Evidence for Mass-dependent Circumstellar Disk Evolution in the 5 Myr-old Upper Scorpius OB Association

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ABSTRACT

We present 4.5, 8, and 16 µm photometry from the Spitzer Space Telescope for 204 stars in the Upper Scorpius OB Association. The data are used to investigate the frequency and properties of circumstellar disks around stars with masses between ∼0.1 and 20 M☉ at an age of ∼5 Myr. We identify 35 stars that have emission at 8 µm or 16 µm in excess of the stellar photosphere. The lower mass stars (∼0.1-1.2 M☉) appear surrounded by primordial optically thick disks based on the excess emission characteristics. Stars more massive than ∼1.8 M☉ have lower fractional excess luminosities suggesting that the inner ∼10 AU of the disk has been largely depleted of primordial material. None of the G and F stars (∼1.2-1.8 M☉) in our sample have an infrared excess at wavelengths ≤16 µm. These results indicate that the mechanisms for dispersing primordial optically thick disks operate less efficiently on average for low mass stars, and that longer time scales are available for the buildup of planetary systems in the terrestrial zone for stars with masses ≤1 M☉.

Subject headings: open clusters and associations: individual(Upper Scorpius OB1) — planetary systems:protoplanetary disks — stars:pre-main sequence

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1. Introduction

Most young (\(\sim 1 \text{ Myr}\)) stars embedded within molecular clouds are surrounded by circumstellar accretion disks (Strom et al. 1989) that are potential sites of planet formation. The ubiquity of disks extends to all masses from as high as 10\(M_\odot\) down through brown dwarfs, and in all environments from isolated stars in Taurus to dense clusters in Orion (Lada et al. 2000; Bouy et al. 2006).

By an age of 10 Myr, the primordial disks so ubiquitous around young stars change dramatically. The inner disk (\(\lesssim 1 \text{ AU}\)) dissipates in >90% of stars (Mamajek et al. 2004), accretion rates drop by an order of magnitude (Muzerolle et al. 2000), and the mass contained in small dust grains declines by at least a factor of four (Liu et al. 2004; Carpenter et al. 2005). Results from the Spitzer Space Telescope (Werner et al. 2004) demonstrate an even more striking degree of evolution, as dust within a \(\sim 1 \text{ AU}\) orbital radius is found in only a few percent of \(\sim 10\) Myr stars (Silverstone et al. 2006). MIPS 24\(\mu\)m surveys have detected dust in 7–48% of 10–30 Myr stars (Young et al. 2004; Rieke et al. 2005; Chen et al. 2005), but with fractional dust luminosities orders of magnitude below that found in younger sources. Together these observations have established that circumstellar disks are at an advanced evolutionary stage by an age of \(\sim 10\) Myr.

Key to understanding the formation of planetary systems is examining the evolution of circumstellar disks after the main accretion phase has terminated. To measure the properties of disks during this epoch for stellar masses ranging from 0.1 to 20\(M_\odot\), we have conducted a photometric survey of 205 stars with spectral types between M5 and B0 in the 5 Myr-old Upper Scorpius OB association using the IRAC, IRS, and MIPS instruments on Spitzer. This Letter presents analysis of the IRAC and IRS photometry to probe for terrestrial-zone material across the stellar mass spectrum at a constant age.

2. Sample Selection

The parent sample for this program was selected from previous membership studies of the Upper Sco OB association. We compiled members identified based on (a) Hipparcos astrometry (B, A, F, and G stars; de Zeeuw et al. 1999), (b) optical color–magnitude diagrams and spectroscopic verification of lithium (G, K, and M stars; Preibisch & Zinnecker 1999; Preibisch et al. 2002), and (c) x–ray sources subsequently verified as lithium-rich, pre-main-sequence stars (G, K, & M stars; Walter et al. 1994; Martín 1998; Preibisch et al. 1998; Kunkel 1999; Köhler et al. 2000). Since these studies identified Upper Sco members based on stellar properties (proper motion, strong lithium, x–ray emission) rather then those linked
to circumstellar material (e.g. Hα emission, near-infrared excess), we believe that our sample is not biased for or against the presence of a circumstellar disk.

The parent sample was cross-matched with the Hipparcos (Perryman & ESA 1997), Tycho–2 (Høg et al. 2000), and UCAC2 (Zacharias et al. 2004) proper motion catalogs where possible. Using the Madsen (2002) kinematic model for Upper Sco, we computed the probability that a given star has a proper motion consistent with membership in the association (see e.g. Mamajek et al. 2002). Any star that deviated more than 2σ from the proper motion model was removed, as was any star with an inferred cluster parallax distance more than 45 pc from the mean Upper Sco distance (where the line-of-sight depth of the association is ∼30 pc; Preibisch & Zinnecker 1999). We also removed stars located in projection against the ρ Oph molecular cloud, which is near Upper Sco and contains stars with ages of <1 Myr. These criteria yielded 341 Upper Sco members with spectral type M5 and earlier.

The aim was to populate five quasi-logarithmically-spaced mass bins with 50 stars each. In paring the list, we (a) removed stars requiring > 20 cycles with MIPS to detect the photosphere at 24µm, (b) dropped sources where a nearby star compromised the 2MASS photometry, (c) removed stars with the highest 70µm background levels, and (d) avoided sources observed by other Spitzer programs. The final source list consists of 205 stars: 48 stars with masses between 0.1 and 0.2 M⊙ (corresponding to spectral types of ∼M3-M5), 50 between 0.2 and 0.4 M⊙ (M0.5-M3), 42 between 0.4 and 1.8 M⊙ (F0-M0.5), 50 between 1.8 and 3.0 M⊙ (B5-F0), and 15 more massive than 3 M⊙ (earlier than B5). The final source list does not constitute a complete sample of stars, but should be a representative population of Upper Sco.

