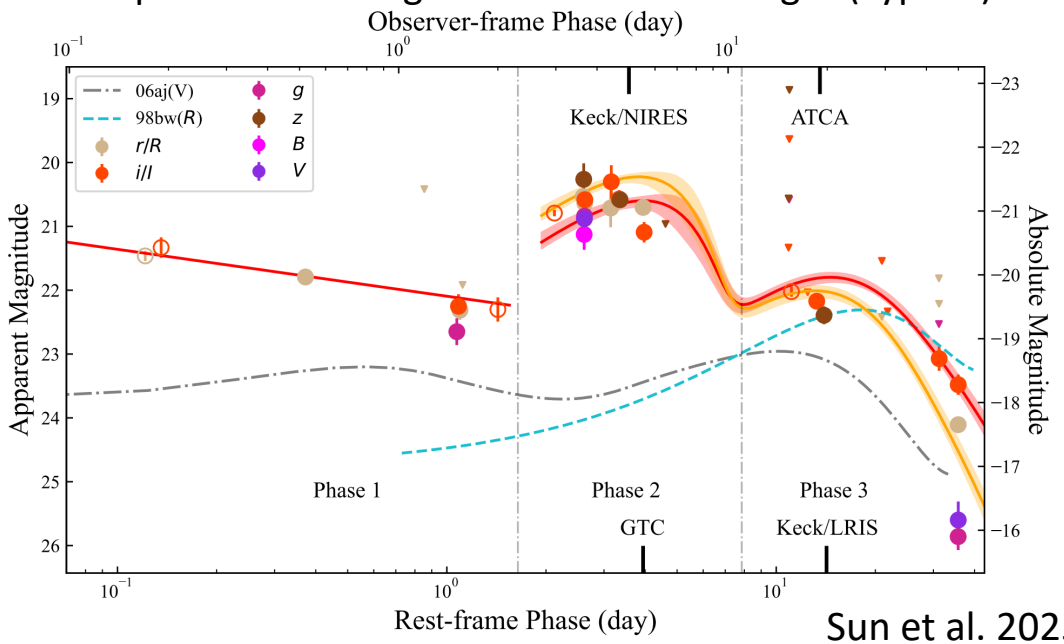
Fast X-ray transients (FXTs)

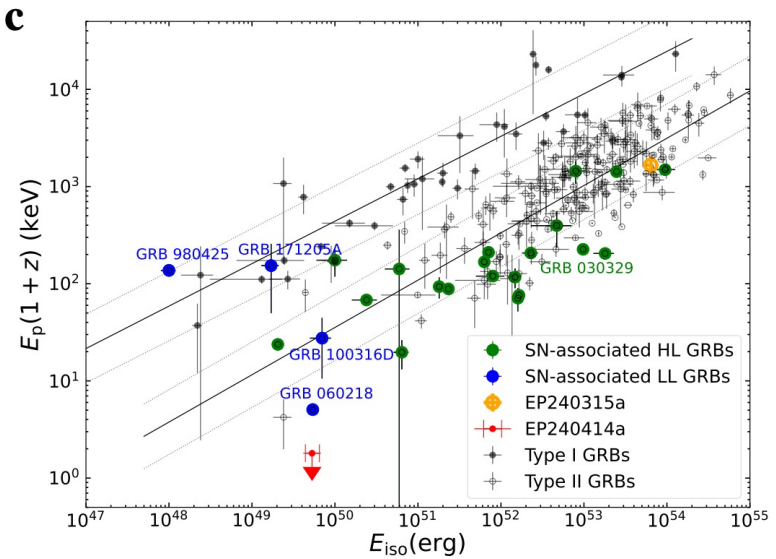
- FXTs are short-lived extra-galactic X-ray sources
  - Duration : seconds to hours;
  - > 30 FXTs have been detected from Chandra and XMM-Newton archival data;
  - Some of them are related to collapsars

X-ray properties of EP240414a



Optical and NIR light curves of SN 2024gsa (Type Ic)



