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The K2 Halo Photometry Campaign

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ABSTRACT

While the *Kepler* mission was designed to look at tens of thousands of faint stars ($V \gtrsim 12$), brighter stars which saturate the detector are nevertheless some of the most interesting because of the ease with which they can be observed by other instruments and the wealth of knowledge about them that is already available. By considering the unsaturated scattered light 'halo' around these stars we retrieve precise light curves of most of the brightest stars in *K2* fields from Campaign 6 onwards. This halo campaign reveals stellar variability ubiquitously, including effects of stellar pulsation, rotation, and binarity. Here we describe our pipeline, and present a catalogue of the halo sources, with classifications and parametrizations of their variability and remarks on interesting objects. These light curves are publicly available as a High Level Science Product.

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REFERENCES

Astropy Collaboration, Robitaille, T. P., Tollerud, E. J., et al. 2013, A&A, 558, A33, doi: 10.1051/0004-6361/201322068

Jones, E., Oliphant, T., Peterson, P., & Others. 2001, SciPy: Open source scientific tools for Python. http://www.scipy.org/

Pérez, F., & Granger, B. E. 2007, Computing in Science and Engineering, 9, 21, doi: 10.1109/MCSE.2007.53

Table 1. All stars observed with halo photometry in K2.

Name	EPIC	RA (J2000) (deg)	Dec (J2000) (deg)	Spectral Type	V mag	Campaign
Ascella	200062593	285.65184	-29.879815	A2.5Va	2.585	7
Albaldah	200062592	287.441295	-21.024023	F2II-III	2.88	7
τ Sgr	200062591	286.733938	-27.671395	K1.5IIIb	3.31	7
ξ2 Sgr	200062590	284.432465	-21.106731	G8/K0II/III	3.51	7
o Sgr	200062589	286.17119	-21.741407	G9IIIb	3.77	7
52 Sgr	200062585	294.176404	-24.885019	B8/9V	4.598	7
Ainalrami	200062588	283.542904	-22.744355	K1II	4.845	7
ψ Sgr	200062584	288.884973	-25.257284	K0/1III+A/F	4.85	7
43 Sgr	200062587	289.409117	-18.953224	G8II-III	4.878	7
ν2 Sgr	200062586	283.779491	-22.671559	K3-II-III:CN1Ba1	4.98	7
ϵ Psc	200068392	15.736117	7.889231	G9IIIbFe-2	4.28	8
Revati	200068393	18.43412	7.574624	A7IV	5.187	8
80 Psc	200068394	17.091325	5.648604	F2V	5.5	8
42 Cet	200068399	19.951281	-0.509707	G8IV+A(8)	5.87	8
33 Cet	200068395	17.639603	2.445331	K4/5III	5.942	8
60 Psc	200068396	11.848427	6.740724	G8III	5.961	8
73 Psc	200068397	16.219136	5.656351	K5III	6.007	8
WW Psc	200068398	14.957207	6.483094	M2.5III	6.14	8
HR 243	200068400	12.826105	3.38449	G8/K0II/III	6.368	8
HR 161	200068401	9.377393	3.135111	K3III	6.407	8
HR 6766	200069361	272.021137	-28.457424	G7:IIIbCN-1CH-3.5HK+1	4.56	9
HR 6842	200069360	274.513094	-27.04213	K3II	4.627	9
4 Sgr	200069357	269.947601	-23.815818	A0	4.724	9
11 Sgr	200069358	272.931094	-23.701391	K0III	4.98	9
7 Sgr	200069362	270.713151	-24.282028	F2II-III	5.34	9
15 Sgr	200069359	273.80418	-20.728554	O9.7Iab	5.37	9
HR 6838	200069363	274.298269	-17.37435	K2III	5.75	9
Y Sgr	200069364	275.34515	-18.859826	F8II	5.75	9
HR 6716	200069365	270.476773	-22.780204	B0Iab/b	5.77	9
HR 6681	200069366	269.079263	-15.812584	A0V	5.929	9
9 Sgr	200069368	270.968745	-24.361063	O4V((f))z	5.97	9
16 Sgr	200069367	273.803883	-20.388154	O9.5III	6.02	9

Table 2. All stars observed with halo photometry in K2 (cont'd).

