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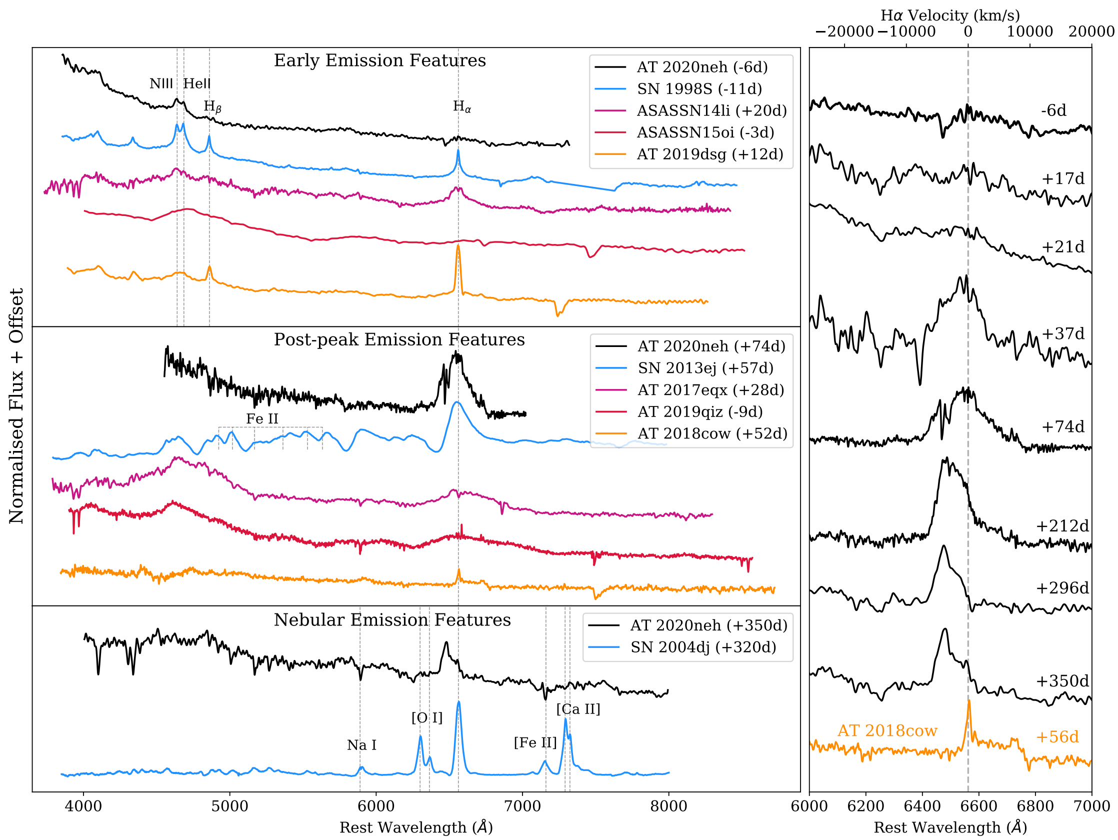
A fast-rising tidal disruption event from a candidate intermediate-mass black hole

