Lab 6

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1 IRAS Sources around KR 140

Output table from ds9 searching around $2^h 20^m 12.589^s$ $61°6'3.255''$ within a $15'$ rectangle filtered for IRAS sources.

Table 1: IRAS point sources

RA (deg)	DEC (deg)	Main ID
02 15 39.7	+60 45 58	02156+6045
02 15 42.8	+60 53 28	02157+6053
02 16 05.1	+60 57 38	02160+6057
02 16 33.0	+60 53 29	02165+6053
02 16 50.7	+60 52 12	02168+6052
02 17 08.7	+60 58 18	02171+6058
02 17 26.0	+60 52 17	02174+6052

The IDs of these sources were then used in a VizieR query of the IRAS catalogue of Point Sources, Version 2.0 (IPAC 1986).

```sql
-- output format : csv
SELECT "II/125/main".IRAS,
"II/125/main".RA1950,
"II/125/main".DE1950,
"II/125/main".Fnu_12,
"II/125/main".e_Fnu_12,
"II/125/main".Fnu_25,
"II/125/main".e_Fnu_25,
"II/125/main".Fnu_60,
"II/125/main".e_Fnu_60,
"II/125/main".Fnu_100,
"II/125/main".e_Fnu_100
FROM "II/125/main"
WHERE "II/125/main".IRAS LIKE '02156+6045' OR
"II/125/main".IRAS LIKE '02157+6053' OR
"II/125/main".IRAS LIKE '02160+6057' OR
"II/125/main".IRAS LIKE '02165+6053' OR
"II/125/main".IRAS LIKE '02168+6052' OR
"II/125/main".IRAS LIKE '02171+6058' OR
"II/125/main".IRAS LIKE '02174+6052'
```

From this query the following table was created. Note the errors are whole number percentage errors (ie 25 means 25% error on the given measurement)

Table 2: IRAS source fluxes

IRAS	$F_{\nu,12}$	$\epsilon_{F_{\nu,12}}$	$F_{\nu,25}$	$\epsilon_{F_{\nu,25}}$	$F_{\nu,60}$	$\epsilon_{F_{\nu,60}}$	$F_{\nu,100}$	$\epsilon_{F_{\nu,100}}$
”02174+6052”	0.8799	6	2.363	6	32.01	0	127.9	0
”02156+6045”	0.2729	0	0.3631	13	3.601	18	44.14	0
”02157+6053”	0.8217	16	1.309	13	21.8	16	215.1	0
”02168+6052”	2.157	24	2.179	22	32.01	0	127.9	14
”02165+6053”	0.3451	25	1.719	15	1.85	0	215.1	0
”02171+6058”	0.3587	15	1.84	6	11.61	10	63.52	17
”02160+6057”	2.403	16	2.99	20	47.37	20	215.1	16

From these values I created a color plot, where

$$x = \log_{10} \frac{F_{\nu,60}}{F_{\nu,100}} \tag{1}$$

$$\sigma_x = \frac{1}{100 \ln 10} \sqrt{\epsilon^2_{F_{\nu,60}} + \epsilon^2_{F_{\nu,100}}} \tag{2}$$

$$y = \log_{10} \frac{F_{\nu,25}}{F_{\nu,12}} \tag{3}$$

$$\sigma_y = \frac{1}{100 \ln 10} \sqrt{\epsilon^2_{F_{\nu,25}} + \epsilon^2_{F_{\nu,12}}} \tag{4}$$

In this plot, there is some clustering around $log_1 0 F_{60}/F_{100}$ with IRAS 02165+6053 being an outlier.