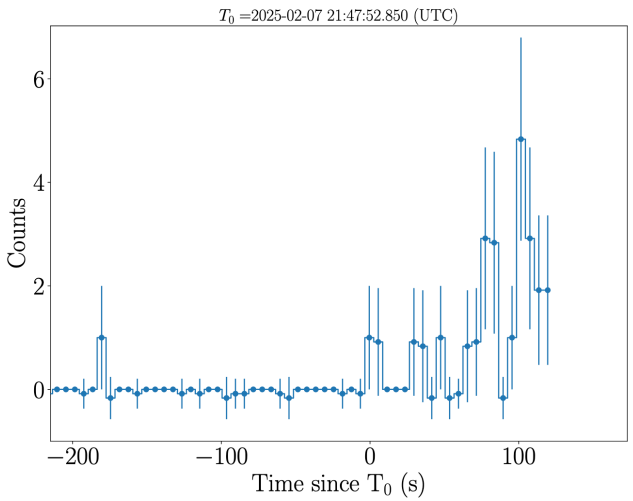


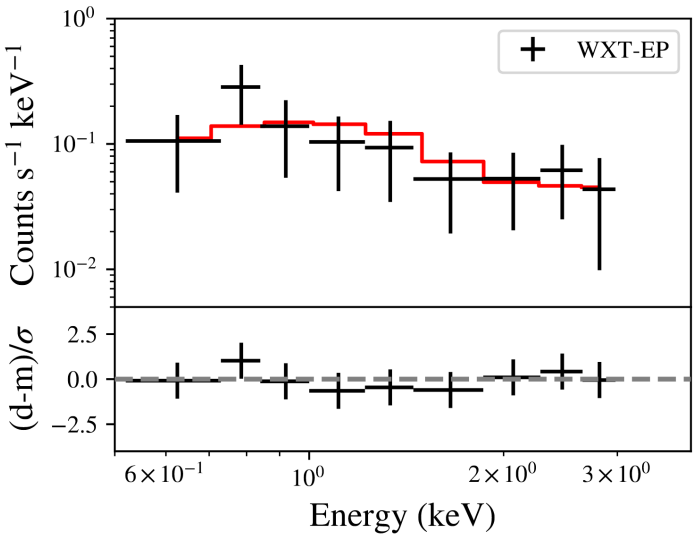
Sun et al. 2025, Nature Astronomy

EP250207b

EP-WXT observation

- Discovered on Feb. 7, 2025, t0=21:47:52.85 (UTC)
- Duration : more than 120 s (lower limit)

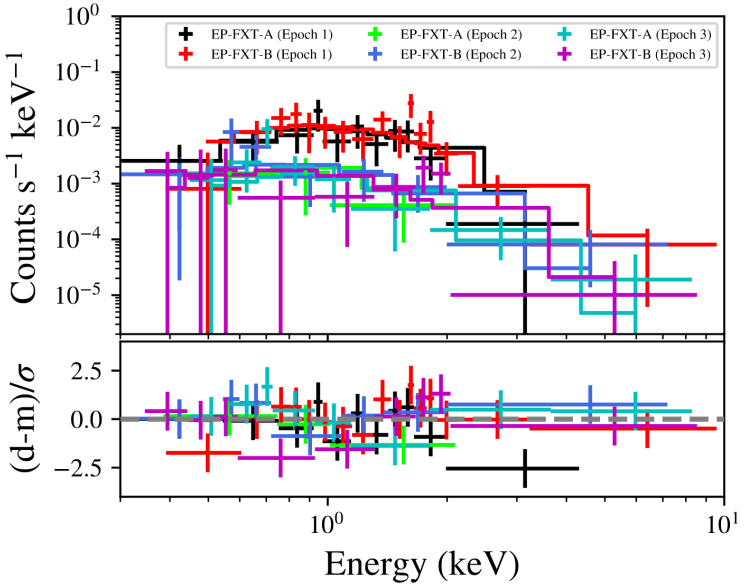


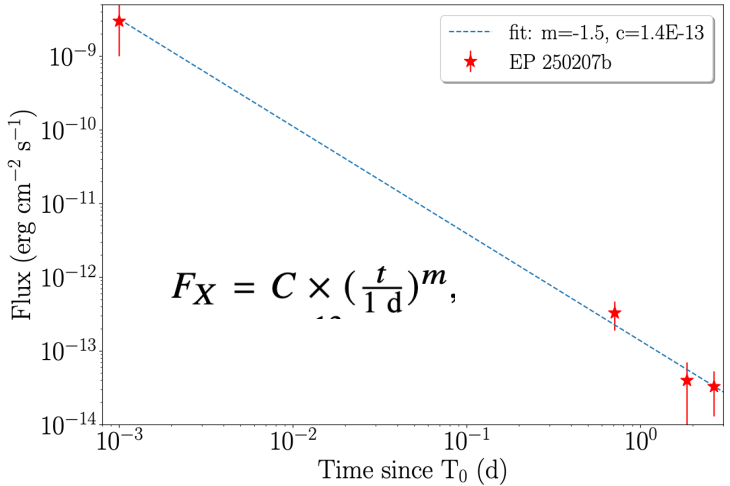


- EP-WXT 0.5-4 keV spectrum can be fitted well by an absorbed power law with N_H =4x20 cm^-2 and a photon index of 0.5±0.7.
- The average unabsorbed 0.5-4 keV flux is (6.5 ± 3.6) × 10^−10 erg cm^−2 s^−1(90% confidence level).