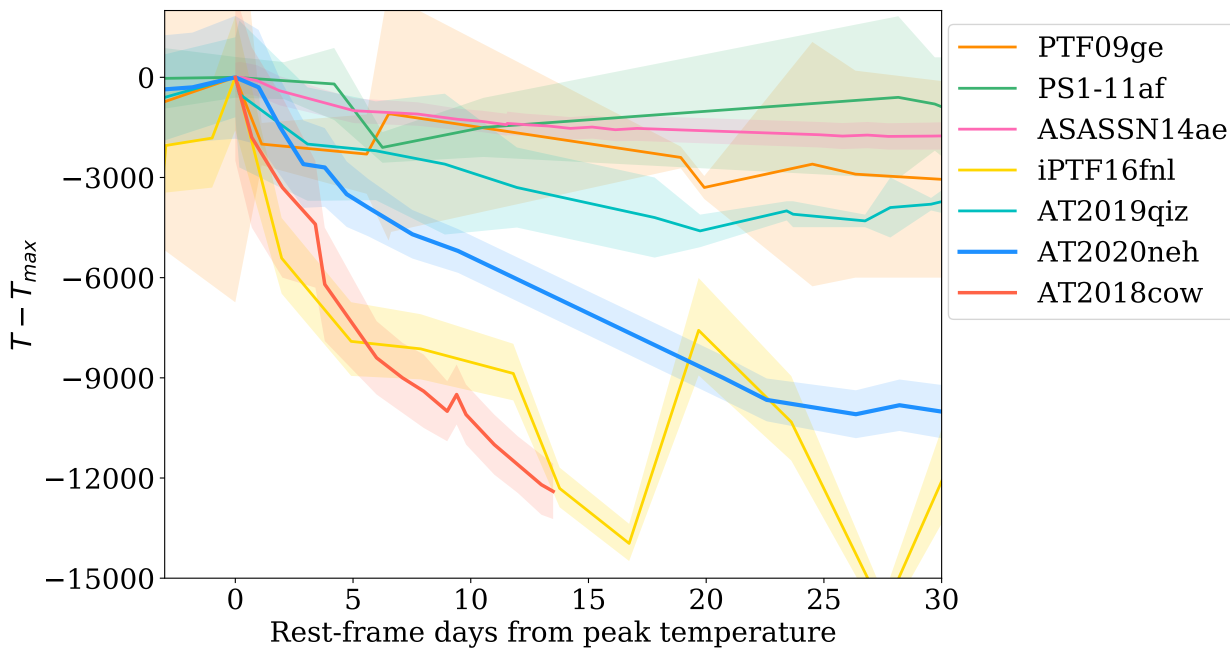
In the format provided by the authors and unedited

