Finding Advanced Spacefaring Civilizations

(very preliminary)

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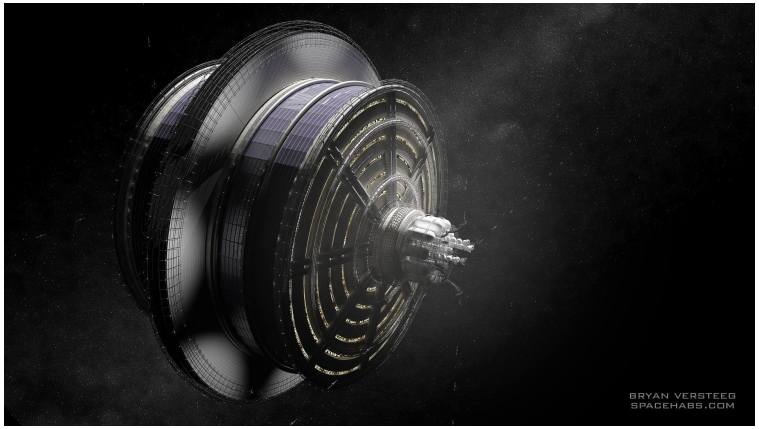
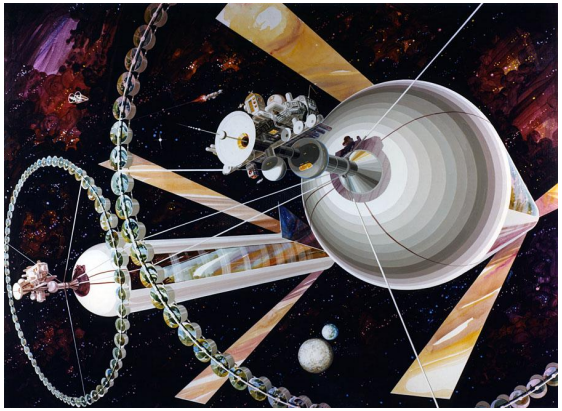
Al Conrad, Arizona State University

Gateway to Space, November 2014

Special thanks to Spitzer and IRSA, NASA

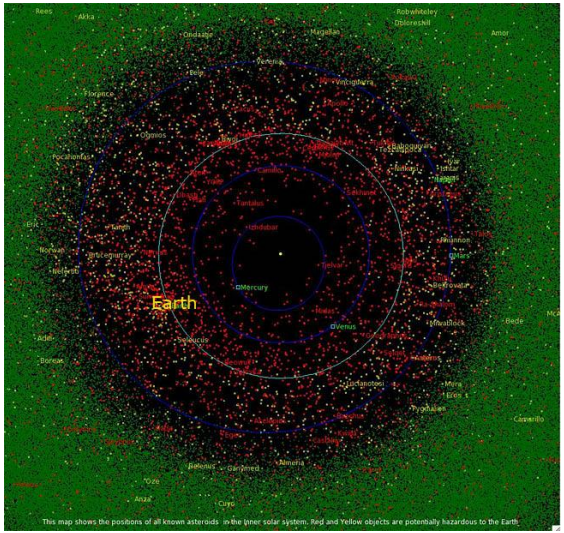
Free-Space Settlements

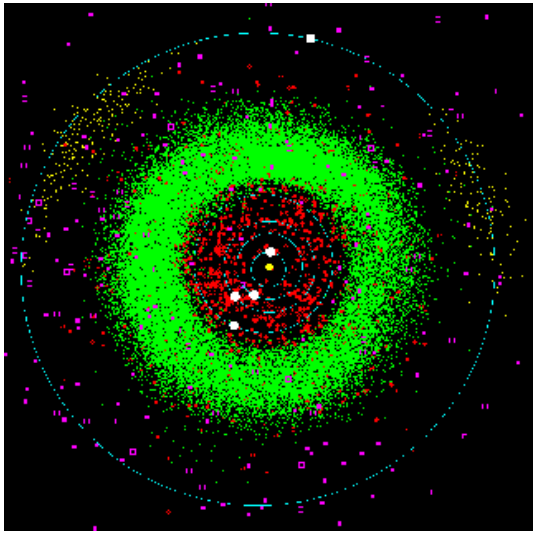




Let’s Assume

1. We can build the first one in < 10,000 years.
2. We can build a lot in < 100,000,000 years

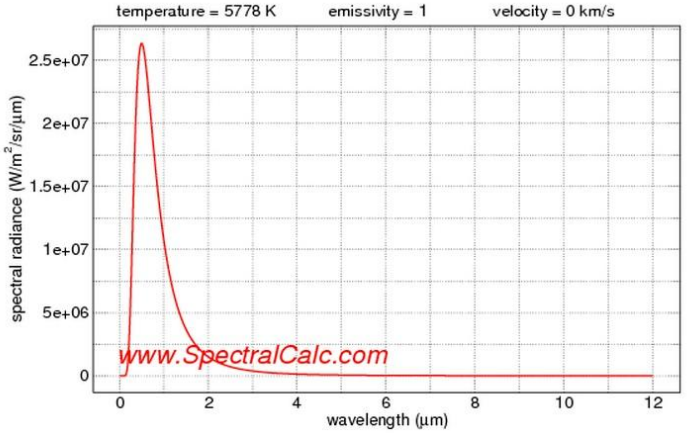




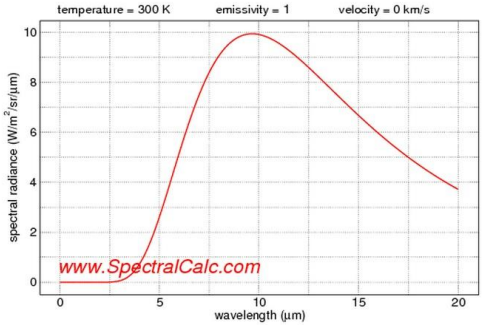
If We Could Do It, So Could ET

- Settlements must use energy, creating heat
- Heat must be rejected
  - For water-based life, between 0-100 C
- This creates a signal
  - Star photosphere almost black body < 0.8 microns
  - Excess energy with a maximum 7.7-10.6 microns
    - near-perfect black body
- NASA’s Spitzer Space Telescope is perfect!

