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A Search for Dyson Spheres Around Late-type Stars in the Solar Neighborhood. III

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Abstract. We continued our search for partial (incomplete) Dyson spheres associated with 135 solar-type stars (spectral types F and G) within 25 pc of the Sun. No candidate objects were found.

1. Introduction

We have shown that Dyson (1960) spheres associated with solar-type stars can be detected as the excess flux at $12\,\mu$m (Jugaku & Nishimura 1991). Even if only 10^{-2} of the radiation energy of the central star is converted to thermal emission from a partial (incomplete) Dyson sphere maintained near 300 K, it could be easily detected with the present capability of infrared photometry. In particular, we note that $2.2\,\mu$m radiation (K magnitude) is a good measure of the photospheric radiation of a central star. Then, the index $K-[12]$, where [12] denotes the magnitude at 12 μm, should show significant positive values for Dyson spheres.

2. Observational Material

The catalog compiled by Woolley *et al.* (1970) lists 1,744 star systems nearer than 25 pc. We find 887 stars of spectral types F, G, and K and luminosity classes IV, V, and VI in the catalog, out of which 458 stars are also listed in the *IRAS Point Source Catalog* (1988) as measured at 12 μm. In Papers I and II (Jugaku *et al.* 1995; Jugaku & Nishimura 1997) we examined $K-[12]$ color of 230 solar-type stars from those 458 stars. However, there exist many stars for which K magnitudes have not been measured but V magnitudes are accurately known (Mermilliod & Mermilliod 1994). To examine these stars for our purpose, we calibrate the $V-K$ index as a function of spectral type by using data of stars given in Table 1 of Paper I. The abbreviated results are shown in Table 1.

Then, with aid of Table 1, we estimate K magnitudes from V magnitudes and obtain $K-[12]$ color for 135 stars. Magnitudes [12] are calculated as described in Jugaku & Nishimura (1991). The results are summarized in Table 2.

Table 1. V-K color as a function of spectral type.

Sp. type	F0	F2	F4	F6	F8	G0	G2	G4	G6	G8
V-K color	0.82	0.97	1.04	1.20	1.29	1.47	1.51	1.54	1.68	1.86

The first column of Table 2 gives the star number in the Woolley *et al.* (1970) catalog, the second column shows the HD number, the third column is the spectral type taken from Woolley *et al.* (1970), the fourth column is our estimated K magnitude, and the fifth column gives $K-[12]$ color.

Table 2. List of stars.

RGO	HD	Type	K mag	K-[12] mag	RGO	HD	Type	K mag	K-[12] mag
6	400	F5	5.05	0.28	245	48682	G0	3.77	0.13
9008	1388	G2	5.01	0.20	243	48938	G2	4.93	-0.20
25A	3443	G5	3.98	0.21	9217	49095	F6	4.72	0.08
9026	4247	F2	4.26	0.22	9218	50223	F5	4.01	0.03
9028	4308	G3	5.02	0.15	9219	50806	G5	4.44	0.14
9049A	7788	F6	3.66	0.05	255A	51825	F8	4.94	-0.03
59	9540	G8	5.10	0.14	275	59468	G5	5.13	0.27
72	10697	G4	4.72	0.32	284	62644	G5	3.45	0.26
9065	12042	F8	4.81	-0.11	288A	63077	G0	3.89	0.15
95	14412	G5	4.76	0.24	292A	64379	F5	3.90	0.18
9088	16417	G5	4.19	-0.13	9253	66751	F8	5.31	0.29
108	17051	G3	3.88	-0.16	9252	67458	G4	5.26	-0.15
132	20407	G3	5.24	-0.05	9255A	68146	F7	4.28	-0.03
159	25457	F6	4.18	0.17	302	69830	G8	4.11	0.05
9143	25945	F0	4.77	0.15	9264	71148	G4	4.80	0.27
9154A	27710	F2	5.06	-0.03	9273	73350	G0	5.28	0.10
9155A	28255	G4	4.74	-0.06	314A	73752	F8	3.76	0.34
9165	29992	F8	3.75	-0.31	327	76151	G3	4.48	0.00
175A	30003	G5	4.94	0.06	9283	77370	F4	4.12	-0.10
187	32743	F4	4.33	-0.02	9287A	78643	G1	5.27	0.15
9172A	32778	G5	5.43	0.25	9294A	80671	F5	4.26	0.00
9176	33256	F5	4.00	0.12	9317	88218	F9	4.76	0.15
198	34721	G0	4.49	0.05	9334	91889	F8	4.40	-0.01

For all stars the value of $K-[12]$ color is in the range of -0.35 to $+0.35$ mag. The scatter in this range can be explained by observational errors. If the waste heat of a Dyson sphere is $\sim 10^{-2}$ of the radiation energy of the central star, the color excess should be > 1 mag.

