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Supplementary information

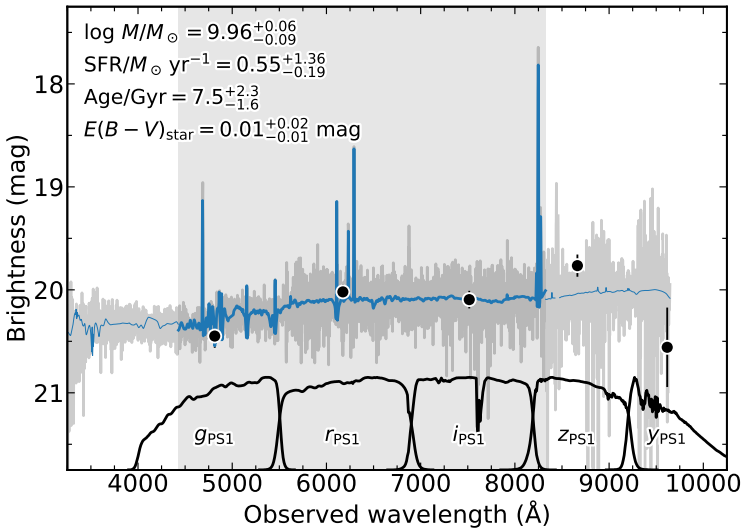
Minutes-duration optical flares with supernova luminosities

In the format provided by the authors and unedited

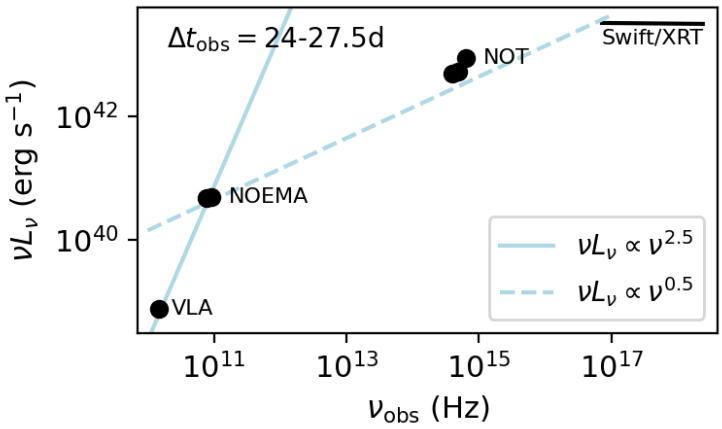
Supplementary Information

Object	Band	$L_{\rm flare}$ (erg s^{-1})	Amp.	Duration	Persistence
		Unknown			
AT2022tsd (this paper)	500 nm	10^{43}–10^{44}	$\gtrsim 100\times$	10–80 min	$\gtrsim 100$ d
GRB 070610 (BH? NS?)	800 nm	10^{35}?	$\gtrsim 100\times$	10 s–mins	5 d
NGC 1313 X-2 (ULX)	0.3–10 keV	10^{40}	$\sim 10\times$	10 min	–
		Neutron Stars			
SGR in M81/M82 (GF Spike)	20 keV–10 MeV	1.8×10^{47}	$\sim 10^{11}\times$	0.5 s	–
SGR 1806-20 (GF Tail)	20 keV–10 MeV	1.3×10^{42}	$\sim 10^{7}\times$	8 min	–
Crab (nanoshot)	8 GHz	10^{34}	$> 1000\times$	2 ns	–
		Stellar-mass black holes			
GRS 1915+105 (XRB)	2.2 μm	$\gtrsim 10^{36}$	$\lesssim 10\times$	10 min	–
GRB 080319B (GRB)	500 nm	10^{50}	$> 10\times$	40 s	60 s
		Supermassive black holes			
AT2019ehz (TDE)	0.3–10 keV	10^{44}	$> 10\times$	10 d	70 d
Sagittarius A*	2.1 μm	10^{34}	$\lesssim 10\times$	30 min	–
M87	350 GeV	10^{42}	$\gtrsim 10\times$	Few days	–
S5 1803+784 (blazar)	600 nm	10^{46}	$10\times$	$\gtrsim 1$ month	–
GSN 069 (QPE)	0.4–1 keV	10^{43}	$\gtrsim 10\times$	1 hr	–
ASASSN-14ko (TDE?)	200–500 nm	10^{43}–10^{44}	$> 10\times$	10 d	–

Table Supplementary Information Table 1: **Summary of large-amplitude ($\gtrsim 10\times$) flares from representative literature objects.** See Methods section 14 for additional details and data sources.