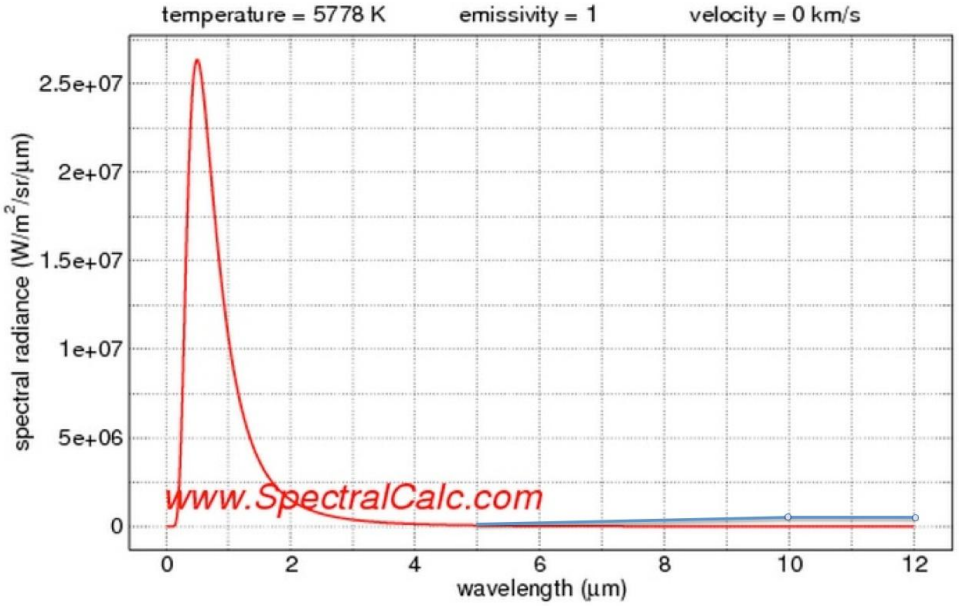
What We're Looking For



Sun



300 K

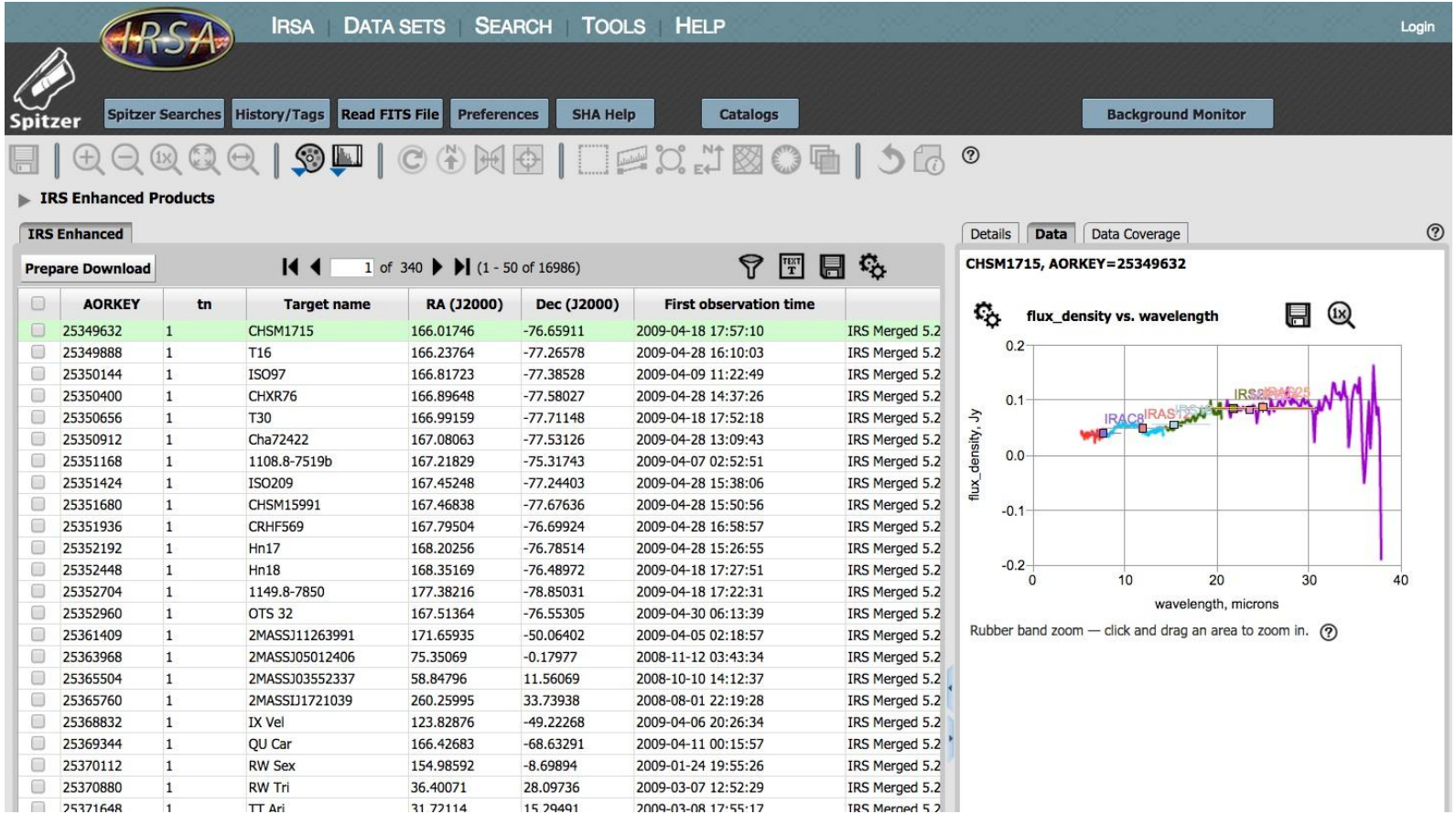


Combined

How Large a Signal?

- Sun output: 10^{26} Watts
- Max population: 10^{16} (lunar materials)
- Energy/person: 10^{6} watts
- So signal 1 part in a 10^{4}, but
- At 10 microns Sol output 10^{4} more than radiator peak so signal about 2x
  - BUT, Sol peak is narrow, radiator peak is wide
  - Do not know exactly how hard it will be to detect