EP-FXT follow up observation

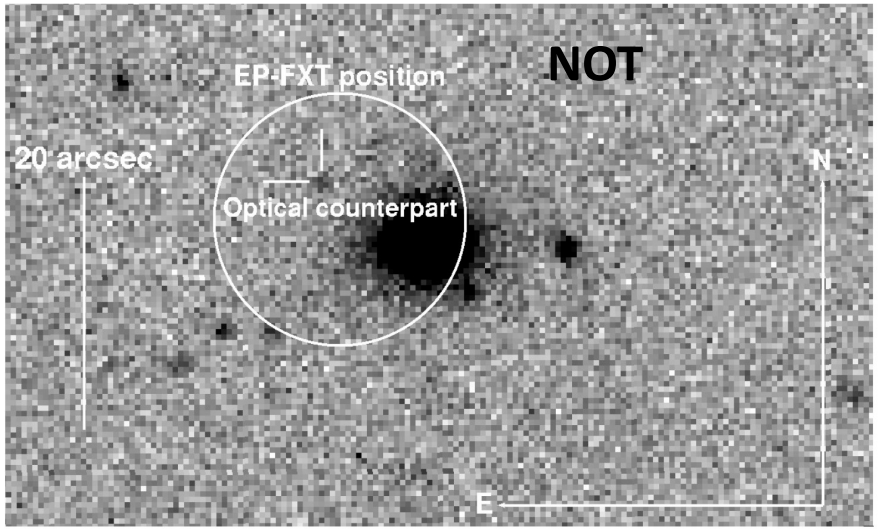
1. t0 + 0.71 d, expotime = 3025 s
2. t0 + 1.85 d, expotime = 5044 s
3. t0 + 2.65 d, expotime = 9045 s





Optical and NIR observation

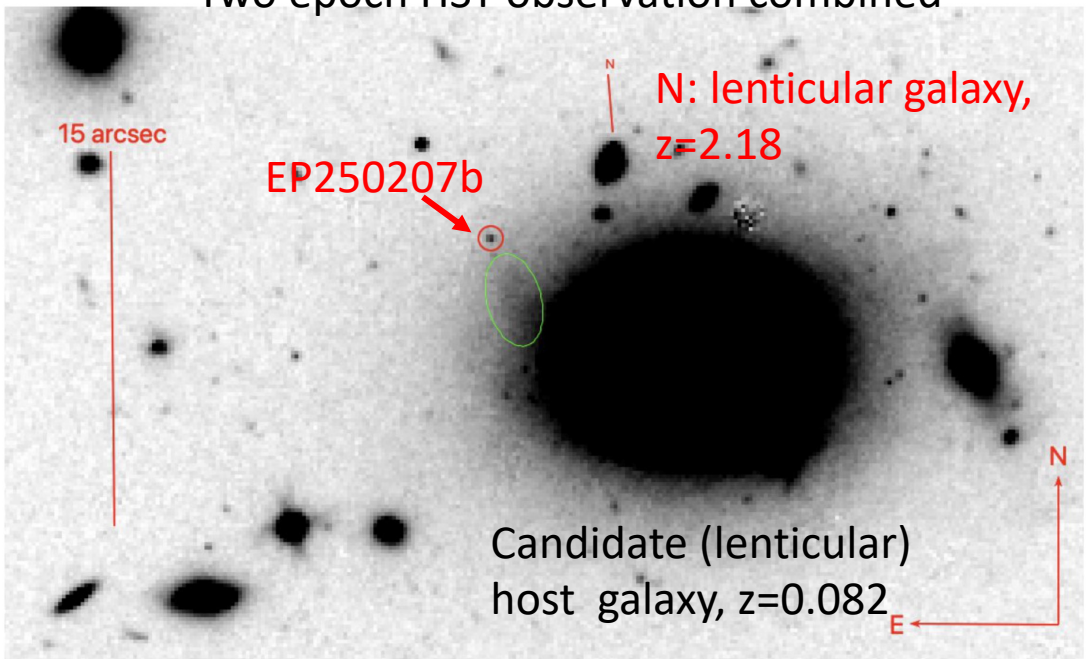
- NOT/ALFOSC + NOT/NOTCam
  - ① t0 + 1.23 d, 4x200s, r'=23.3 ± 0.16 mag
  - ② t0 + 3.22 d, 30x60s, J_{AB}>22.8 mag (3 σ).

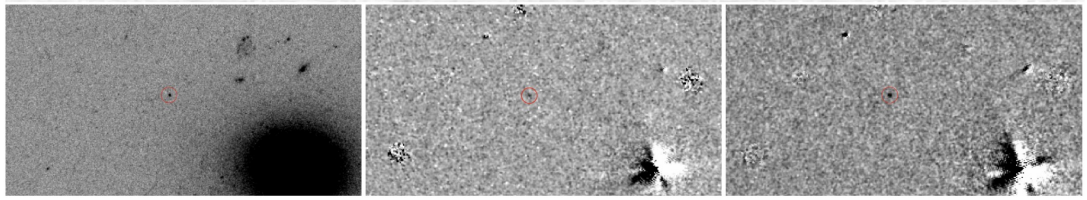


- Gemini North and South Multi-Object Spectrograph observations (GMOS)
  - ① t0 + 2.54 d, 6x60s,GN, z' = 24.7 ± 0.2 mag
  - ② t0 + 3.57 d, 5x60s,GN, z' > 24.1 mag
  - ③ t0 + 4.36 d, 12x60s,GS, g'>24.7 mag
  - ④ t0 + 5.3 d, 27x40s, GS, J_{AB} >24.2 mag(3 σ)
  - ⑤ t0 + 6.3 d , GS, 90x15s, $K_{s,AB}$ >23.15 mag (3 σ)