Supplementary Information Figure 1: **Best-fit host-galaxy properties of AT2022tsd.** The observed host-galaxy photometry is shown as black data points, the observed host-galaxy spectrum is shown in grey, and the best-fit model is shown in blue. The shaded region indicates the region of the spectrum used in the `prospector` fit.



Supplementary Information Figure 2: **SED of AT2022tsd at $\Delta t_{\rm obs} \approx 25$ d post-discovery.** X-ray data are shown with a photon index of $\Gamma = 2.01$ across the *Swift*/XRT 0.3–10 keV bandpass. Lines mark power laws connecting the radio to submillimeter data (solid), and the millimeter to X-ray data (dashed).

Table Supplementary Information Table 2: **Host-galaxy photometry for AT2022tsd, not corrected for Milky Way extinction.** Error bars are 1σ confidence intervals.

Survey	Filter	Brightness (AB mag)
PanSTARRS	g	21.32 ± 0.10
PanSTARRS	r	20.59 ± 0.07
PanSTARRS	i	20.67 ± 0.05
PanSTARRS	z	20.87 ± 0.36
PanSTARRS	y	20.14 ± 0.10

t (UT)	Δt (days)	$t_{\rm exp}$ (ks)	Count Rate (10^{-3} s^{-1})	F_X (10^{-14} erg s^{-1} cm^{-2})	L_X (10^{43} erg s^{-1})
2022-10-04 09:17	22.65 ± 0.24	3.64	10.43 ± 2.06	53.17 ± 10.50	11.43 ± 2.26
2022-10-06 14:55	24.41 ± 0.22	3.78	9.06 ± 1.85	46.19 ± 9.44	9.93 ± 2.03
2022-10-08 02:17	25.65 ± 0.29	2.47	8.46 ± 2.24	43.14 ± 11.43	9.28 ± 2.46
2022-10-09 05:06	26.54 ± 0.29	2.29	10.92 ± 2.91	55.67 ± 14.84	11.97 ± 3.19
2022-10-10 09:47	27.31 ± 0.11	2.37	5.07 ± 2.60	25.85 ± 13.26	5.56 ± 2.85
2022-10-21 16:35	36.60 ± 0.42	1.44	< 11.89	< 60.63	< 13.04
2022-10-24 09:25	38.57 ± 0.24	1.04	< 13.97	< 71.27	< 15.32
2022-10-26 01:27	40.03 ± 0.37	2.77	5.35 ± 1.88	27.30 ± 9.56	5.87 ± 2.06
2022-11-06 01:21	48.65 ± 0.24	4.39	1.86 ± 0.99	9.50 ± 5.04	2.04 ± 1.08
2022-11-16 01:40	56.48 ± 0.11	1.87	2.02 ± 1.57	10.29 ± 8.01	2.21 ± 1.72
2022-11-17 07:44	57.61 ± 0.24	1.96	3.60 ± 1.99	18.38 ± 10.16	3.95 ± 2.18
2022-12-01 02:23	68.65 ± 0.32	5.75	1.28 ± 0.78	6.54 ± 3.99	1.41 ± 0.86
2022-12-15 00:09	79.78 ± 0.38	2.97	< 3.99	< 20.33	< 4.37
2022-12-16 09:52	81.10 ± 0.58	2.67	< 4.50	< 22.97	< 4.94

Table Supplementary Information Table 3: *Swift* **XRT (0.3–10 keV) observations of AT2022tsd.** The table includes epochs Δt since discovery in the rest frame, exposure time $t_{\rm exp}$, flux F_X, and luminosity L_X. Error bars are 1σ and upper limits are given as 3σ.