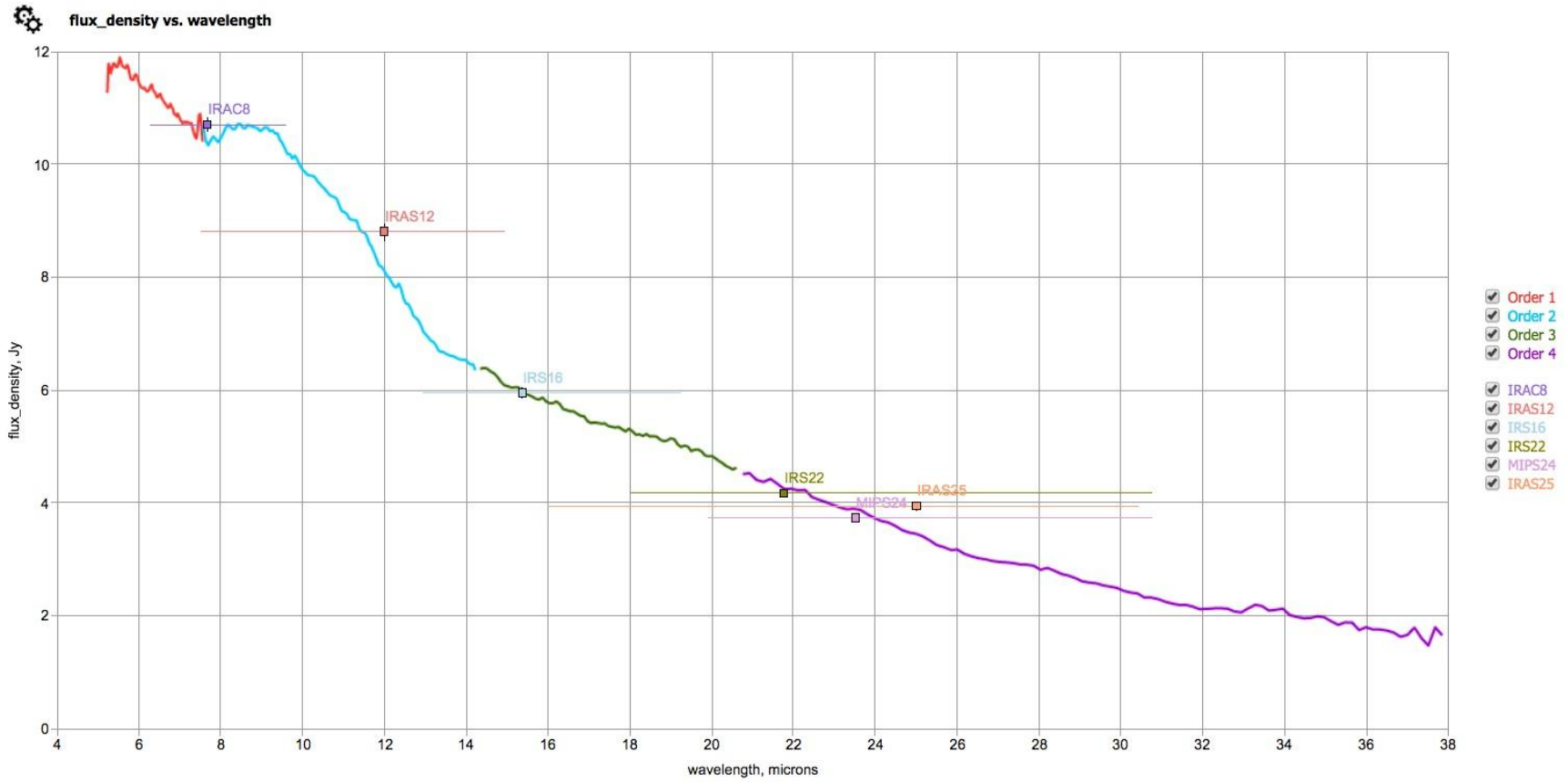
Spitzer IRSA Data



AORKEY	tn	Target name	RA (J2000)	Dec (J2000)	First observation time	
25349632	1	CHSM1715	166.01746	-76.65911	2009-04-18 17:57:10	IRS Merged 5.2
25349888	1	T16	166.23764	-77.26578	2009-04-28 16:10:03	IRS Merged 5.2
25350144	1	ISO97	166.81723	-77.38528	2009-04-09 11:22:49	IRS Merged 5.2
25350400	1	CHXR76	166.89648	-77.58027	2009-04-28 14:37:26	IRS Merged 5.2
25350656	1	T30	166.99159	-77.71148	2009-04-18 17:52:18	IRS Merged 5.2
25350912	1	Cha72422	167.08063	-77.53126	2009-04-28 13:09:43	IRS Merged 5.2
25351168	1	1108.8-7519b	167.21829	-75.31743	2009-04-07 02:52:51	IRS Merged 5.2
25351424	1	ISO209	167.45248	-77.24403	2009-04-28 15:38:06	IRS Merged 5.2
25351680	1	CHSM15991	167.46838	-77.67636	2009-04-28 15:50:56	IRS Merged 5.2
25351936	1	CRHF569	167.79504	-76.69924	2009-04-28 16:58:57	IRS Merged 5.2
25352192	1	Hn17	168.20256	-76.78514	2009-04-28 15:26:55	IRS Merged 5.2
25352448	1	Hn18	168.35169	-76.48972	2009-04-18 17:27:51	IRS Merged 5.2
25352704	1	1149.8-7850	177.38216	-78.85031	2009-04-18 17:22:31	IRS Merged 5.2
25352960	1	OTS 32	167.51364	-76.55305	2009-04-30 06:13:39	IRS Merged 5.2
25361409	1	2MASSJ11263991	171.65935	-50.06402	2009-04-05 02:18:57	IRS Merged 5.2
25363968	1	2MASSJ05012406	75.35069	-0.17977	2008-11-12 03:43:34	IRS Merged 5.2
25365504	1	2MASSJ03552337	58.84796	11.56069	2008-10-10 14:12:37	IRS Merged 5.2
25365760	1	2MASSIJ1721039	260.25995	33.73938	2008-08-01 22:19:28	IRS Merged 5.2
25368832	1	IX Vel	123.82876	-49.22268	2009-04-06 20:26:34	IRS Merged 5.2
25369344	1	QU Car	166.42683	-68.63291	2009-04-11 00:15:57	IRS Merged 5.2
25370112	1	RW Sex	154.98592	-8.69894	2009-01-24 19:55:26	IRS Merged 5.2
25370880	1	RW Tri	36.40071	28.09736	2009-03-07 12:52:29	IRS Merged 5.2
25371648	1	TT Ari	31.72114	15.29491	2009-03-08 17:55:17	IRS Merged 5.2