Supplemetary Materials

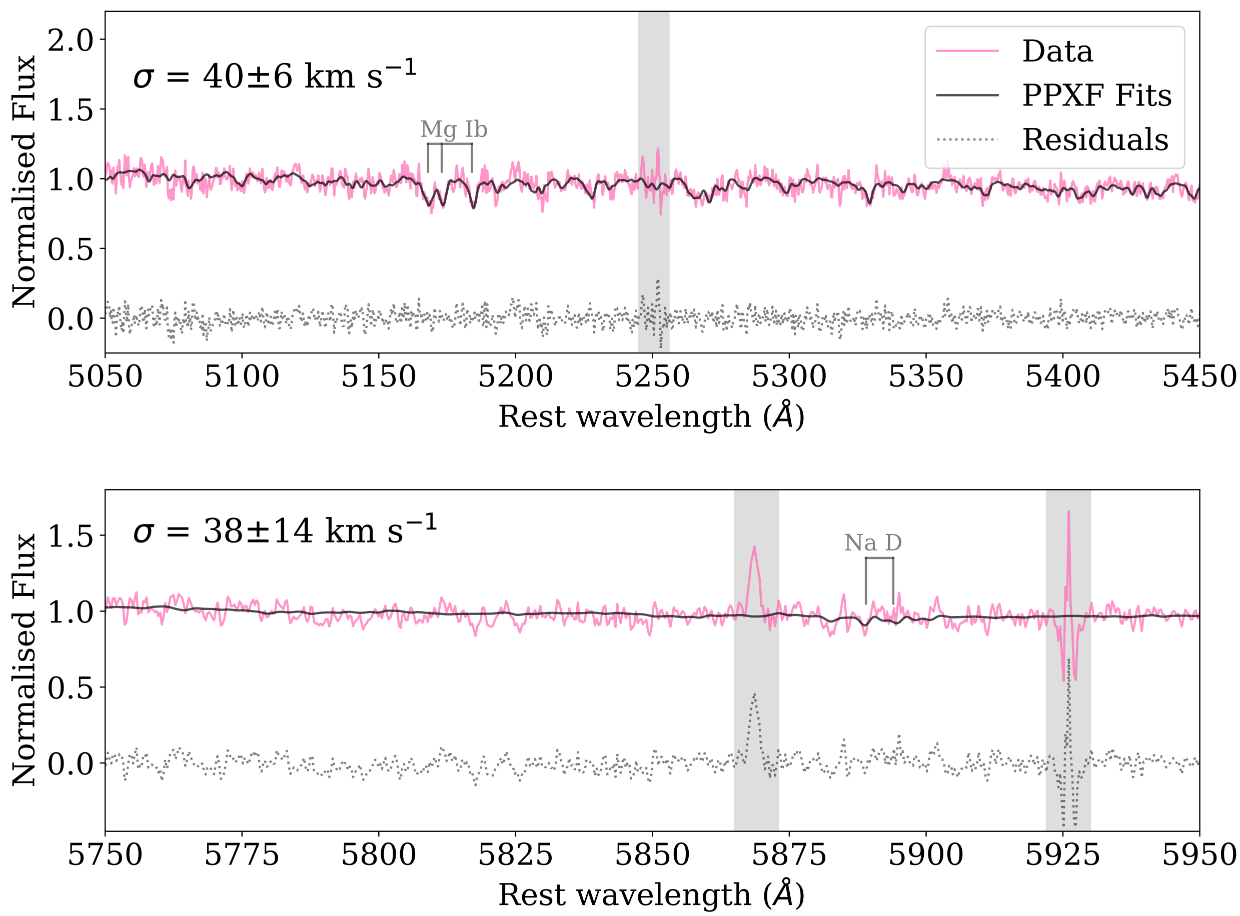


Supplementary Figure 1 | Spectroscopic comparison with other transients. *Top:* The early time spectrum of AT 2020neh alongside other TDEs which show Bowen fluorescence and an example of an alternative to this interpretation (CCSN flash-ionisation, as exemplified in SN 1998S). *Middle:* Comparison of the post-maximum features in AT 2020neh with other TDEs, a CCSN and the FBOT AT 2018cow. AT 2020neh presents a Hα profile in emission, lacking the typical P-Cygni profile of a SN II but much broader than the FBOT. The rest of the spectrum is featureless, lacking absorption features from iron-group elements which would be expected of a CCSN during the photospheric phase. *Bottom:* The ‘nebular’ phase spectrum of AT 2020neh alongside a nebular phase

CCSN. Expected emission features from SN during this phase are marked. *Right:* The evolution of the Hα profile of AT 2020neh. This feature appears late in the post-peak evolution, and retains a strongly blue-shifted profile, unseen in normal SNe. The narrow profile of AT 2018cow is shown for comparison.



Supplementary Figure 2 | Cooling rates of transients The early time cooling AT 2020neh compared to that exhibited in the optically selected TDEs, including AT2019qiz and iPTF16fnl, alongside the FBOT AT 2018cow. For each event the mean temperature evolution is shown, with the 1σ standard deviation (shaded regions). AT 2020neh does exhibit significant cooling of approximately 9000k during the first 30 days from peak. This rate of cooling is comparable to that observed in iPTF16fnl and AT 2019qiz, which are both believed to be produced by relatively low mass SMBHs ($M_{BH} \sim 10^6 M_\odot$; 3,12). This rate of cooling is much slower than that exhibited by AT 2018cow, which cools by nearly 10,000K in the first 10 days from peak (16).



Supplementary Figure 3 | Fitting the velocity dispersion of the host The late-time DEIMOS spectrum of AT 2020neh used to fit the stellar absorption features is shown, highlighting the regions around the Mg Ib triplet (top) and the Na D doublet (bottom). These two regions are fit independently. The best-fitting pPXF model is shown alongside each spectrum. We perform Monte-Carlo bootstrap fitting of the data to determine the uncertainties on the velocity dispersion.