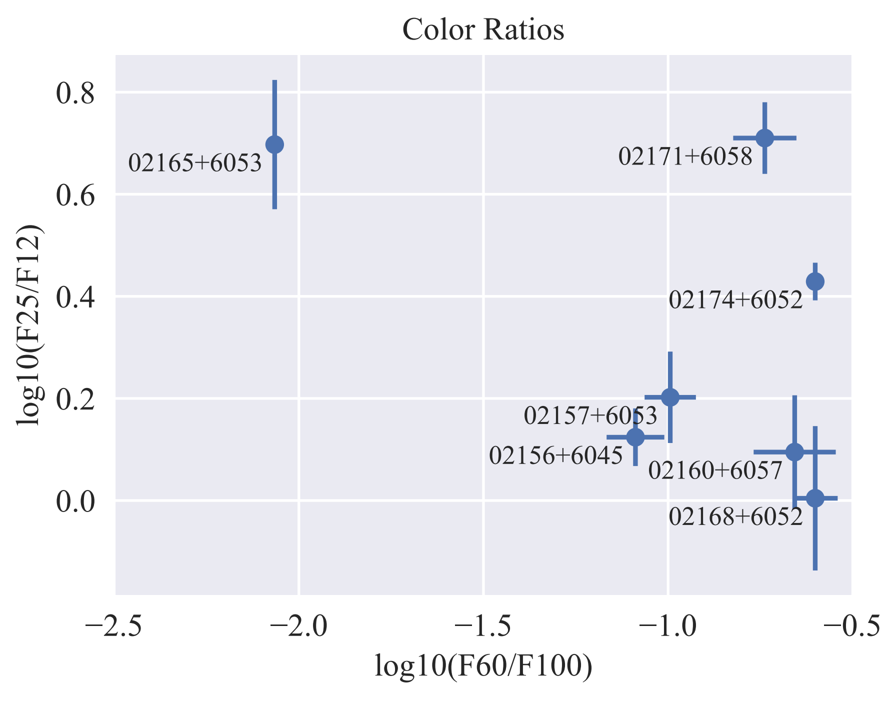

Figure 1: Color ratio plot of IRAS sources in the HII clump

I also made a spectral energy density plot shown in Figure 2. Using this, I integrated using Simpson's rule (quadratic interpolation) to find the total infrared flux to be 239 jy. Using this and an assumed distance of 2.3 kpc I can estimate the integrated flux over the whole star and find its luminosity using Equation 5. The luminosity I have estimated is 7.50×10^{18} W or 1.95×10^{-8} $L_\odot$

$$L = 4\pi D^2 F \quad (5)$$

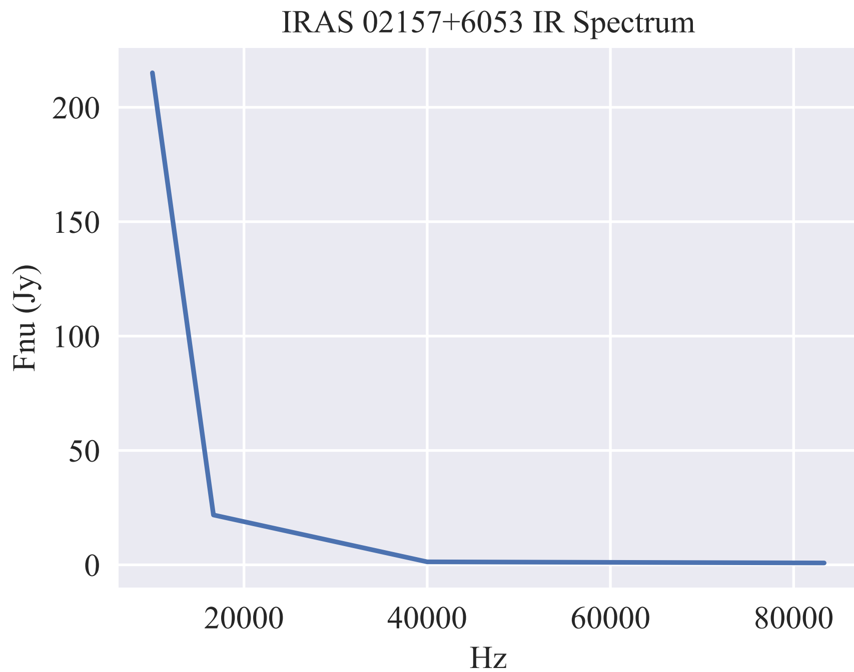

Figure 2: Spectral energy density of IRAS 02157+6053

2 KR 140 in the submm

In the submm photo there is a clump around $i = +133.436, b = -0.022$ that does not correspond with any of the IRAS sources