Close

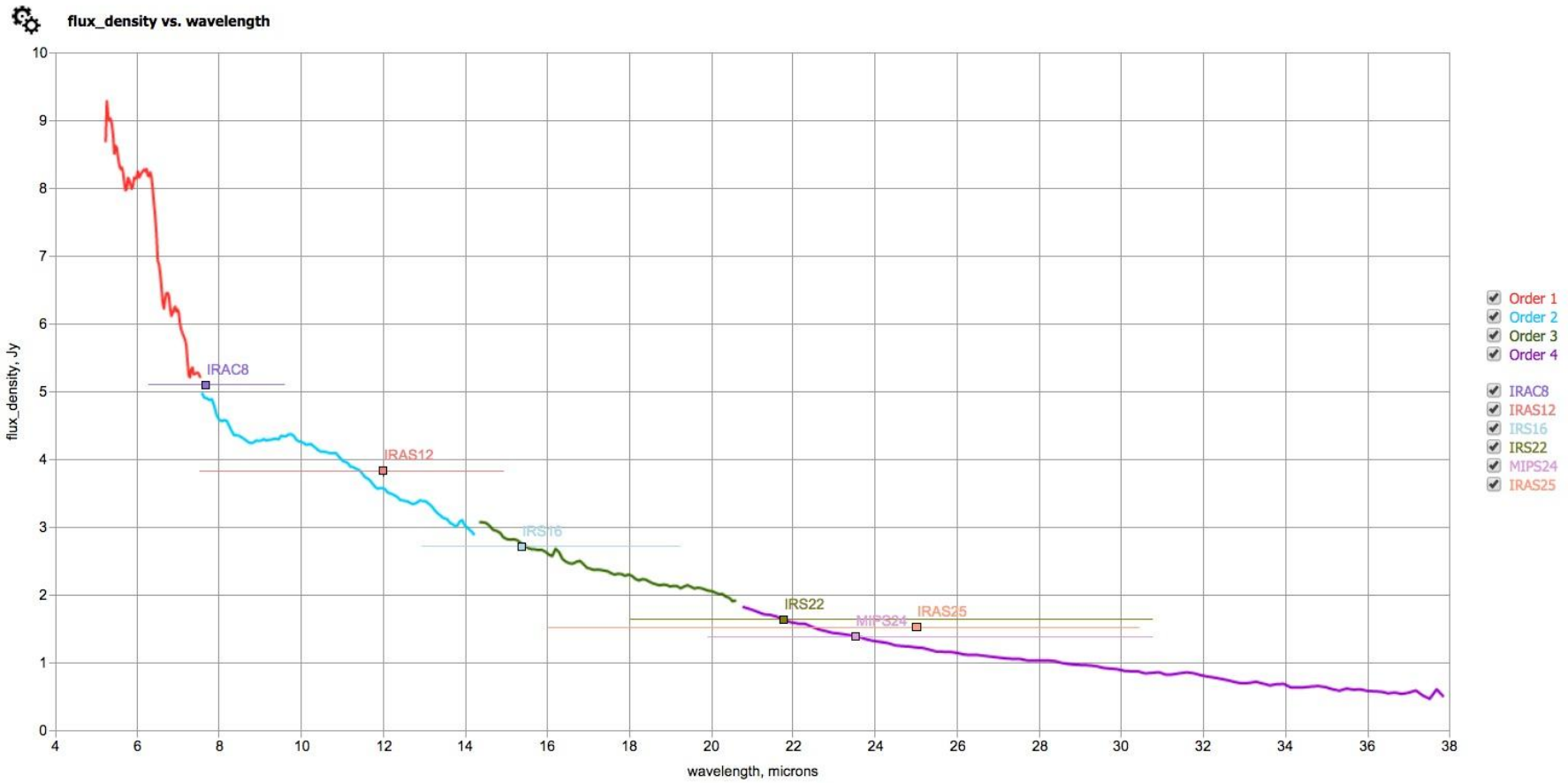
GG Car, AORKEY=9858048