- Hubble Space Telescope observations
  - ① t0 + (7.4–8.7)d
  - ② t0 + (28.8-29.0) d

Two epoch HST observation combined





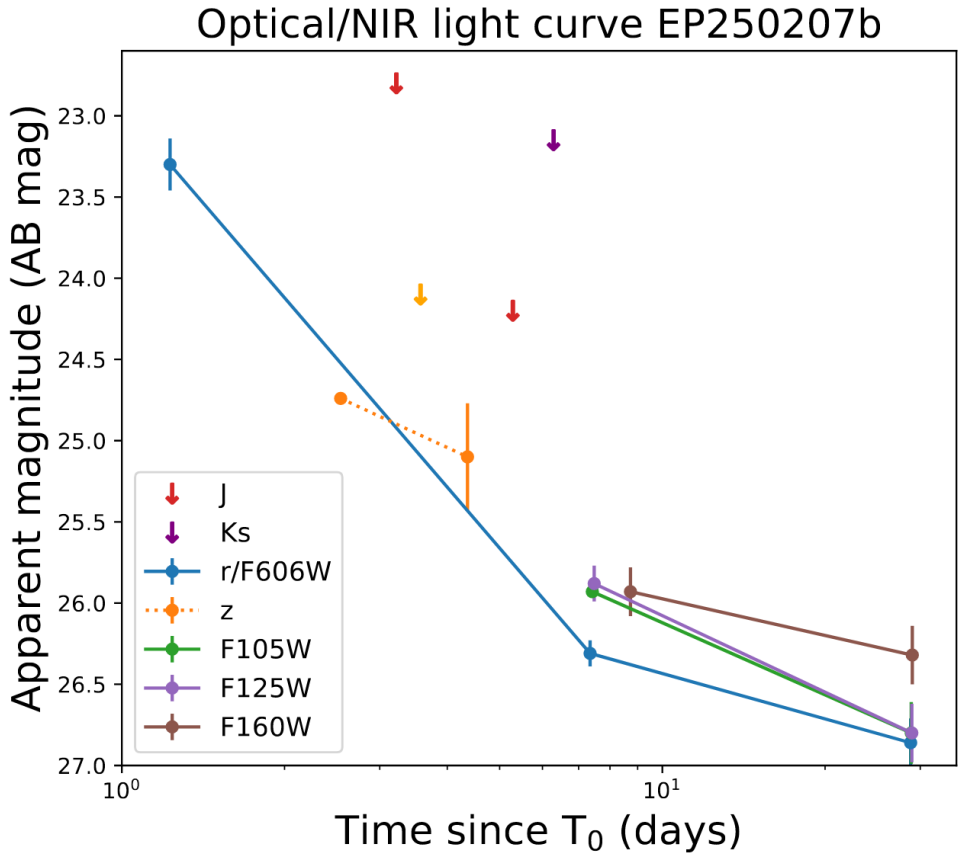
First epcoh F606W=26.31 mag

Residual(F105W): First epcoh - second epoch

Residual(F125W): First epcoh - second epoch

Optical and NIR photometry, light curve

Telescope (1)	Instrument (2)	Date (UTC) (3)	Days since trigger (4)	Exposure time (s) (5)	Filter (6)	AB magnitude (7)
NOT	ALFOSC	2025-02-09 03:16:13	1.228	4×200	r'	23.3±0.16
NOT	NOTCam	2025-02-11 03:07:13	3.22	30×60	J	> 22.8
GN	GMOS	2025-02-10 10:45:59	2.54	6×60	z'	24.7±0.2
GN	GMOS	2025-02-11 11:25:46	3.57	5×60	g'	>24.7
GN	GMOS	2025-02-11 11:27:33	3.57	5×60	z'	>24.1
GS	GMOS	2025-02-12 06:23:32	4.36	12×60	z'	25.1±0.3
GS	F2	2025-02-13 04:46:44	5.29	27×40	J	>24.2
GS	F2	2025-02-14 04:39:23	6.29	90×15	K_s	>23.15
HST	WFC3	2025-02-15 06:15:17	7.35	4×505	F606W	26.31±0.08
HST	WFC3	2025-02-15 07:50:29	7.42	4×553	F105W	25.93±0.02
HST	WFC3	2025-02-15 09:24:56	7.48	4×553	F125W	25.88±0.11
HST	WFC3	2025-02-16 15:19:42	8.73	4×553	F160W	25.93±0.15
HST	WFC3	2025-03-08 17:06:56	28.8	2×505	F606W	26.86±0.15
HST	WFC3	2025-03-08 18:41:49	28.87	4×553	F105W	26.8±0.2
HST	WFC3	2025-03-08 20:16:15	28.94	4×553	F125W	26.8±0.2
HST	WFC3	2025-03-08 21:50:40	29	4×553	F160W	26.32±0.18