Preibisch & Zinnecker (1999) estimated an age of 5 Myr for a x-ray-selected sample of stars in Upper Sco as inferred from D’Antona & Mazzitelli (1994) pre-main sequence evolutionary tracks after allowing for binaries. This age is consistent with the nuclear (5-6 Myr; de Geus et al. 1989) and dynamical (4.5 Myr; Blaauw 1991) age of the high mass stars. Moreover, Preibisch & Zinnecker (1999) find that the intrinsic age spread within the association is less than 2 Myr. We therefore adopt an age of 5 Myr for Upper Sco, but recognize that the age is uncertain by at least 1-2 Myr depending on the choice of model evolutionary tracks.

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1One source, HIP 80112, was observed only with MIPS and is not further discussed.
3. Observations and Data Reduction

IRAC (4.5µm and 8µm, Fazio et al. 2004) observations for 204 stars and IRS peak-up-imaging (PUI; 16µm, Houck et al. 2004) data for 195 stars were obtained with the Spitzer Space Telescope. IRS PUI observations were not attempted for nine B-stars since the detector would have saturated on the stellar photosphere. Exposure times ranged from 0.02 to 12 seconds for IRAC and from 6 to 30 seconds for IRS PUI depending on the stellar brightness estimated from 2MASS photometry. At least nine dither positions were obtained per band, and the number was increased as needed to achieve a minimum signal to noise ratio on the stellar photosphere of 50 for IRAC and 20 for IRS PUI.

Data analysis was performed on the Basic Calibrated Data images produced by the S14 pipeline for IRAC and S13 for IRS PUI. Photometry was measured on individual frames using a modified version of IDLPHOT. For IRAC, we adopted an aperture radius of 3 pixels (1 pixel = 1.22") and a sky annulus between 10 and 20 pixels. For IRS PUI, we used an aperture radius of 2 pixels (1 pixel = 1.8") and a sky annulus between 5 and 8 pixels. A multiplicative aperture correction of 1.110, 1.200, and 1.316 was applied to the IRAC 4.5µm, IRAC 8µm, and IRS 16µm flux densities to place the photometry on the calibration scale described in the IRAC and IRS data handbooks. Photometric corrections at the few percent level were applied to the IRAC data to account for distortion and variations in the effective bandpass across the detector (Reach et al. 2005). Internal photometric uncertainties were computed as standard deviation of the mean of measurements made on individual frames. We adopted a minimum uncertainty of 1.22, 0.66, and 0.58% for 4.5µm, 8µm, and 16µm respectively based on repeatability achieved for bright stars.

We incorporate into the analysis 14 solar-type stars in Upper Sco from the FEPS Spitzer Legacy Program (Meyer et al. 2006) that were selected for that study based on criteria similar to those stated in §2. We exclude the FEPS source HD 143006 since this star was recognized as a Upper Sco member based on an IRAS excess (Odenwald 1986) and thus would bias the sample. The FEPS IRAC data were processed using the above procedures. FEPS did not obtain IRS PUI observations.

Table 1 lists the sources, spectral types, Spitzer fluxes, and internal uncertainties for the 218 stars analyzed here. The uncertainties do not include calibration uncertainties of 2% for IRAC (Reach et al. 2005) and 6% for IRS PUI as quoted in the IRS data handbook\(^2\). Five sources are flagged in Table 1 where the curve of growth at 16µm deviates from

\(^2\)The calibration factors adopted here are 0.1388 and 0.2021 MJy/sr per DN/s for IRAC 4.5µm and 8µm and 0.01375 MJy/sr per e\(^{-1}\)/sec for IRS 16µm PUI.
a point source by more than 4% for the adopted aperture radius, indicating that the flux measurement may include contributions from a second source.

4. Sources with Infrared Excesses

Color-color diagrams for the Upper Sco sources are presented in Figure 1. The top panel shows the 8\(\mu\)m to 4.5\(\mu\)m flux ratio (\(\equiv R_8\)) as a function of the \(J - H\) color, and the bottom panel shows the 16\(\mu\)m to 4.5\(\mu\)m flux ratio (\(\equiv R_{16}\)). In both panels, most sources lie along a tight locus that is assumed to represent emission dominated by reddened stellar photospheres. However, several sources have large values of \(R_8\) or \(R_{16}\) diagnostic of 8\(\mu\)m or 16\(\mu\)m emission in excess of the photosphere.

Since the scatter in the observed colors is likely dominated by factors not easily quantified on a star-by-star basis, we determined empirically a threshold to identify sources with intrinsic infrared excesses. A linear relation was fitted between \(\log R_{16}\) and \(J - H\). Any outliers more distant than four times the RMS of the fit residuals were removed, and the fit was repeated until no additional outliers were identified. A similar fit was performed between \(\log R_8\) and \(J - H\) after removing all \(R_{16}\) outliers.

The RMS residuals from the final linear fit were 1.9% and 5.7% for \(R_8\) and \(R_{16}\) respectively. A source was identified with an infrared excess if \(R_8\) or \(R_{16}\) exceeded the fitted relation by both four times the RMS of the fit residuals and four times the internal uncertainty in the flux ratio. We further required that a large value of \(R_8\) or \(R_{16}\) does not result from extinction as determined from \(B, V\) and 2MASS photometry, spectral types, and the Mathis (1990) extinction law.

Excesses were inferred toward 35 sources as indicated in Table 1: 29 at 8\(\mu\)m and 33 at 16\(\mu\)m. The 16\(\mu\)m excess sources include [PBB2002] USco J161420.2−190648, which saturated the IRS detector. HIP 78207 and [PZ99] J161411.0−230536 have 8\(\mu\)m excesses but were not observed at 16\(\mu\)m. An IRS spectrum of the latter source shows a clear excess at this wavelength (Carpenter et al. 2007), and HIP 78207 exhibits IRAS excesses at 12\(\mu\)m and 25\(\mu\)m (Oudmaijer et al. 1992).