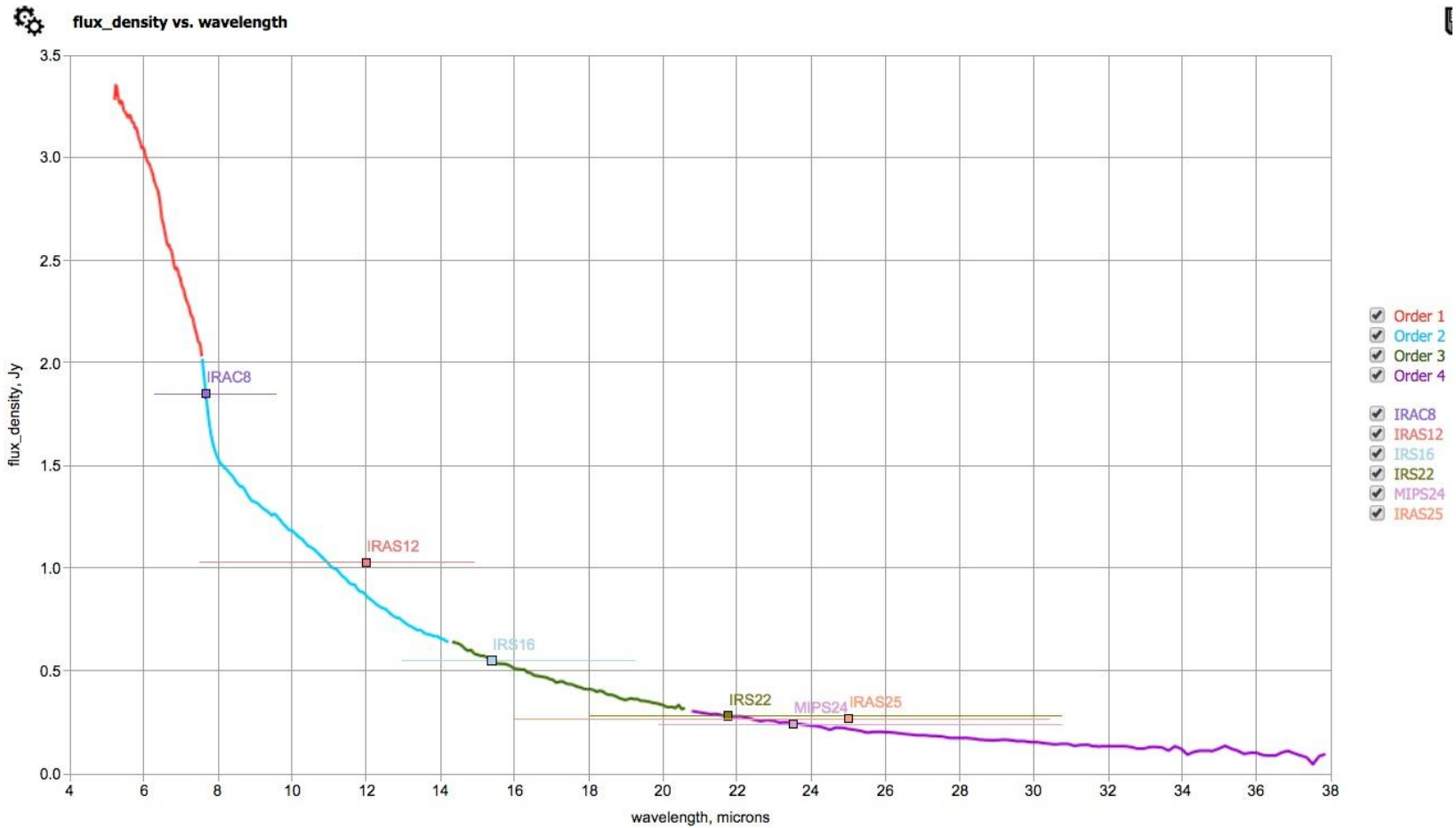
eclipsing binary classified as a B[e] supergiant star