Very Large Telescope observation on host galaxy

Obs date: 2025-03-03

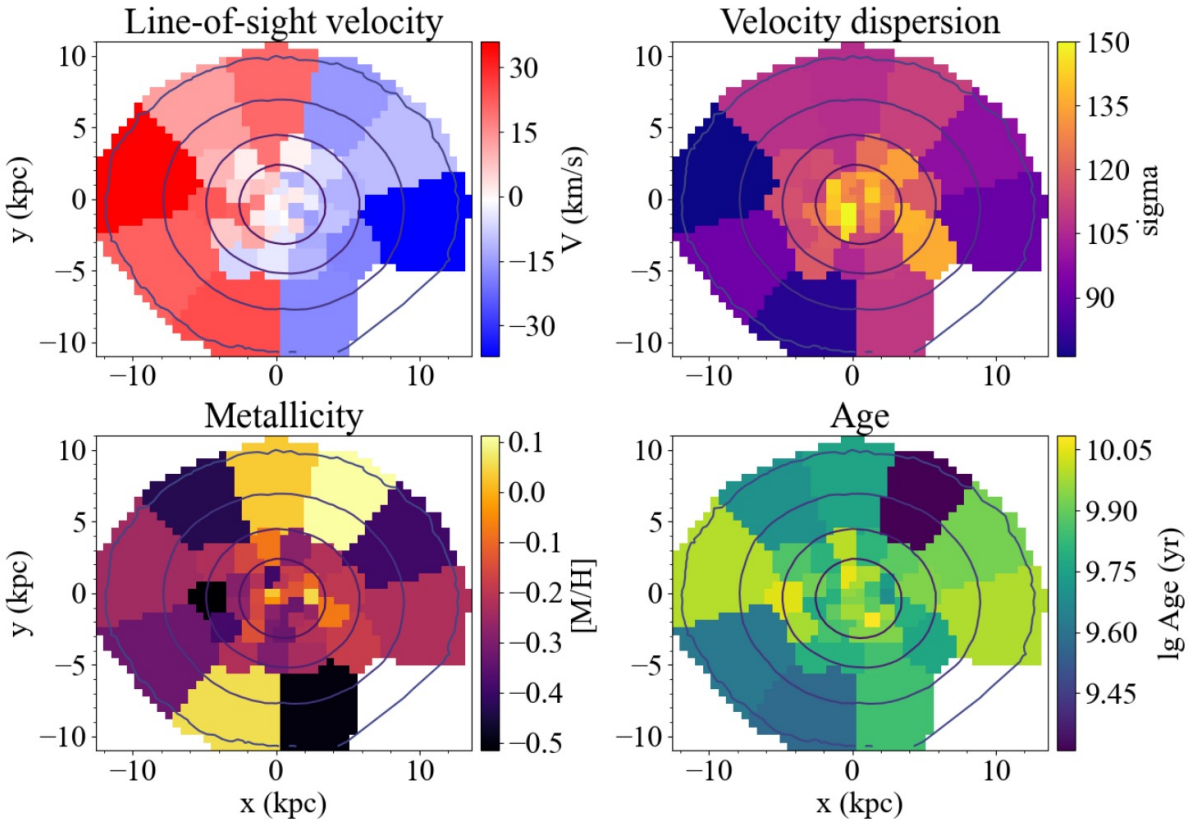
We note that the spatial variation detected in V, is typical for that observed in a lenticular galaxy.

Candidate host galaxy:

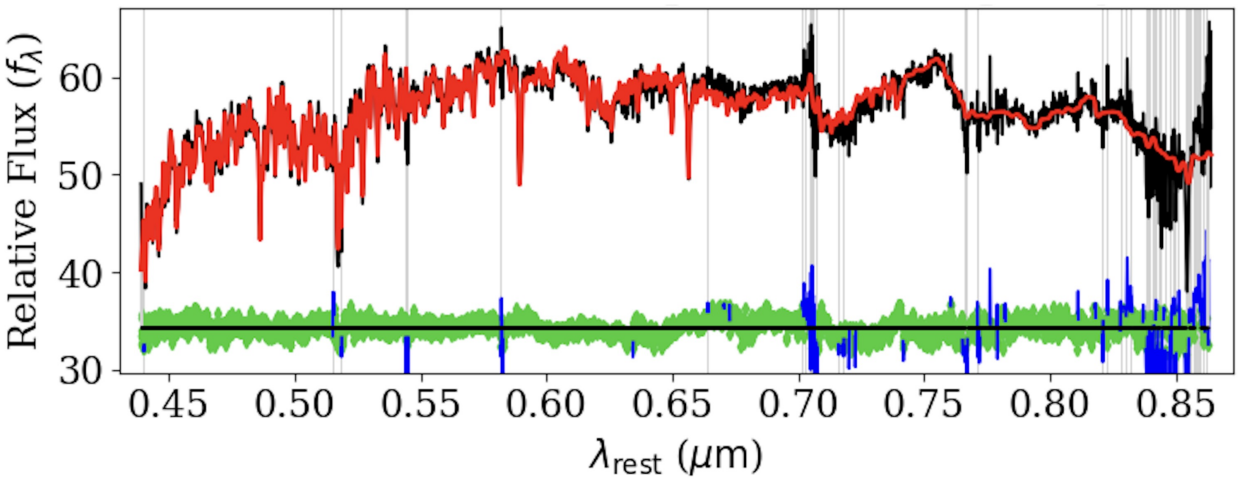
WISEA J111002.65−075211.9 (z=0.082)

P_{chance} < 0.5%

offset : 15.9 kpc (in projection)

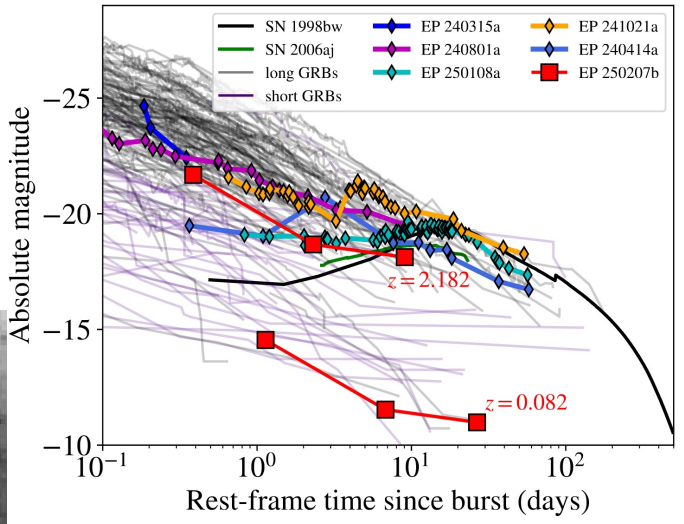


Average spectrum and fitting results

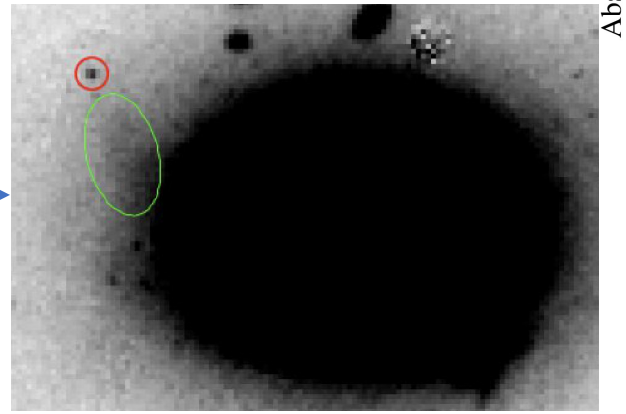


Discussion

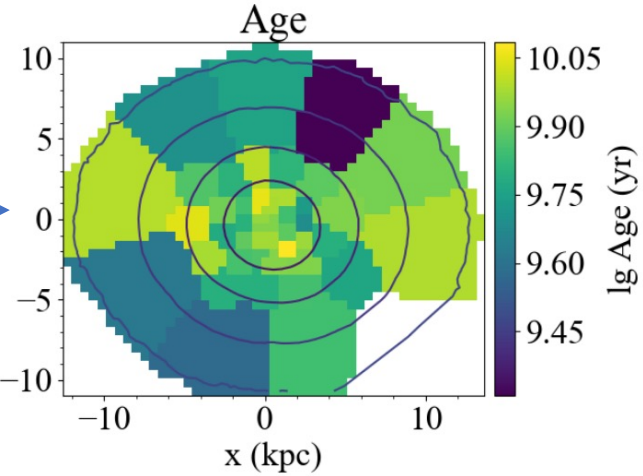
- The observed brightest M_r'=14.5 mag is consistent with the peak absolute magnitude and light curve evolution of some fainter, merger-driven short GRBs.