5. Discussion

The excess properties of the Upper Sco sources are not uniform across spectral type as demonstrated in Figure 1. The 8\(\mu\)m excess fraction for K+M stars (24/127) is higher than for B+A stars (5/61) at the 92% confidence level and higher than for F+G stars (0/30)
at 99.2% confidence as determined from the two-tailed Fisher’s Exact Test. At 16\(\mu\)m, the K+M excess fraction (23/121) is similar to that for B+A stars (10/52), but higher than for F+G stars (0/22) at 97.5% confidence.

More telling differences between early and late spectral types are observed in the magnitude of the excesses. Nine B+A stars have a \(R_{16}\) color excess less than twice the stellar photosphere, while all K+M sources exceed this limit with excesses up to 27 times the photospheric level. Similarly, at 8\(\mu\)m, all but two B+A excess sources have a \(R_{8}\) excess less than 10% of the photosphere, while 23 of the 24 K+M excess sources have larger color excesses.

In Figure 2, we assess the evolutionary state of the circumstellar disks in Upper Sco by comparing normalized, dereddened spectral energy distributions (SEDs) for stars in Upper Sco with a sample of well known T Tauri (Hartmann et al. 2005) and Herbig Ae/Be (Hillenbrand et al. 1992) stars that have tabulated photometry. The Taurus and Herbig Ae/Be objects are expected to represent young stars surrounded by primordial, optically thick, circumstellar accretion disks.

As shown in Figure 2, the SEDs for B and A stars in Upper Sco differ substantially from most Herbig Ae/Be stars. Herbig Ae/Be stars typically have excesses at wavelengths as short as 2\(\mu\)m and have fractional excess luminosities that are 10-100 times the photosphere at 10-20\(\mu\)m. By comparison, only one B or A star in Upper Sco has a \(K\)-band excess (HIP 78207), and the fractional excess luminosity at 16\(\mu\)m is typically less than twice the photosphere.

Surprisingly, none of the F and G stars in our Upper Sco sample exhibit a detectable excess. While Chen et al. (2005) identified a 24\(\mu\)m excess around one of five F+G stars in Upper Sco, and the G6 V star HD 143006 is surrounded by an optically thick disk (Sylvester et al. 1996), overall infrared excesses at wavelengths \(\leq\) 16\(\mu\)m are relatively rare for this spectral type range at the age of Upper Sco.

The results for the B, A, F, and G stars imply that the reservoir of small dust grains in a primordial, optically thick, inner disk have been largely depleted by an age of 5 Myr for \(\sim\)1-20\(M_{\odot}\) stars. The inner-disk radius inferred by the weak (or lack-of) excess emission at 16\(\mu\)m is \(\sim\)4-10 AU for 6000-10,000 K photospheres assuming optically thin, blackbody dust emission (Jura 2003). These results are consistent with the low fraction of accreting B and A stars found in the 4 Myr-old Trumpler 37 cluster (Sicilia-Aguilar et al. 2006) and the 5 Myr-old Orion OB1b association (Hernández et al. 2006). However, Hernández et al. (2006) found that 7 of 11 F-stars in Orion OB1b contain 24\(\mu\)m excesses consistent with a debris disk, suggesting that the excess fraction for F and G-stars in Upper Sco may increase once our longer wavelength observations are obtained.
In contrast to the massive stars, the K and M stars in Upper Sco with infrared excesses have characteristics similar to optically thick primordial disks. As discussed above and demonstrated in Figure 2, the K+M stars have larger fractional excesses than the B+A stars, and the magnitude of the excesses overlaps with that observed toward Class II stars in Taurus. A further connection between the disks in Upper Sco and Taurus is found by considering evidence for disk accretion as traced by Hα emission. Of the 100 stars in our sample with measured Hα line strengths (see references in §2), nine have Hα equivalent widths consistent with accretion according to the criteria recommended by White & Basri (2003). Eight of these nine sources have an infrared excess and are therefore likely surrounded by accretion disks. We note however that the Hα equivalent widths for 14 K+M stars with excesses are consistent with active chromospheres. These similarities suggest that many of the K+M stars in Upper Sco remain surrounded by optically thick disks. Assuming optically thick blackbody emission, the 4.5µm and 8µm excesses may imply the presence of dust at radii as small as ~0.05 AU (Jura 2003).

Differences in the excess characteristics between the ~1-2 Myr-old Taurus and 5 Myr Upper Sco populations are notable since they may reflect temporal evolution in the disk properties. While the magnitude of the excesses overlaps between the two samples, the excesses are larger on average for Taurus as seen in Figure 2. Furthermore, about half of the stars in Taurus exhibit a K-band excess (Strom et al. 1989) compared to only two (1.5%) K+M stars in Upper Sco ([PBB2002] USco J161420.2−190648 and [PZ99] J160421.7−213028). Similarly, while 68% of the stars in Taurus exhibit a 3.6µm excess (Haisch et al. 2001), only 19±5% of K+M stars in Upper Sco have a 8µm excess. Therefore, not only are there fewer sources with disks in Upper Sco, but the disks that remain lack the hot dust found in younger stars. Sicilia-Aguilar et al. (2006) found similar tendencies for the low mass population in Trumpler 37 compared to Taurus. They attribute these differences to grain growth or dust settling in the inner disk, although further observations and modeling are needed to explore the relevance of these ideas to stars in Upper Sco.