Close

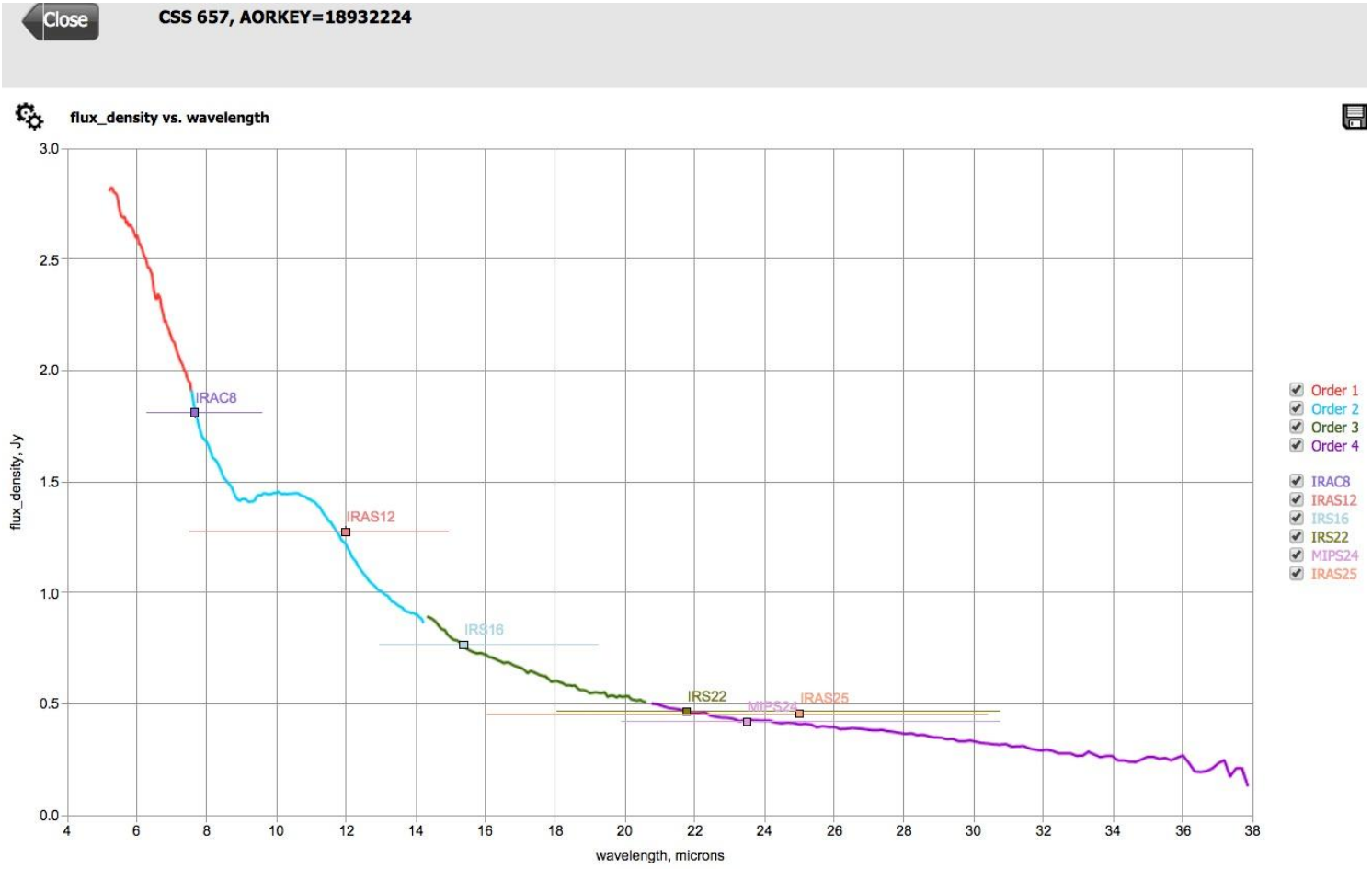
RT Dra, AORKEY=11224576



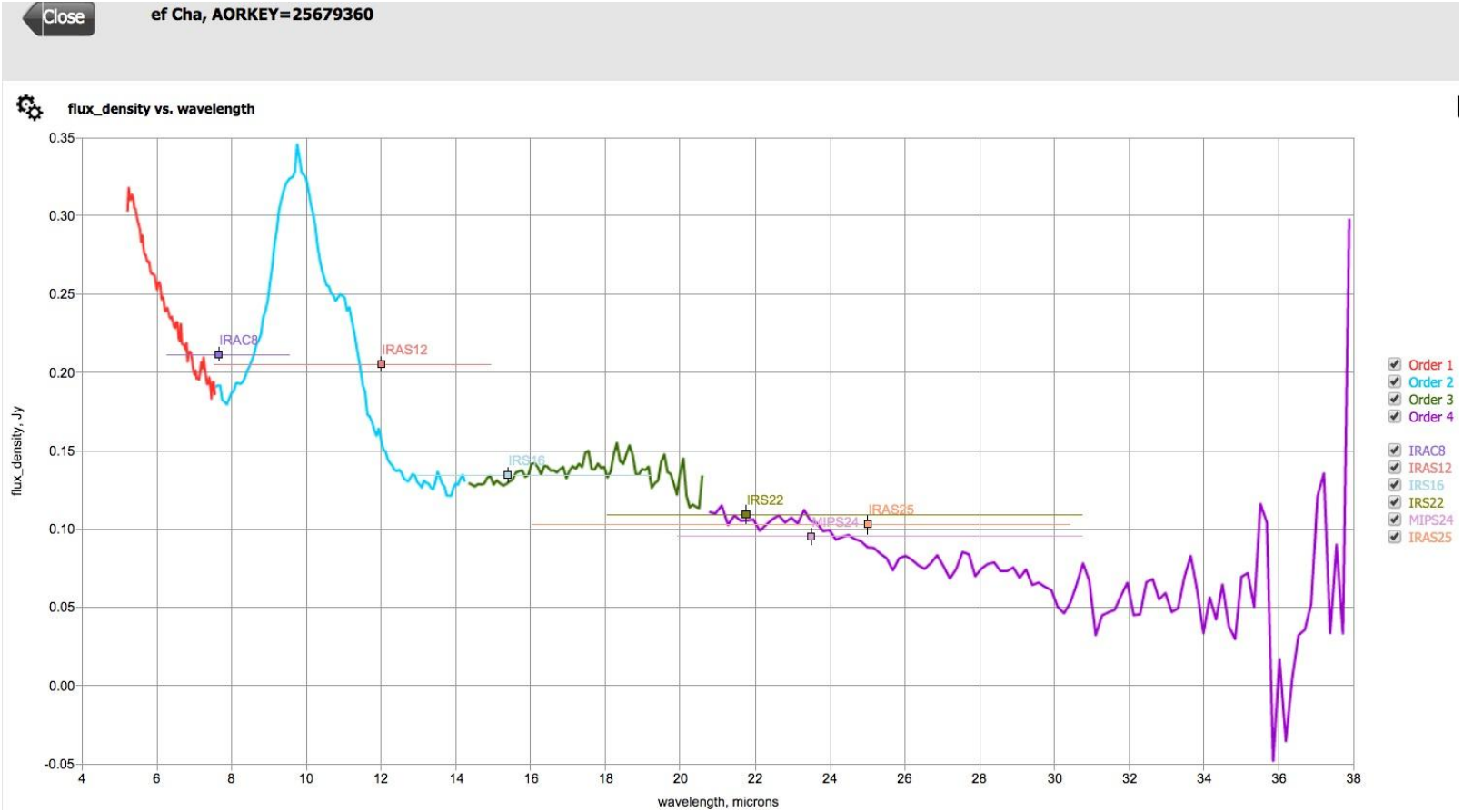
Variable star



A Giant Red Star



An S-type star



10 Myr old with dust

Comparison With Dust

- Can generate signal at same wavelengths
- Has non-black body signal
  - Ballering, Nicholas P., George H. Rieke, and András Gáspár. “Probing the Terrestrial Regions of Planetary Systems: Warm Debris Disks with Emission Features.” *The Astrophysical Journal* 793, no. 1 (2014): 57.
- Characteristic of young stars
- Space faring civilizations more likely around old stars
  - How much dust generated by settlements?

Compared to Radio-Astronomy SETI

- Radio Wave Signal
  - Depends on inefficient communication tech or deliberate signal
  - Lifetime very likely << 1 million years
  - Even if look at the right star, probably wrong time
- Heat Rejection Signal
  - Depends on basic physics
  - For Sol, lifetime around 5 billion year

Previous Work

- "Search for Artificial Stellar Sources of Infrared Radiation," Freeman Dyson, 1960, Science, 131, 1667
- Jugaku and Nishimura papers 1991, 1995, 1997, 2000, and 2004.
  - Examined a few stars, no candidates
- "Searching for Partial-Dyson Spheres," Al Globus, Dana Backman, and Fred Witteborn, September 12, 2003.
  - Searched databases for potential candidates.
- “IRAS-Based Whole-Sky Upper Limit on Dyson Spheres,” Richard Carrigan, Fermi National Accelerator Laboratory, 2009 ApJ 698 2075
  - Focus on complete Dyson spheres, claims partial as well
- “Glimpsing Heat from Alien Technologies,” Jason Wright, Penn. State, ongoing.
  - Looking at galaxies.