$t_{\rm start}$ (UT)	Δt (days)	$t_{\rm exp}$ (ks)	F_X (10^{-14} erg s^{-1} cm^{-2})	L_X (10^{43} erg s^{-1})
2022-10-16 23:14	32.42	20	$14.60^{+3.33}_{-3.22}$	$3.14^{+0.72}_{-0.69}$
2022-10-27 21:54	41.13	20	$10.46^{+2.78}_{-2.22}$	$2.25^{+0.60}_{-0.48}$
2022-11-04 12:33	47.19	20	$7.59^{+2.64}_{-2.40}$	$1.63^{+0.57}_{-0.52}$
2022-11-22 05:26	61.27	20	$9.17^{+3.14}_{-2.53}$	$1.97^{+0.68}_{-0.54}$
2022-12-26 14:11	88.62	24	$1.68^{+2.03}_{-0.92}$	$0.36^{+0.44}_{-0.20}$
2022-12-29 07:06	90.77	16	$2.48^{+4.98}_{-1.57}$	$0.53^{+1.07}_{-0.34}$
2023-01-30 16:28	116.55	40	$0.96^{+1.04}_{-0.51}$	$0.21^{+0.22}_{-0.11}$
2023-07-11 03:37	244.09	16	$0.66^{+0.54}_{-0.43}$	$0.14^{+0.12}_{-0.09}$
2023-07-11 to 2023-07-16	244–248	40	$0.38^{+0.15}_{-0.12}$	$0.08^{+0.03}_{-0.03}$

Table Supplementary Information Table 4: *Chandra X-ray Observatory* **0.5–6 keV observations of AT2022tsd.** The table includes epochs Δt since discovery in the rest frame, exposure time $t_{\rm exp}$, flux F_X, and luminosity L_X. Error bars are 1σ confidence intervals. The final row shows the stacked measurement from three observations conducted on three different days.

Table Supplementary Information Table 5: **Radio observations of AT2022tsd.** Table includes epochs since discovery Δt in the rest frame, observed frequency $\nu_{\rm obs}$, flux density f_ν of the source (if detected), and root-mean-square (RMS) of a region close to the source in the image.

Start Date (UT)	Δt (days)	$\nu_{\rm obs}$ (GHz)	f_ν (mJy)	RMS (mJy)	Telescope
2022-10-02 06:50:00	19.75	15.00	0.023	0.004	VLA
2022-10-04 07:20:00	21.36	230.00	–	0.270	SMA
2022-10-04 22:07:00	21.85	77.26	0.283	0.075	NOEMA
2022-10-04 22:07:00	21.85	92.74	0.245	0.065	NOEMA
2022-10-10 08:02:00	26.16	45.00	0.127	0.033	VLA
2022-10-10 08:02:00	26.16	22.00	0.038	0.009	VLA
2022-10-10 08:02:00	26.16	15.00	0.031	0.004	VLA
2022-10-10 08:02:00	26.16	33.00	0.086	0.013	VLA
2022-10-10 21:16:00	26.59	134.76	0.212	0.047	NOEMA
2022-10-10 21:16:00	26.59	150.24	0.232	0.057	NOEMA
2022-10-11 00:45:00	26.71	77.26	0.239	0.035	NOEMA
2022-10-11 00:45:00	26.71	92.74	0.284	0.032	NOEMA
2022-10-11 02:53:00	26.78	207.26	0.574	0.114	NOEMA
2022-10-11 02:53:00	26.78	222.74	0.551	0.117	NOEMA
2022-10-12 02:50:00	27.57	77.26	0.298	0.082	NOEMA
2022-10-12 02:50:00	27.57	92.74	0.316	0.078	NOEMA
2022-10-13 23:24:00	29.05	77.26	0.170	0.039	NOEMA
2022-10-13 23:24:00	29.05	92.74	0.179	0.037	NOEMA
2022-10-14 02:04:00	29.14	134.76	0.277	0.087	NOEMA
2022-10-14 02:04:00	29.14	150.24	0.411	0.117	NOEMA
2022-10-19 04:29:00	33.20	350.50	0.313	0.027	ALMA
2022-10-20 05:44:00	34.04	15.00	0.033	0.004	VLA
2022-10-20 05:44:00	34.04	33.00	0.071	0.010	VLA
2022-10-20 05:44:00	34.04	22.00	0.056	0.007	VLA
2022-10-20 05:44:00	34.04	10.00	0.031	0.004	VLA
2022-10-20 05:44:00	34.04	45.00	0.075	0.021	VLA
2022-10-21 04:54:40	34.81	412.00	0.259	0.038	ALMA