To summarize, 19% of K0-M5 stars in Upper Sco possess infrared excesses similar to Class II sources in Taurus, indicating primordial disks last around an appreciable number of 0.1-1 M⊙ stars for at least 5 Myr. By contrast, only ~1% of the more massive stars in Upper Sco contain such disks within an orbital radius of ~4-10 AU. Similar results have been reported for the 4 Myr-old Trumpler 37 cluster (Sicilia-Aguilar et al. 2006), and the 2-3 Myr-old IC 348 cluster may also contain a higher fraction of disks around later type stars (Lada et al. 2006). Our observations of Upper Sco extend these conclusions to the full range of stellar masses down to the hydrogen burning limit at an age of ~5 Myr. These results establish that warm dust in the terrestrial zone persist for longer times around stars with masses < 1 M⊙.
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Fig. 1.— Color-color diagrams showing $J - H$ along the abscissa, tracing the stellar photosphere, and the 8$\mu$m to 4.5$\mu$m flux ratio (top panel) and 16$\mu$m to 4.5$\mu$m flux ratio (bottom) along the ordinate, diagnostic of circumstellar disks. Dashed lines indicate the thresholds adopted to identify sources with infrared excesses, corresponding to a color excess above the photosphere of 8% (top panel) and 25% (bottom). Black circles represent sources identified with a 8$\mu$m or 16$\mu$m excess, and gray circles are sources without a detectable excess. The open circle represents ScoPMS 17 for which the 16$\mu$m excess is questionable based on possible source confusion (see Table 1). The internal uncertainties in the Spitzer flux ratios are all smaller than the symbol size, and the median $J - H$ uncertainty is 0.036 mag. The source [PBB2002] USco J161420.2−190648, which has an excess at both 8$\mu$m and 16$\mu$m, is offscale on these plots. The reddening vector from Mathis (1990) is indicated.
Fig. 2.— Dereddened spectral energy distributions for B+A (top), F+G, K, and M (bottom) stars. Gray circles represent Upper Sco sources that do not have a detectable excess at wavelengths $\leq 16\mu$m, and open circles are sources with an excess in one or more bands. Plus-symbols represent Herbig Ae/Be stars (B, A, and F spectral types) and Class II sources in Taurus (G, K, and M spectral types) listed in Hillenbrand et al. (1992) and Hartmann et al. (2005). The SEDs have been normalized to $J$-band, and a random offset has been added to the wavelengths to illustrate the distribution of points.
Table 1. Observed IRAC and IRS Fluxes

| Source       | SpT | SpT Ref | IRAC 4.5µm<sup>a</sup> | IRAC 8µm<sup>b</sup> | IRS 16µm<sup>c,d</sup> | Excess? |
|--------------|-----|---------|-------------------------|----------------------|-------------------------|---------|
|              |     |         | S<sub>ν</sub> (mJy)  | σ (mJy)  | S<sub>ν</sub> (mJy)  | σ (mJy)  | S<sub>ν</sub> (mJy)  | σ (mJy)  | 8µm | 16µm |
| HD 142987    | G4  | MML     | 181.3                   | 2.2                  | 67.9                    | 0.4      | 19.9                    | 0.1      | N   | N   |
| HD 147810    | G1  | MML     | 228.9                   | 2.8                  | 82.0                    | 0.8      | 26.3                    | 0.2      | N   | N   |
| HD 149598    | G0  | MML     | 113.0                   | 1.4                  | 41.4                    | 0.3      | 12.9                    | 0.1      | N   | N   |
| HIP 76071    | B9V | H88     | 277.0                   | 3.4                  | 93.2                    | 0.8      | 27.4                    | 0.2      | N   | N   |
| HIP 76310    | A0V | H88     | 247.6                   | 3.0                  | 88.8                    | 0.8      | 89.4                    | 0.5      | N   | Y   |
| HIP 76633    | B9V | H88     | 179.4                   | 2.2                  | 63.2                    | 0.4      | 19.9                    | 0.1      | N   | N   |
| HIP 77457    | A7V | H82     | 224.4                   | 2.7                  | 77.0                    | 0.9      | 23.0                    | 0.1      | N   | N   |
| HIP 77545    | A2/3V| H88    | 130.0                   | 1.6                  | 46.8                    | 0.3      | 16.1                    | 0.1      | N   | N   |
| HIP 77635    | B1.5Vn| H88    | 2070.8                  | 25.3                 | 698.9                   | 4.6      | ...                     | ...      | N   | ... |
| HIP 77815    | A5V | H88     | 257.0                   | 3.1                  | 89.4                    | 0.8      | 27.5                    | 0.2      | N   | N   |
| HIP 77840    | B2.5Vn| H88    | 2055.2                  | 25.1                 | 691.2                   | 4.6      | ...                     | ...      | N   | ... |
| HIP 77858    | B5V | H88     | 1256.5                  | 15.3                 | 432.6                   | 2.9      | 131.8                   | 0.8      | N   | N   |
| HIP 77859    | B2V | H88     | 1403.0                  | 17.1                 | 605.2                   | 4.0      | 259.0                   | 1.5      | Y   | Y   |
| HIP 77900    | B7V | H82     | 519.9                   | 6.3                  | 174.8                   | 1.2      | 51.1                    | 0.3      | N   | N   |
| HIP 77909    | B8III/IV| H88   | 675.1                   | 8.2                  | 229.6                   | 1.5      | 68.4                    | 0.4      | N   | N   |
| HIP 77911    | B9V | H88     | 379.8                   | 4.6                  | 132.1                   | 0.9      | 76.2                    | 0.4      | N   | N   |
| HIP 77960    | A4IV/V| H88    | 209.6                   | 2.6                  | 70.3                    | 0.8      | 21.6                    | 0.1      | N   | N   |
| HIP 78099    | A0V | H88     | 254.5                   | 3.1                  | 86.5                    | 0.8      | 28.7                    | 0.2      | N   | N   |
| HIP 78104    | B2IV/V| H82    | 2790.4                  | 34.0                 | 938.7                   | 6.2      | ...                     | ...      | N   | ... |
| HIP 78168    | B3V | H88     | 898.8                   | 11.0                 | 302.9                   | 2.0      | 89.3                    | 0.5      | N   | N   |
| HIP 78196    | A0V | H88     | 268.0                   | 3.3                  | 91.0                    | 0.8      | 26.5                    | 0.2      | N   | N   |
| HIP 78207    | B8Ia/Iab| H88  | 4019.5                  | 49.0                 | 2268.5                  | 15.0     | ...                     | ...      | Y   | ... |
| HIP 78233    | F2/3IV/V| H88  | 153.3                   | 1.9                  | 54.7                    | 0.4      | 16.2                    | 0.1      | N   | N   |
| HIP 78246    | B5V | H88     | 932.4                   | 11.4                 | 315.5                   | 2.1      | 91.6                    | 0.5      | N   | N   |
| HIP 78265    | B1V+B2V| H88  | 7050.9                  | 86.0                 | 2327.1                  | 15.4     | ...                     | ...      | N   | ... |
| HIP 78483    | G0V | H82     | 185.3                   | 2.3                  | 67.5                    | 0.4      | 19.4                    | 0.1      | N   | N   |
| HIP 78494    | A2mA7-F2| H88  | 316.2                   | 3.9                  | 108.8                   | 0.8      | 33.3                    | 0.2      | N   | N   |
| HIP 78530    | B9V | H88     | 317.5                   | 3.9                  | 107.9                   | 0.8      | 32.2                    | 0.2      | N   | N   |
| HIP 78549    | B9.5V| H88     | 301.2                   | 3.7                  | 102.2                   | 0.8      | 30.8                    | 0.2      | N   | N   |
| HIP 78702    | B9V | H88     | 239.5                   | 2.9                  | 82.7                    | 0.8      | 25.9                    | 0.1      | N   | N   |
| HIP 78809    | B9V | H88     | 213.1                   | 2.6                  | 72.8                    | 0.9      | 21.9                    | 0.1      | N   | N   |
| HIP 78820    | B0.5V| H88     | 12417.1                 | 151.5                | 4108.3                  | 27.1     | ...                     | ...      | N   | ... |
| HIP 78847    | A0V | H88     | 261.7                   | 3.2                  | 91.2                    | 0.8      | 27.2                    | 0.2      | N   | N   |