Name	EPIC	RA (J2000) (deg)	Dec (J2000) (deg)	Spectral Type	V mag	Campaign
HR 6825	200069369	273.877872	-18.661964	ApSi	6.15	9
63 Oph	200069370	268.725668	-24.886798	O8II((f))	6.2	9
HR 6679	200069373	268.97931	-18.801918	A1V	6.469	9
HD 165784	200069371	272.161183	-21.44927	A2Iab	6.58	9
HD 161083	200069374	266.100216	-22.194983	F0V	6.58	9
5 Sgr	200069372	270.048298	-24.284432	K0III	6.64	9
HD 167576	200069378	274.239359	-27.716096	K1III	6.66	9
HR 6773	200069380	272.225749	-25.473139	B3/5IV	6.71	9
HD 163296	200071159	269.088907	-21.956371	A1Vep	6.85	9
HD 165052	200069379	271.293504	-24.398154	O5.5:Vz+O8:V	6.87	9
17 Sgr	200069375	274.147867	-20.544369	G8/K0III	6.886	9
HD 169966	200069376	277.029565	-22.999934	G8/K0III	6.97	9
HD 162030	200069377	267.489563	-24.207101	K1III	7.02	9
Porrima	200084004	190.41486	-1.449475	F1V+F0mF2V	2.74	10
Zaniah	200084005	184.97638	-0.667183	A2IV	3.9	10
21 Vir	200084006	188.444462	-9.452253	B9V	5.48	10
FW Vir	200084007	189.593819	1.854722	M3+IIICa0.5	5.71	10
HR 4837	200084008	190.908208	-1.57638	G8III	5.918	10
HR 4591	200084009	180.256803	-1.768302	K1III	6.316	10
HR 4613	200084010	181.499356	-3.131519	G8/K0III	6.364	10
HD 107794	200084011	185.814177	-4.974539	K0III	6.46	10
θ Oph	200128906	260.502159	-24.999975	OB	3.26	11
44 Oph	200128907	261.592348	-24.17599	kA5hA9mF1III	4.153	11
45 Oph	200128908	261.837707	-29.868083	F5III-IV	4.269	11
51 Oph	200128909	262.85357	-23.963494	A0V	4.81	11
36 Oph	200129035	258.83327	-26.604429	K2V+K1V	5.03	11
o Oph	200128910	259.502324	-24.286539		5.2	11
26 Oph	200129034	255.039748	-24.989128	F3V	5.731	11
HR 6472	200128911	261.174968	-21.441283	K0III	5.83	11
HR 6366	200128913	257.196761	-30.403635	Fm dD	5.911	11
HR 6365	200128912	257.062511	-17.608806	K0III	5.977	11
191 Oph	200128914	261.275705	-24.243761	K0III	6.171	11

Table 3. All stars observed with halo photometry in K2 (cont'd).

Name	EPIC	RA (J2000) (deg)	Dec (J2000) (deg)	Spectral Type	V mag	Campaign
κ Psc	200164167	351.732716	1.255165	A2VpSrCrSi	4.94	12
83 Aqr	200164168	346.291555	-7.693773	F0V	5.47	12
24 Psc	200164169	358.231585	-3.155866	K0II/III	5.94	12
HR 8759	200164170	345.382614	-4.711516	G5II/III	5.933	12
14 Psc	200164171	353.53746	-1.247154	A2II	5.87	12
HR 8921	200164172	352.25226	-9.266444	K4/5III	6.191	12
81 Aqr	200164173	345.348622	-7.061254	K4III	6.215	12
HR 8897	200164174	350.883513	0.290695	K4III	6.34	12
Aldebaran	200173843	68.980934	16.509007	K5+III	0.86	13
θ2 Tau	200173845	67.165927	15.87053	A7III	3.41	13
ϵ Tau	200173844	67.154639	19.179692	G9.5IIICN0.5	3.53	13
θ1 Tau	200173846	67.14417	15.961688	G9IIIFe-0.5	3.84	13
κ1 Tau	200173847	66.342857	22.293035	A7IV-V	4.201	13
δ3 Tau	200173849	66.372261	17.926961	A2IV-Vs	4.25	13
τ Tau	200173850	70.557694	22.954783	B3V	4.258	13
υ Tau	200173848	66.577858	22.812849	A8Vn	4.282	13
ρ Tau	200173851	68.456844	14.858859	A8V	4.65	13
11 Ori	200173853	76.142365	15.403705	A1VpSiCr	4.661	13
HR 1427	200173855	67.640376	16.193275	A6IV	4.764	13
15 Ori	200173854	77.42463	15.597631	F2IV	4.82	13
75 Tau	200173852	67.110364	16.359293	K1IIIb	4.969	13
97 Tau	200173857	72.84359	18.840322	A7IV-V	5.085	13
HR 1684	200173856	77.923187	16.045798	K5III	5.163	13
κ2 Tau	200173859	66.354939	22.199235	F0Vn	5.264	13
56 Tau	200173861	64.90355	21.772847	A0VpSi	5.346	13
81 Tau	200173860	67.662125	15.691144	Am	5.454	13
53 Tau	200173864	64.859035	21.141481	B9Vsp	5.482	13
HR 1585	200173858	74.343209	17.152963	K1III	5.49	13
80 Tau	200173866	67.536514	15.637471	F0V	5.552	13
51 Tau	200173865	64.597374	21.578461	F0V	5.631	13
HR 1403	200173867	67.004481	21.619624	Am	5.711	13
89 Tau	200173868	69.540041	16.032569	F0V	5.776	13

Table 4. All stars observed with halo photometry in K2 (cont'd).