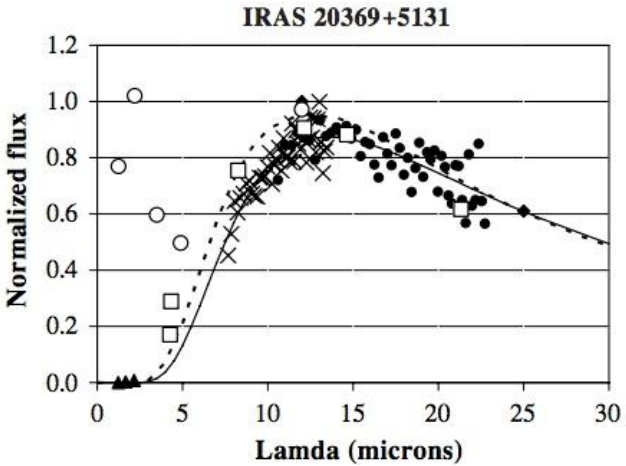
Conclusion

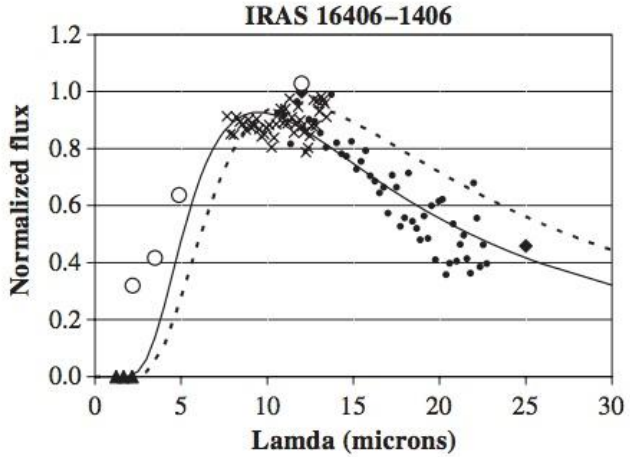
- It may be possible to detect advanced spacefaring civilizations around other stars
- Spitzer Space Telescope data seems right
  - Web accessible, thank you NASA!
- The analysis will be complex and difficult, but not a huge amount of work
- Failure is almost certain, but success means the Nobel Prize!

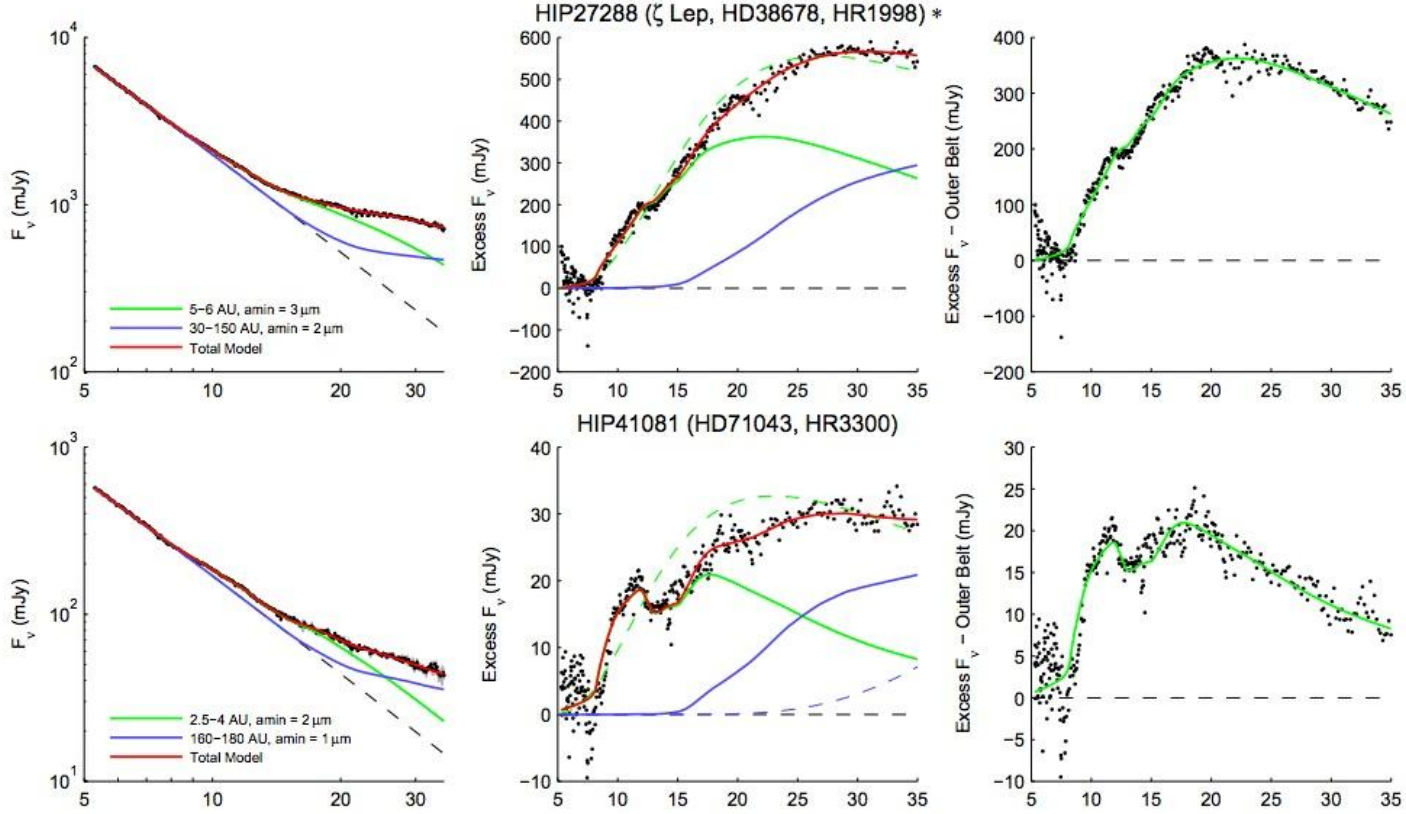
Reserved

“IRAS-Based Whole-Sky Upper Limit on Dyson Spheres,”

- Richard A. Carrigan Jr, Fermi National Accelerator Laboratory, 2009 ApJ 698 2075. Focus on full Dyson spheres, also partial
- Looking for a black body in 100-600K, based on 12 & 25 um filters
- Found 17 marginal candidates







Ballering, Nicholas P., George H. Rieke, and András Gáspár. “Probing the Terrestrial Regions of Planetary Systems: Warm Debris Disks with Emission Features.” *The Astrophysical Journal* 793, no. 1 (2014): 57.