<sup>a</sup> Upper Sco sources from this study

<sup>b</sup> a, b, and c refer to the references.
Table 1—Continued

| Source | SpT  | SpT Ref | IRAC 4.5μm<sup>a</sup> | IRAC 8μm<sup>b</sup> | IRS 16μm<sup>c,d</sup> | Excess? |
|--------|------|---------|------------------------|------------------------|------------------------|---------|
|        |      |         | $S_\nu$ (mJy) | $\sigma$ (mJy) | $S_\nu$ (mJy) | $\sigma$ (mJy) | $S_\nu$ (mJy) | $\sigma$ (mJy) | $S_\nu$ (mJy) | $\sigma$ (mJy) | $S_\nu$ (mJy) | $\sigma$ (mJy) | $S_\nu$ (mJy) | $\sigma$ (mJy) |
| HIP 78877 | B8V | H88 | 758.9 | 9.3 | 261.8 | 1.7 | 78.4 | 0.5 | N | N |
| HIP 78933 | B1V | H88 | 3990.0 | 48.7 | 1329.6 | 8.8 | ... | ... | N | ... |
| HIP 78956 | B9.5V | H88 | 242.2 | 3.0 | 84.1 | 0.8 | 30.1 | 0.2 | N | N |
| HIP 78963 | A9V | H82 | 225.5 | 2.8 | 75.2 | 0.8 | 23.9 | 0.1 | N | N |
| HIP 78968 | B9V | H88 | 206.6 | 2.5 | 66.9 | 0.8 | 26.5 | 0.2 | N | N |
| HIP 78996 | A9V | H88 | 237.8 | 2.9 | 90.1 | 0.9 | 45.5 | 0.3 | Y | Y |
| HIP 79083 | F3V | H88 | 415.2 | 5.1 | 144.1 | 1.0 | 44.6 | 0.3 | N | N |
| HIP 79097 | F3V | H88 | 244.6 | 3.0 | 86.1 | 0.8 | 25.9 | 0.1 | N | N |
| HIP 79124 | A0V | H88 | 299.4 | 3.7 | 103.2 | 0.8 | 30.8 | 0.2 | N | N |
| HIP 79156 | A0V | H88 | 203.1 | 2.5 | 75.3 | 0.8 | 35.7 | 0.2 | Y | Y |
| HIP 79250 | A3III/IV | H88 | 233.2 | 2.8 | 79.9 | 0.9 | 27.0 | 0.2 | N | N |
| HIP 79366 | A3V | H88 | 234.9 | 2.9 | 78.7 | 0.9 | 24.0 | 0.1 | N | N |
| HIP 79374 | B2IV | H88 | 5570.8 | 70.2 | 1938.4 | 12.8 | ... | ... | N | ... |
| HIP 79392 | A2IV | H88 | 181.2 | 2.2 | 63.9 | 0.4 | 18.7 | 0.1 | N | N |
| HIP 79404 | B2V | H88 | 1745.3 | 21.3 | 597.6 | 3.9 | 174.3 | 1.0 | N | N |
| HIP 79410 | B9V | H88 | 279.1 | 3.4 | 104.6 | 0.8 | 59.4 | 0.3 | Y | Y |
| HIP 79439 | B9V | H88 | 305.4 | 3.7 | 109.6 | 0.8 | 44.5 | 0.3 | N | Y |
| HIP 79462 | G2V | H88 | 232.0 | 2.8 | 84.4 | 1.0 | 29.5 | 0.2 | N | N |
| HIP 79530 | B6IV | H88 | 652.9 | 8.0 | 222.1 | 1.5 | 65.0 | 0.4 | N | N |
| HIP 79606 | F6 | H88 | 286.3 | 3.5 | 101.9 | 0.8 | 29.8 | 0.2 | N | N |
| HIP 79643 | F2 | H88 | 117.9 | 1.4 | 42.1 | 0.3 | 14.8 | 0.1 | N | N |
| HIP 79644 | F5 | H88 | 76.5 | 0.9 | 27.1 | 0.2 | 8.12 | 0.07 | N | N |
| HIP 79733 | A1m9-F2 | H82 | 126.9 | 1.5 | 44.3 | 0.3 | 12.9 | 0.1 | N | N |
| HIP 79739 | B8V | H88 | 291.4 | 3.6 | 99.3 | 0.8 | 29.0 | 0.2 | N | N |
| HIP 79771 | B9V | H88 | 277.8 | 3.4 | 96.0 | 0.9 | 27.9 | 0.2 | N | N |
| HIP 79785 | B9V | H88 | 443.9 | 5.4 | 153.6 | 1.0 | 45.7 | 0.3 | N | N |
| HIP 79860 | A0V | H82 | 127.6 | 1.6 | 44.7 | 0.3 | 12.9 | 0.1 | N | N |
| HIP 79878 | A0V | H82 | 268.9 | 3.3 | 93.7 | 0.8 | 45.2 | 0.3 | N | Y |
| HIP 79897 | B9V | H88 | 287.2 | 3.5 | 97.1 | 0.8 | 30.2 | 0.2 | N | N |
| HIP 80024 | B9IV/III | H88 | 368.2 | 4.5 | 126.1 | 0.8 | 61.6 | 0.4 | N | Y |
| HIP 80059 | A7III/IV | H88 | 191.3 | 2.3 | 70.9 | 0.5 | 20.6 | 0.1 | N | N |
| HIP 80898 | A9V | H88 | 143.5 | 1.8 | 53.1 | 0.3 | 23.4 | 0.1 | N | Y |