Supplementary Table 1 | Hα Spectroscopic Followup Observations

Date (UT)	Phase	Telescope	Instrument	Grating	λ Range (Å)
25/06/2020	-6 d	NOT	ALFOSC	Gr 4	4000 - 9000
11/07/2020	+9 d	Gemini	GMOS-N	B1200	4400 - 6000
17/07/2020	+ 15 d	Gemini	GMOS-N	B1200	4400 - 6000
19/07/2020	+17 d	Shane-3m	KAST	B452/3306	3300 - 6200
				R300/7500	3300 - 6200
23/07/2020	+21 d	Keck	LRIS	400/3400	3200 - 5700
				400/8500	5500 - 10300
24/07/2020	+ 22 d	Gemini	GMOS-N	B1200	4400 - 6000
09/08/2020	+37 d	Shane-3m	KAST	B452/3306	3300 - 6200
				R300/7500	3300 - 6200
17/09/2020	+74 d	Keck	DEIMOS	B1200	4800 - 7400
12/02/2021	+212 d	Keck	LRIS	400/3400	3200 - 5700
				400/8500	5500 - 10300
12/05/2021	+296 d	Keck	LRIS	400/3400	3200 - 5700
				400/8500	5500 - 10300
08/07/2021	+350 d	Keck	LRIS	400/3400	3200 - 5700
				400/8500	5500 - 10300

Supplementary Table 2 | Hα Photometry of AT 2020neh

MJD	Mag	Mag Err	Filter
59031.357	17.431	0.112	U
59033.821	17.546	0.096	U
59034.879	17.500	0.148	U
59035.744	17.644	0.112	U
59036.613	17.663	0.042	U
59037.736	17.748	0.116	U
59039.448	17.903	0.096	U
59040.923	18.131	0.042	U
59045.026	18.362	0.116	U
59047.956	18.937	0.145	U
59053.724	19.464	0.171	U
59055.713	19.401	0.181	U
59061.763	20.163	0.191	U
59066.541	19.758	0.177	U
59031.357	17.860	0.144	B
59033.822	17.686	0.111	B
59034.879	17.553	0.168	B
59035.745	17.787	0.129	B
59037.736	17.732	0.127	B
59039.449	17.928	0.105	B
59045.027	18.558	0.131	B
59047.956	18.984	0.153	B
59053.724	18.966	0.154	B
59055.714	19.282	0.179	B
59057.244	19.501	0.169	B
59061.764	19.332	0.165	B
59066.542	20.239	0.189	B
59084.468	19.834	0.191	B
59033.826	17.668	0.171	V
59039.455	18.001	0.161	V
59055.720	18.229	0.183	V
59031.359	17.637	0.072	UVW2
59033.824	17.828	0.065	UVW2
59034.880	17.897	0.102	UVW2
59035.746	18.181	0.081	UVW2
59037.738	18.533	0.092	UVW2
59039.452	18.665	0.076	UVW2
59045.030	19.527	0.102	UVW2

MJD	Mag	Mag Err	Filter	MJD	Mag	Mag Err	Filter
59047.959	20.771	0.144	UVW2	59039.460	18.483	0.071	UVM2
59049.026	19.995	0.193	UVW2	59045.037	19.433	0.100	UVM2
59053.727	20.389	0.131	UVW2	59047.965	20.088	0.124	UVM2
59055.717	20.958	0.146	UVW2	59049.029	19.982	0.180	UVM2
59057.247	20.706	0.143	UVW2	59053.734	20.598	0.136	UVM2
59061.767	21.303	0.160	UVW2	59055.724	20.512	0.128	UVM2
59066.544	21.384	0.158	UVW2	59057.253	20.529	0.132	UVM2
59068.064	21.550	0.160	UVW2	59063.765	22.293	0.170	UVM2
59070.188	20.697	0.171	UVW2	59066.551	20.907	0.147	UVM2
59074.114	20.885	0.177	UVW2	59068.071	21.105	0.146	UVM2
59078.425	21.898	0.174	UVW2	59070.193	20.981	0.165	UVM2
59084.471	23.592	0.187	UVW2	59078.431	21.426	0.164	UVM2
59086.263	22.616	0.178	UVW2	59080.365	21.569	0.162	UVM2
59088.989	21.792	0.184	UVW2	59082.490	22.157	0.164	UVM2
59031.363	17.463	0.066	UVM2	59084.477	21.445	0.155	UVM2
59033.827	17.826	0.135	UVM2	59086.269	22.335	0.174	UVM2
59034.882	17.922	0.101	UVM2	59031.356	17.417	0.085	UVW1
59035.751	17.949	0.073	UVM2	59033.819	17.675	0.078	UVW1
59037.743	18.268	0.083	UVM2	59035.743	17.967	0.097	UVW1
59038.735	18.548	0.063	UVM2	59037.735	18.064	0.100	UVW1