2022-10-22 03:52:39	35.57	242.00	0.300	0.028	ALMA
2022-10-28 00:54:00	40.25	77.26	0.363	0.113	NOEMA
2022-10-28 00:54:00	40.25	92.74	0.299	0.093	NOEMA
2022-10-28 00:54:00	40.25	150.24	0.328	0.037	NOEMA
2022-10-29 23:00:00	41.77	150.24	0.330	0.040	NOEMA
2022-10-29 23:00:00	41.77	134.76	0.228	0.028	NOEMA
2022-11-01 23:03:00	44.16	222.74	0.198	0.052	NOEMA
2022-11-01 23:03:00	44.16	207.26	0.175	0.048	NOEMA
2022-11-08 04:52:00	49.13	15.00	0.031	0.004	VLA
2022-11-08 04:52:00	49.13	22.00	0.043	0.006	VLA
2022-11-08 04:52:00	49.13	33.00	0.075	0.008	VLA
2022-11-08 04:52:00	49.13	45.00	0.120	0.015	VLA
2022-11-18 20:08:00	57.60	77.26	0.252	0.039	NOEMA
2022-11-18 20:08:00	57.60	92.74	0.304	0.030	NOEMA
2022-11-26 22:16:00	64.04	134.76	0.111	0.030	NOEMA
2022-11-26 22:16:00	64.04	150.24	0.119	0.032	NOEMA
2022-12-03 03:26:00	68.98	22.00	0.078	0.007	VLA
2022-12-03 03:26:00	68.98	33.00	0.099	0.009	VLA
2022-12-03 03:26:00	68.98	45.00	0.108	0.018	VLA
2022-12-03 03:26:00	68.98	15.00	0.049	0.004	VLA
2022-12-14 18:56:00	78.25	77.25	0.131	0.028	NOEMA
2022-12-14 18:56:00	78.25	92.74	0.153	0.024	NOEMA
2023-01-27 01:26:00	112.69	45.00	–	0.016	VLA
2023-01-27 01:26:00	112.69	33.00	0.052	0.011	VLA
2023-01-27 01:26:00	112.69	15.00	0.048	0.003	VLA
2023-01-27 01:26:00	112.69	22.00	0.048	0.006	VLA
2023-03-04 12:14	141.70	1.27	0.140	0.033	uGMRT
2023-03-05 12:14	142.50	0.65	–	0.195	uGMRT
2023-03-06 10:19	143.23	0.44	–	0.810	uGMRT
2023-03-23 13:19:00	156.86	77.25	–	0.045	NOEMA
2023-03-23 13:19:00	156.86	92.74	–	0.047	NOEMA
2023-03-31 08:10	163.06	1.37	0.131	0.035	uGMRT
2023-04-01 10:05	163.92	0.65	–	0.165	uGMRT

2023-04-02 10:05	164.71	0.43	–	0.465	uGMRT
2023-04-05 23:00:00	167.53	6.00	–	0.009	VLA
2023-04-05 23:00:00	167.53	10.00	0.038	0.009	VLA
2023-04-05 23:00:00	167.53	22.00	–	0.009	VLA
2023-04-05 23:00:00	167.53	3.00	–	0.018	VLA

1632