| HIP 80130 | A9V | H88 | 215.0 | 2.6 | 70.8 | 0.8 | 21.6 | 0.1 | N | N |
| HIP 80311 | A0V | H82 | 121.7 | 1.5 | 42.6 | 0.3 | 12.2 | 0.1 | N | N |
| Source                  | SpT       | SpT Ref | IRAC 4.5μm | IRAC 8μm | IRS 16μm | Excess? |
|------------------------|-----------|---------|------------|----------|----------|---------|
| HIP 80324              | A0V+A0V   | H82     | 282.6      | 98.7     | 31.1     | N       |
| HIP 80338              | B8I       | H88     | 431.9      | 152.1    | 52.1     | N       |
| HIP 80493              | B9V       | H82     | 285.2      | 97.8     | 29.2     | N       |
| HIP 80896              | F3V       | H82     | 201.5      | 68.3     | 21.7     | N       |
| HIP 81266              | B0V       | H82     | 6240.2     | 2090.3   | 13.8     | N       |
| HIP 82319              | F3V       | H88     | 133.3      | 46.7     | 13.7     | N       |
| HIP 82397              | A3V       | H82     | 220.5      | 75.9     | 27.8     | N       |
| [PBB2002] USco J155624.8-222555 | M4 | P02 | 22.8 | 18.7 | 22.1 | N |
| [PBB2002] USco J155625.7-224027 | M3 | P02 | 16.4 | 6.11 | 2.00 | N |
| [PBB2002] USco J155629.5-225657 | M3 | P02 | 15.9 | 5.97 | 1.98 | N |
| [PBB2002] USco J155655.5-225839 | M0 | P02 | 36.5 | 13.9 | 4.25 | N |
| [PBB2002] USco J155706.4-220066 | M4 | P02 | 15.1 | 10.0 | 8.43 | N |
| [PBB2002] USco J155729.9-225843 | M4 | P02 | 11.4 | 6.65 | 6.52 | N |
| [PBB2002] USco J155746.6-222919 | M3 | P02 | 15.7 | 5.82 | 4.93 | N |
| [PBB2002] USco J155829.8-231007 | M3 | P02 | 17.6 | 14.1 | 22.8 | N |
| [PBB2002] USco J155918.4-221042 | M4 | P02 | 24.2 | 8.96 | 2.99 | N |
| [PBB2002] USco J160159.7-195219 | M5 | P01 | 6.77 | 2.62 | 0.85 | N |
| [PBB2002] USco J160210.9-200749 | M5 | P01 | 7.00 | 2.67 | 0.89 | N |
| [PBB2002] USco J160222.4-195653 | M3 | P01 | 13.5 | 4.94 | 1.54 | N |
| [PBB2002] USco J160226.2-200241 | M5 | P01 | 11.1 | 4.04 | 1.41 | N |
| [PBB2002] USco J160245.4-193037 | M5 | P01 | 9.72 | 3.65 | 1.19 | N |
| [PBB2002] USco J160329.9-195503 | M5 | P01 | 10.0 | 3.73 | 1.17 | N |
| [PBB2002] USco J160341.8-200557 | M2 | P01 | 35.0 | 13.0 | 4.16 | N |
| [PBB2002] USco J160343.3-201531 | M2 | P01 | 28.7 | 10.9 | 3.38 | N |
| [PBB2002] USco J160350.4-194121 | M5 | P01 | 13.7 | 5.06 | 1.62 | N |
| [PBB2002] USco J160357.9-194210 | M2 | P01 | 23.9 | 20.1 | 27.2 | N |
| [PBB2002] USco J160418.2-191055 | M4 | P01 | 13.0 | 4.84 | 1.51 | N |
| [PBB2002] USco J160428.4-190441 | M3 | P01 | 47.0 | 17.4 | 5.61 | N |
| [PBB2002] USco J160435.6-194830 | M5 | P01 | 9.46 | 3.57 | 1.12 | N |
| [PBB2002] USco J160439.1-194245 | M4 | P01 | 11.9 | 4.39 | 1.52 | N |
| [PBB2002] USco J160449.9-203835 | M5 | P01 | 11.2 | 4.22 | 1.47 | N |
| [PBB2002] USco J160456.4-194045 | M4 | P01 | 12.5 | 4.66 | 1.46 | N |
| [PBB2002] USco J160502.1-203507 | M2 | P01 | 40.5 | 15.3 | 4.93 | N |
| [PBB2002] USco J160508.3-201531 | M4 | P01 | 33.9 | 12.5 | 4.13 | N |
Table 1—Continued