MJD	Mag	Mag Err	Filter	MJD	Mag	Mag Err	Filter
59039.446	18.228	0.084	UVW1	58968.429	21.027	0.202	PS1 r
59041.708	18.644	0.177	UVW1	58997.342	21.215	0.251	PS1 r
59045.024	18.941	0.110	UVW1	59037.367	17.989	0.046	PS1 r
59047.954	19.400	0.139	UVW1	59039.352	17.983	0.030	PS1 r
59053.722	20.051	0.166	UVW1	59053.281	18.435	0.038	PS1 r
59055.711	20.343	0.193	UVW1	59061.299	18.833	0.140	PS1 r
59057.241	20.411	0.179	UVW1	59065.275	18.767	0.042	PS1 r
59061.762	20.210	0.166	UVW1	59096.249	20.017	0.298	PS1 r
58958.530	21.095	0.306	PS1 g	59098.298	19.859	0.317	PS1 r
58968.426	21.241	0.254	PS1 g	58942.491	20.369	0.358	PS1 i
58990.375	21.282	0.287	PS1 g	58960.455	20.562	0.186	PS1 i
59021.287	18.962	0.051	PS1 g	58966.516	20.771	0.327	PS1 i
59024.381	17.964	0.020	PS1 g	58972.442	20.602	0.196	PS1 i
59027.278	17.727	0.026	PS1 g	58990.372	20.522	0.151	PS1 i
59053.284	18.615	0.041	PS1 g	59017.287	20.726	0.171	PS1 i
59071.274	19.453	0.163	PS1 g	59024.383	18.487	0.034	PS1 i
59106.237	20.490	0.259	PS1 g	59027.276	18.217	0.030	PS1 i
59115.231	20.633	0.225	PS1 g	59039.349	18.055	0.036	PS1 i
59024.381	17.970	0.020	PS1 g	59048.298	18.263	0.031	PS1 i
58958.533	20.786	0.201	PS1 r	59065.278	18.614	0.046	PS1 i

MJD	Mag	Mag Err	Filter
59065.278	18.598	0.045	PS1 i
59071.271	18.886	0.103	PS1 i
59096.252	19.265	0.156	PS1 i
59106.234	19.479	0.092	PS1 i
59037.364	18.308	0.079	PS1 z
59061.302	18.840	0.170	PS1 z
59098.295	19.519	0.294	PS1 z
59115.228	19.719	0.187	PS1 z
59019.255	20.667	0.145	ZTF g
59022.199	18.755	0.032	ZTF g
59025.231	17.879	0.021	ZTF g
59028.201	17.716	0.020	ZTF g
59031.189	17.631	0.029	ZTF g
59034.195	17.688	0.030	ZTF g
59040.232	17.913	0.017	ZTF g
59043.191	18.108	0.019	ZTF g
59049.207	18.404	0.026	ZTF g
59062.191	19.177	0.103	ZTF g
59022.232	18.985	0.034	ZTF r
59025.190	18.194	0.026	ZTF r
59028.213	17.968	0.024	ZTF r
59031.211	17.970	0.043	ZTF r
59037.189	17.930	0.023	ZTF r
59040.197	17.996	0.019	ZTF r
59046.190	18.232	0.023	ZTF r
59049.185	18.326	0.026	ZTF r
59062.229	18.886	0.074	ZTF r
59063.168	18.534	0.044	ZTF r
59065.168	18.914	0.070	ZTF r