Name	EPIC	RA (J2000) (deg)	Dec (J2000) (deg)	Spectral Type	V mag	Campaign
HR 1576	200173871	73.959576	15.038117	B9V	5.776	13
98 Tau	200173870	74.539067	25.050123	A0V	5.785	13
99 Tau	200173862	74.45255	23.948656	K0III	5.806	13
105 Tau	200173869	76.981141	21.704531	B2Ve	5.92	13
HR 1554	200173874	73.195975	27.897278	F2IVn	5.961	13
HR 1385	200173875	66.238157	19.041326	F4V	5.965	13
HR 1741	200173873	79.811052	20.133961	K0III	6.107	13
HR 1633	200173872	76.090102	21.277497	K0	6.188	13
HR 1755	200173876	80.236334	19.814277	K0III	6.205	13
ρ Leo	200182931	158.2027987	9.30658596	B1Iab	3.87	14
58 Leo	200182925	165.140102	3.617234	K0.5IIIFe-0.5	4.838	14
48 Leo	200182926	158.700527	6.953542	G8.5IIIFe-1	5.07	14
53 Leo	200182928	162.314054	10.545122	A2V	5.312	14
65 Leo	200182927	166.725448	1.955523	K0III	5.52	14
35 Sex	200182929	160.836978	4.747282	K2II-III+K1II-III	5.79	14
43 Leo	200182930	155.751349	6.541923	K3III	6.08	14
Dschubba	200194910	240.0833554	-22.62170643	B0.3IV	2.32	15
Zubenelhakrabi	200194911	233.8815784	-14.78953551	G8.5III	3.91	15
ι1 Lib	200194912	228.0553761	-19.7917109	B9IVpSi	4.54	15
41 Lib	200194913	234.7273243	-19.30189583	G8III/IV	5.359	15
ζ4 Lib	200194914	233.2300896	-16.85284783	B3V	5.499	15
HR 5762	200194915	233.1529208	-19.6704581	A2IV	5.52	15
HR 5806	200194916	234.4501566	-23.1416961	K0III	5.79	15
ζ3 Lib	200194917	232.6683426	-16.60946629	K0III	5.806	15
HR 5810	200194918	234.5678373	-21.01632868	K0III	5.816	15
ι2 Lib	200194919	228.3299554	-19.6475503	A2V	6.066	15
HR 5620	200194920	226.6130965	-22.03182838	K0III	6.14	15
28 Lib	200194921	230.2236529	-18.15865908	G8II/III	6.17	15
HD 138810	200194958	233.7482933	-17.13883858	K1(III)(+G)	7.02	15
Asellus Australis	200200356	131.1712467	18.154306	K0+IIIb	3.94	16
Acubens	200200357	134.6217613	11.85770033	kA7VmF0/2III/IVSr	4.249	16
ξ Cnc	200200358	137.3397219	22.04544592	G8.5IIIFe-0.5CH-1	5.149	16

Table 5. All stars observed with halo photometry in K2 (cont'd).

Name	EPIC	RA (J2000) (deg)	Dec (J2000) (deg)	Spectral Type	V mag	Campaign
o1 Cnc	200200360	134.3122908	15.3227667	A5III	5.22	16
η Cnc	200200359	128.1770667	20.44116292	K3III	5.325	16, 18
45 Cnc	200200728	130.8013754	12.68087381	A3III:+G7III	5.65	16
o2 Cnc	200200361	134.3966669	15.58128181	F0IV	5.677	16
50 Cnc	200200363	131.7334112	12.10995057	A1Vp	5.885	16, 18
Spica	200213067	201.2982474	-11.16131949	B1V	0.97	17
82 Vir	200213053	205.4032356	-8.70298448	M1+III	5.01	17
76 Vir	200213054	203.2419673	-10.16500253	G8III	5.21	17
68 Vir	200213055	201.6798633	-12.70766332	K5III	5.25	17
80 Vir	200213056	203.8804021	-5.39619162	K0III	5.706	17
HR 5106	200213057	203.6685425	-13.21432544	A0V	5.932	17
HR 5059	200213058	201.5475623	-1.19247178	A8V	5.965	17
γ Cnc	200233186	130.8214508	21.46850022	A1IV	4.652	18
ζ Cnc	200233643	123.0530265	17.64776708	F8V+G0V	4.67	18
60 Cnc	200233188	133.98145	11.62602	K5III	5.44	18
49 Cnc	200233189	131.1876504	10.08166753	A1VpHgMnSiEu	5.66	18
HR 3264	200233190	125.08739	20.74772	K1III	5.798	18
29 Cnc	200233192	127.1555775	14.21082345	A5V	5.948	18
HR 3222	200233193	123.2488715	16.51431877	G8III	6.047	18
21 Cnc	200233196	125.9800391	10.63205666	M2III	6.08	18
25 Cnc	200233644	126.45782	17.04627	F5IIIm?	6.1	18
HR 3558	200233195	134.284504	17.14374897	K1III	6.146	18
HR 3541	200233194	133.84534	17.23128	C-N4.5	6.4	18