| Source          | SpT | SpT Ref | IRAC 4.5$\mu$m$^a$ | IRAC 8$\mu$m$^b$ | IRS 16$\mu$m$^{c,d}$ | Excess? | 8$\mu$m | 16$\mu$m |
|-----------------|-----|---------|---------------------|-------------------|----------------------|---------|--------|---------|
| [PBB2002] USco J160516.1-193830 | M4   | P01     | 6.90 0.08           | 2.56 0.02          | 0.86 0.03            | N       | N      |         |
| [PBB2002] USco J160517.9-202420 | M3   | P01     | 51.8 0.6            | 19.4 0.1           | 6.12 0.06            | N       | N      |         |
| [PBB2002] USco J160521.9-193602 | M1   | P01     | 19.7 0.2            | 7.38 0.10          | 2.38 0.03            | N       | N      |         |
| [PBB2002] USco J160525.5-203539 | M5   | P01     | 11.8 0.1            | 6.18 0.04          | 4.85 0.04            | Y       | Y      |         |
| [PBB2002] USco J160528.5-201037 | M1   | P01     | 20.6 0.3            | 7.66 0.07          | 2.50 0.05            | N       | N      |         |
| [PBB2002] USco J160531.3-192623 | M5   | P01     | 6.66 0.08           | 2.55 0.02          | 0.81 0.02            | N       | N      |         |
| [PBB2002] USco J160532.1-193315 | M5   | P01     | 12.7 0.2            | 8.94 0.06          | 7.33 0.04            | Y       | Y      |         |
| [PBB2002] USco J160545.4-202308 | M2   | P01     | 21.2 0.3            | 18.0 0.1           | 22.3 0.1             | Y       | Y      |         |
| [PBB2002] USco J160600.6-195711 | M5   | P01     | 21.9 0.3            | 11.2 0.1           | 12.0 0.1             | Y       | Y      |         |
| [PBB2002] USco J160611.9-193532 | M5   | P01     | 18.0 0.1            | 12.5 0.03          | 1.28 0.04            | N       | N      |         |
| [PBB2002] USco J160619.3-192332 | M5   | P01     | 7.04 0.09           | 2.62 0.02          | 0.87 0.03            | N       | N      |         |
| [PBB2002] USco J160622.8-201124 | M5   | P01     | 10.4 0.1            | 7.02 0.05          | 14.7 0.1             | Y       | Y      |         |
| [PBB2002] USco J160628.7-200357 | M5   | P01     | 16.8 0.2            | 6.28 0.04          | 1.96 0.04            | N       | N      |         |
| [PBB2002] USco J160643.8-190805 | K6   | P01     | 52.3 0.6            | 25.2 0.2           | 15.4 0.1             | Y       | Y      |         |
| [PBB2002] USco J160647.5-202232 | M2   | P01     | 24.7 0.3            | 9.09 0.07          | 2.97 0.04            | N       | N      |         |
| [PBB2002] USco J160702.1-201938 | M5   | P01     | 11.9 0.1            | 7.66 0.05          | 8.67 0.07            | Y       | Y      |         |
| [PBB2002] USco J160704.7-201555 | M4   | P01     | 6.68 0.08           | 2.49 0.02          | 0.77 0.02            | N       | N      |         |
| [PBB2002] USco J160707.7-192715 | M2   | P01     | 29.1 0.4            | 10.8 0.1           | 3.65 0.07            | N       | N      |         |
| [PBB2002] USco J160708.7-192733 | M4   | P01     | 8.48 0.10           | 3.14 0.02          | 0.90 0.06            | N       | N      |         |
| [PBB2002] USco J160719.7-202055 | M3   | P02     | 12.3 0.1            | 4.68 0.03          | 1.52 0.04            | N       | N      |         |
| [PBB2002] USco J160739.4-191747 | M2   | P01     | 27.3 0.3            | 10.2 0.1           | 3.89 0.07            | N       | N      |         |
| [PBB2002] USco J160801.4-202741 | K8   | P01     | 40.4 0.5            | 15.3 0.1           | 4.75 0.03            | N       | N      |         |
| [PBB2002] USco J160801.5-192757 | M4   | P02     | 31.6 0.4            | 11.6 0.1           | 3.75 0.05            | N       | N      |         |
| [PBB2002] USco J160802.4-202233 | M5   | P01     | 15.4 0.2            | 5.71 0.04          | 1.83 0.04            | N       | N      |         |
| [PBB2002] USco J160804.3-194712 | M4   | P01     | 11.0 0.1            | 4.33 0.03          | 1.35 0.05            | N       | N      |         |
| [PBB2002] USco J160815.3-203811 | M3   | P02     | 12.4 0.2            | 4.62 0.03          | 1.49 0.05            | N       | N      |         |
| [PBB2002] USco J160818.4-190059 | M3   | P02     | 19.9 0.2            | 7.53 0.06          | 2.39 0.06            | N       | N      |         |
| [PBB2002] USco J160823.2-193001 | K9   | P01     | 47.0 0.6            | 44.7 0.3           | 67.7 0.4             | Y       | Y      |         |
| [PBB2002] USco J160823.5-191131 | M2   | P01     | 23.2 0.3            | 8.71 0.06          | 2.77 0.07            | N       | N      |         |
| [PBB2002] USco J160828.3-193551 | M1   | P01     | 47.5 0.6            | 17.9 0.1           | 5.57 0.06            | N       | N      |         |
| [PBB2002] USco J160825.1-201224 | M1   | P01     | 24.2 0.3            | 9.10 0.06          | 2.97 0.06            | N       | N      |         |
| [PBB2002] USco J160827.5-194904 | M5   | P01     | 17.2 0.2            | 11.1 0.1           | 8.75 0.05            | Y       | Y      |         |
| [PBB2002] USco J160843.1-190051 | M4   | P01     | 20.3 0.2            | 7.62 0.06          | 2.55 0.04            | N       | N      |         |
| [PBB2002] USco J160854.0-203417 | M4   | P02     | 25.3 0.3            | 9.41 0.11          | 3.09 0.05            | N       | N      |         |
Table 1—Continued