Table 2. List of stars (continued).

RGO	HD	Type	K mag	K-[12] mag	RGO	HD	Type	K mag	K-[12] mag
9186	37495	F4	4.24	0.14	9338	94388	F6	4.03	0.03
9189	39091	G3	4.13	-0.04	9346	96700	G2	5.02	0.02
224	39881	G0	5.13	-0.20	437	101805	G1	4.98	-0.31
9199	41330	G0	4.64	0.27	446	102438	G5	4.89	0.09
9200	41700	G0	4.88	-0.31	9377A	103437	F8	5.16	0.08
230	42807	G6	4.76	-0.08	9380A	103493	G4	5.15	0.14
9212A	45588	F9	4.68	-0.04	454	104304	G7	3.79	0.03
9406	108309	G5	4.67	-0.07	744	177565	G5	4.57	0.20
9417	111456	F6	4.65	0.17	746	178428	G4	4.54	0.23
9421	111998	F6	4.93	0.04	9650	180161	G9	5.10	-0.04
496A	113415	F8	4.29	-0.09	9658	183650	G5	5.38	0.16
501A	114378	F5	3.20	0.02	9663	184985	F6	4.27	0.05
504	115383	G0	3.74	-0.03	9666	186185	F6	4.30	-0.06
9457A	119124	F8	5.04	0.25	9668	186760	F8	4.95	0.04
530	120690	G5	4.84	0.31	9670A	187013	F5	3.87	0.08
538	122742	G8	4.43	0.15	9671A	187691	F8	3.83	0.12
9467	122862	G1	4.53	0.02	9679	189245	F8	4.37	0.02
9487	128020	F8	4.74	-0.11	9678	189340	G0	4.41	0.00
564	130948	G2	4.35	-0.07	9683	190360	G6	4.06	0.07
580A	135204	G8	4.74	0.08	9685	190771	G5	4.58	-0.02
9517	136064	F8	3.85	0.06	9691	193307	G2	4.76	0.11
9527A	140538	G5	4.28	0.10	788	193664	G5	4.33	-0.17
599A	140901	G6	4.33	-0.05	790	194640	G5	5.02	0.20
9531	142908	F0	4.62	0.16	9701	196378	F8	3.82	0.14
9537	143761	G2	3.91	0.02	9708	197937	F1	4.21	0.07
9542	144287	G8	5.24	0.04	811	199260	F8	4.43	0.13
9548A	145958	G9	4.75	-0.13	9712	199288	G0	5.05	0.15
616	146233	G1	4.01	0.06	9719A	200525	G3	4.15	0.09
9557A	147365	F0	4.65	0.25	9726	201647	F7	4.58	-0.24
632	150706	G3	5.51	-0.27	9730	202628	G5	5.15	-0.09
641	152391	G6	4.96	0.09	9745	205905	G4	5.20	-0.16

3. Conclusions

Combined with the results of Paper I (180 stars) and Paper II (50 stars), we have not found any candidate stars which may have Dyson spheres in a sample of 365 solar-type stars within 25 pc of the Sun.

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Table 2. List of stars (continued).

RGO	HD	Type	K mag	K-[12] mag	RGO	HD	Type	K mag	K-[12] mag
652	154088	G8	4.72	-0.02	9751	206860	G0	4.47	0.10
651	154345	G8	4.90	-0.02	838	207129	G2	4.07	-0.18
6583	154417	F8	4.72	0.08	9761	207958	F0	4.26	0.10
678A	158614	G8	3.46	-0.15	9769	210277	G9	4.66	0.05
684A	160269	G1	3.74	0.12	9770	210302	F5	3.81	0.00
9616	165499	G3	3.96	-0.05	853A	211415	G1	3.87	0.20
9618A	166285	F4	4.64	0.20	859A	212698	G2	4.05	0.07
9624	167954	F8	5.56	0.15	9786	213429	F8	4.86	0.21
9622	168009	G0	4.82	0.12	9789	213845	F3	4.20	0.08
9619	168151	F5	3.90	0.06	871A	214953	G1	4.53	0.00
722	172051	G4	4.32	0.18	9807	217792	F0	4.28	-0.02
738A	176051	G0	3.75	0.14	9811A	218630	F6	4.61	0.10
9639	176377	G0	5.32	0.06	9843	223731	F5	5.45	0.00
9642A	177474	F8	2.92	0.04					

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