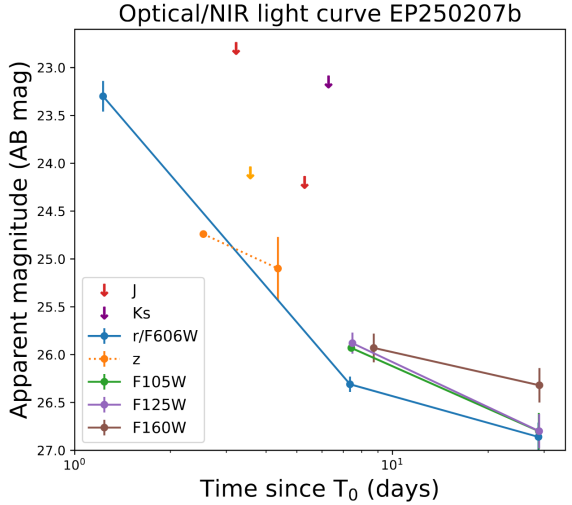
- Offset =15.9 kpc is well within the range of typical host galaxy offsets observed for short GRBs and simulated merger origin GRB population studies.



- The high age of the stars in the lenticular galaxy is inconsistent with a collapsar origin, but is consistent with a merger-driven (short) GRB scenario.



- The rate of decay observed in the r' and F606W-band seems to decelerate. This could be consistent with persistent contributions from a globular cluster or the core of a (tidally disrupted) dwarf galaxy host for EP 250207b.

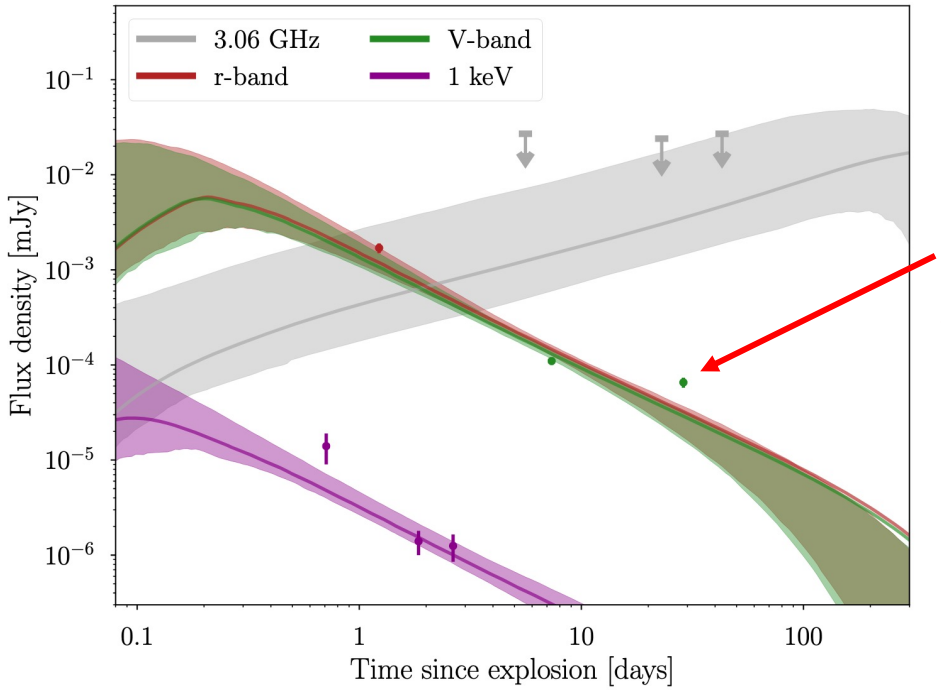


- The absolute magnitudes on rest frame timescales of ≈ 5 to 25 d rule out the presence of a Type Ic SN.