3 A 2MASS View of an IRAS Source

From the 2MASS image server, I found a list of point sources within $1'$ of $i = +133.16, b = 0.040$ shown in Table 3. Using intrinsic values from Table 4, I plotted the color ratios shown in Figure 3.

Table 3: 2MASS source data around $i = +133.16, b = 0.040$

RA	DEC	2MASS	J	ϵ_J	H	ϵ_H	K	ϵ_K
34.835133	61.120991	02192043+6107155	16.974		15.292	0.106	14.239	0.09
34.832579	61.124966	02191981+6107298	15.82	0.063	14.053	0.04	13.274	0.031
34.856937	61.120834	02192566+6107150	18.317		16.165		15.34	0.151
34.858394	61.12318	02192601+6107234	18.293		16.278	0.161	14.858	0.107
34.841009	61.118584	02192184+6107069	14.362	0.045	12.412	0.045	11.044	0.025
34.829935	61.119396	02191918+6107098	16.616		16.119	0.155	14.836	0.104
34.836449	61.122482	02192074+6107209	16.135	0.085	15.394	0.12	15.458	0.205
34.846349	61.12291	02192312+6107224	17.316	0.258	15.495	0.085	14.223	0.063
34.853145	61.122124	02192475+6107196	16.28		14.649	0.081	13.119	0.057
34.851606	61.122772	02192438+6107219	16.234		15.163	0.079	13.791	0.064
34.844669	61.121048	02192272+6107157	16.575		15.956	0.143	14.791	0.121
34.828195	61.116192	02191876+6106582	16.175	0.089	15.749	0.11	15.298	0.151
34.828007	61.110168	02191872+6106366	16.274	0.095	15.172	0.054	14.854	0.102
34.846831	61.127975	02192323+6107407	11.03	0.026	10.761	0.032	10.666	0.018

Table 4: Intrinsic color data from Koornneef (1983)

Sp.	V-K	J-K	H-K	K-L	K-M
o6-8	-0.93	-0.21	-0.05	-0.04	
o9	-0.89	-0.19	-0.05	-0.03	
o9.5	-0.87	-0.18	-0.05	-0.03	
b0	-0.85	-0.17	-0.05	-0.03	
b0.5	-0.79	-0.15	-0.04	-0.02	
b1	-0.76	-0.14	-0.14	-0.02	
b2	-0.67	-0.13	-0.04	-0.02	-0.08
b3	-0.57	-0.11	-0.03	-0.02	-0.07
b4	-0.5	-0.1	-0.03	-0.02	-0.06
b5	-0.43	-0.08	-0.02	-0.01	-0.05
b6	-0.37	-0.07	-0.02	-0.01	-0.04
b7	-0.3	-0.05	-0.02	-0.01	-0.03
b8	-0.25	-0.04	-0.01	-0.01	-0.02
b9	-0.14	-0.02	-0.01	0	-0.01
a0	0	0.01	0	0	0
a1	0.06	0.02	0	0	0
a2	0.13	0.04	0.01	0	0
a3	0.2	0.05	0.01	0.01	0
a4	0.28	0.07	0.02	0.01	-0.01
a5	0.35	0.09	0.02	0.01	-0.01
a6	0.4	0.1	0.02	0.01	-0.01
a7	0.45	0.12	0.02	0.01	-0.01
a8	0.56	0.14	0.03	0.02	-0.02
a9	0.68	0.17	0.04	0.02	-0.02
f0	0.79	0.2	0.04	0.02	-0.02
f2	0.93	0.24	0.05	0.03	-0.03
f5	1.01	0.26	0.06	0.03	-0.03
f8	1.12	0.29	0.06	0.03	-0.03
g0	1.22	0.31	0.07	0.04	-0.03
g3	1.49	0.37	0.08	0.04	-0.04
g8	1.6	0.41	0.09	0.05	-0.04
k0	1.75	0.47	0.1	0.05	-0.04
k1	2	0.54	0.11	0.05	-0.04
k2	2.25	0.62	0.13	0.06	
k3	2.5	0.67	0.14	0.07	
k4	2.75	0.72	0.15	0.08	
k5	3	0.77	0.16	0.1	
m0	3.25	0.83	0.18	0.13	
m1	3.5	0.86	0.19	0.15	
m2	3.75	0.89	0.21	0.15	
m3	4	0.92	0.26	0.16	
m4	4.25	0.9	0.28	0.16	
m5	4.5	0.9	0.29	0.18	
m6	4.75	0.88	0.3		
m7	5	0.89	0.31		
m8	5.25	0.9	0.33		
	5.5	0.92	0.34		
	5.75	0.95	0.36		
	6	0.98	0.37		
	6.25	1.01	0.38		
	6.5	1.05	0.4		
	6.75	1.09	0.41		
	7	1.11	0.42		
	7.25	1.14	0.43		