Model fitting and comparison

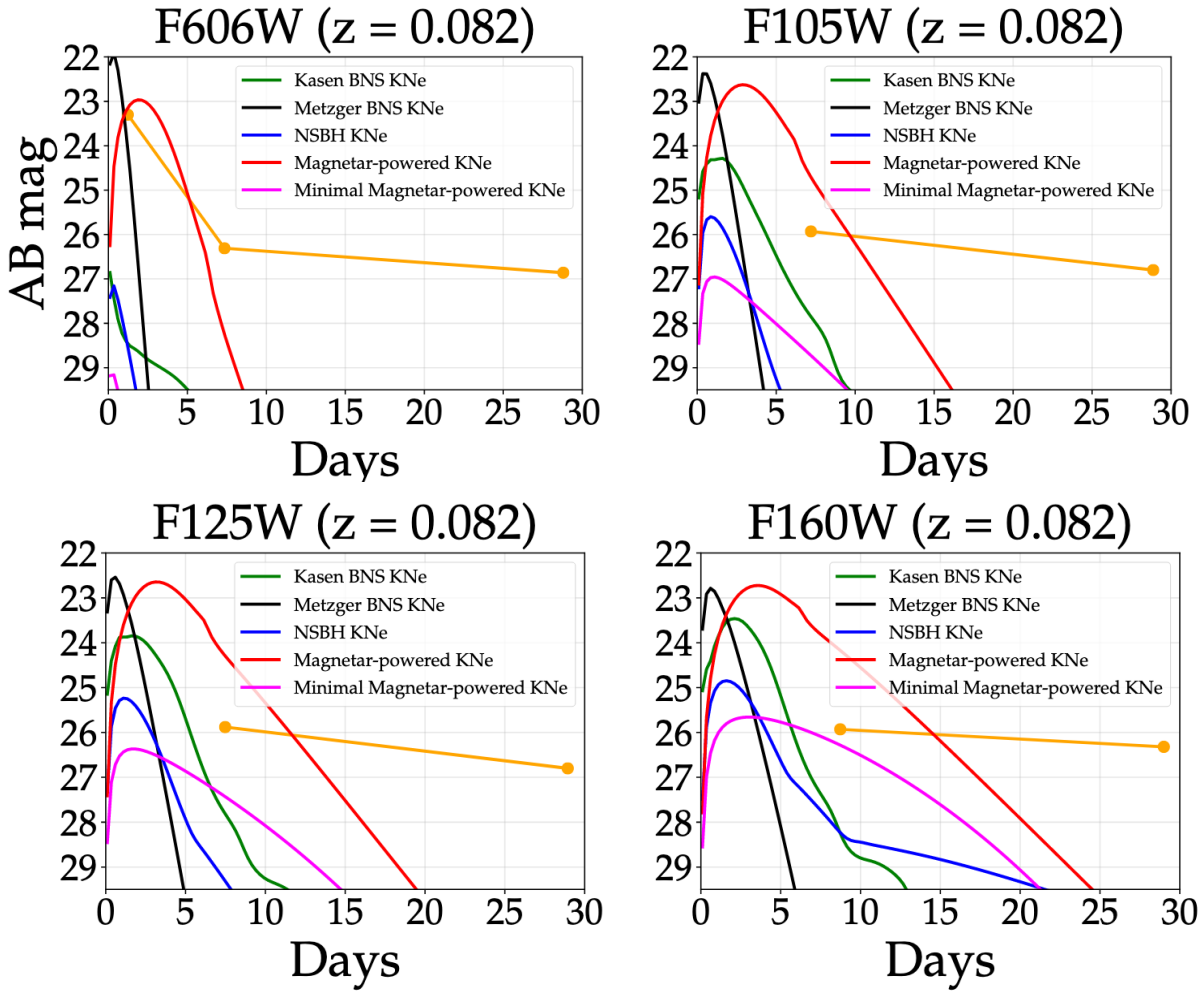
Afterglow model (off-axis)

Parameter	Prior	Posterior	Description
$\theta_{\rm observer}$ (rad)	[sin]$0 \leftrightarrow \pi/2$	0.16 ± 0.02	Observers line-of-sight angle
$\log E_{\rm K,iso}$ (log erg)	$44 \leftrightarrow 54$	$53.00^{+0.53}_{-0.65}$	Isotropic equivalent kinetic energy
$\theta_{\rm core}$ (rad)	$0.01 \leftrightarrow 0.1$	0.08 ± 0.01	Jet core half opening angle
$\theta_{\rm edge}$ (rad)	$0.1 \leftrightarrow 0.2$	$0.18^{+0.01}_{-0.02}$	Angular extent of structured jet
$\log n_{\rm ism}$ (log cm^{-3})	$-5 \leftrightarrow 2$	$-4.67^{+0.42}_{-0.24}$	Ambient medium number density
p	$1.4 \leftrightarrow 3.1$	$2.97^{+0.06}_{-0.07}$	Electron spectral energy density index
$\log \epsilon_e$	$-5 \leftrightarrow 0$	$-0.60^{+0.42}_{-0.63}$	Fraction of energy in electrons
$\log \epsilon_B$	$-5 \leftrightarrow 0$	$-3.82^{+1.30}_{-0.79}$	Fraction of energy in magnetic field
ε_N	$0.0 \leftrightarrow 1.0$	$0.20^{+0.28}_{-0.14}$	Synchrotron participation fraction
Γ_0	$100 \leftrightarrow 2000$	1262^{+522}_{-556}	Initial bulk Lorentz factor



Optical emission brighter than the afterglow

Kilonova model



Summary

- FXTs are short-lived extra-galactic X-ray sources
  - Duration : seconds to hours;
  - Some of them are related to collapsars.

- EP250207b: EP-discovered fast X-ray transient
  - Duration : more than 155 s (lower limit);
  - X-ray spectrum can be fitted well by an absorbed power law;
  - Optical and NIR light curve shows decelerate decaying;
  - High age of the stars in candidate host galaxy;
  - Brighter emission in the comparison with afterglow and kilonova models.

- An even brighter globular cluster could be responsible for nearly all the optical/NIR light in this final epoch.
- A tidal stream from a tidally disrupted dwarf galaxy could also explain the enhanced emission linking WISEA J111002.65−075211.9 and the location of the transient.

- EP 250207b is not a collapsar fast X-ray transient. It is likely due to a compact object merger.

Thanks.