4 Identifying YSOs using 2MASS Data

From Figure 3 we can try to characterize the types of stars present. Consider interstellar reddening- the effect of the medium will shift the intensities of the J, H, and K bands. Shown on the plot, extinction accounts for the stars that appear in the same path of the intrinsic curve but at a different location.

There are still stars that do not follow under this simple guise, which are even redder. We can hypothesize that these stars have some sort of dust or debris cloud around the object itself causing extra reddening. These stars are good candidates for young stellar objects (YSO) and are marked in Figure 3.

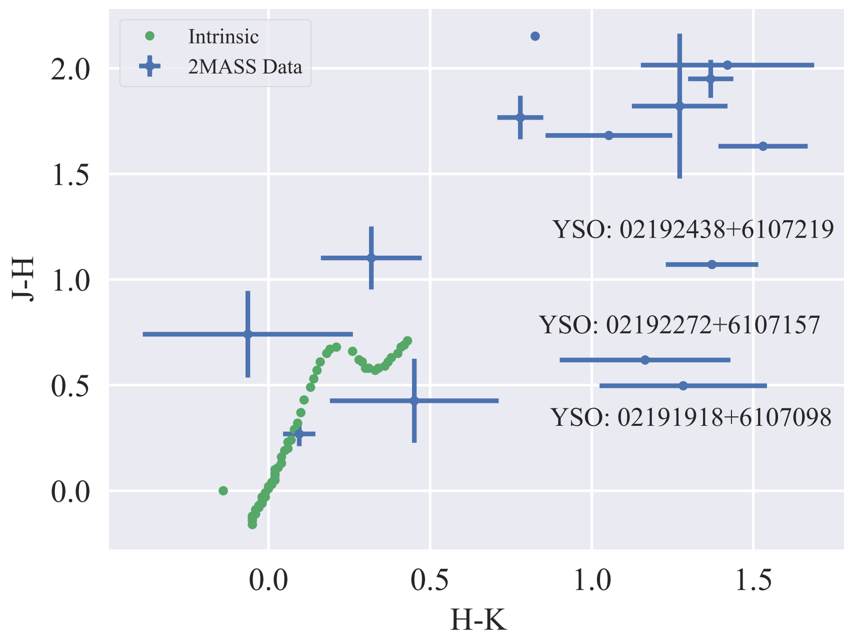

Figure 3: Intrinsic colors compared to 2MASS data shows how most of the stars are simply affected by reddening along the plot's diagonal, but a few objects are given extra reddening and appear off this linear axis. These objects are marked and are potential candidates for YSO