| Source Ref | Source | SpT | SpT Ref | IRAC 4.5μm | IRAC 8μm | IRS 16μm | Excess? |
|------------|--------|-----|---------|------------|----------|----------|---------|
|            |        |     |         |            |          |          |         |
| [PBB2002]  | USco J160900.0-190836 | M5 | P02 | 14.1 | 0.2 | 12.1 | 0.1 | 17.2 | 0.1 | Y | Y |
| [PBB2002]  | USco J160900.7-190852 | K9 | P01 | 56.4 | 0.7 | 68.5 | 0.5 | 188.6 | 1.1 | Y | Y |
| [PBB2002]  | USco J160903.9-193944 | M4 | P02 | 17.7 | 0.2 | 6.69 | 0.04 | 2.23 | 0.05 | N | N |
| [PBB2002]  | USco J160904.0-193359 | M4 | P02 | 13.0 | 0.2 | 4.93 | 0.04 | 1.66 | 0.04 | N | N |
| [PBB2002]  | USco J160913.4-194328 | M3 | P01 | 13.9 | 0.2 | 5.22 | 0.03 | 1.73 | 0.08 | N | N |
| [PBB2002]  | USco J160915.8-193706 | M5 | P01 | 6.93 | 0.09 | 2.53 | 0.02 | 0.88 | 0.04 | N | N |
| [PBB2002]  | USco J160933.8-190456 | M2 | P01 | 27.7 | 0.3 | 10.5 | 0.1 | 3.24 | 0.05 | N | N |
| [PBB2002]  | USco J160946.4-193735 | M1 | P01 | 30.5 | 0.4 | 11.5 | 0.1 | 3.50 | 0.07 | N | N |
| [PBB2002]  | USco J160953.6-175446 | M3 | P02 | 8.55 | 0.10 | 7.00 | 0.05 | 8.13 | 0.05 | Y | Y |
| [PBB2002]  | USco J160954.4-190654 | M1 | P01 | 31.4 | 0.4 | 12.1 | 0.1 | 4.02 | 0.03 | N | N |
| [PBB2002]  | USco J160959.4-180009 | M4 | P01 | 24.2 | 0.3 | 25.7 | 0.2 | 66.0 | 0.4 | Y | Y |
| [PBB2002]  | USco J161010.4-194539 | M3 | P01 | 16.4 | 0.2 | 6.18 | 0.04 | 2.08 | 0.09 | N | N |
| [PBB2002]  | USco J161011.8-194603 | M5 | P02 | 7.79 | 0.10 | 3.04 | 0.02 | 1.07 | 0.03 | N | N |
| [PBB2002]  | USco J161014.7-191909 | M3 | P02 | 22.6 | 0.3 | 8.84 | 0.08 | 2.99 | 0.07 | N | N |
| [PBB2002]  | USco J161021.5-194132 | M3 | P02 | 28.8 | 0.4 | 10.7 | 0.1 | 3.54 | 0.04 | N | N |
| [PBB2002]  | USco J161024.7-191407 | M3 | P01 | 18.1 | 0.2 | 6.94 | 0.05 | 2.18 | 0.07 | N | N |
| [PBB2002]  | USco J161026.4-193950 | M4 | P02 | 19.8 | 0.2 | 7.42 | 0.05 | 2.48 | 0.05 | N | N |
| [PBB2002]  | USco J161031.9-191305 | K7 | P01 | 60.0 | 0.7 | 23.5 | 0.2 | 7.21 | 0.07 | N | N |
| [PBB2002]  | USco J161052.4-193734 | M3 | P02 | 12.7 | 0.2 | 4.84 | 0.04 | 1.78 | 0.06 | N | N |
| [PBB2002]  | USco J161115.3-175728 | M4 | P01 | 47.3 | 0.6 | 17.9 | 0.1 | 5.67 | 0.05 | N | N |
| [PBB2002]  | USco J161142.0-190648 | K5 | P02 | 606.5 | 7.4 | 614.1 | 4.1 | sat | sat | Y | Y |
| PPM 732705 |       | G6 | MML | 82.0 | 1.0 | 30.0 | 0.2 | 9.02 | 0.05 | N | N |
| PPM 747651 |       | G3 | MML | 78.9 | 1.0 | 29.1 | 0.2 | 8.91 | 0.06 | N | N |
| PPM 747978 |       | G3 | MML | 69.9 | 0.9 | 25.4 | 0.2 | 8.10 | 0.11 | N | N |
| [PZ99]     | J153557.8-232405 | K3 | P98 | 33.4 | 0.4 | 12.5 | 0.1 | 3.94 | 0.05 | N | N |
| [PZ99]     | J154413.4-252258 | M1 | P98 | 94.4 | 0.6 | 19.0 | 0.1 | 5.89 | 0.03 | N | N |
| [PZ99]     | J155106.6-240218 | M2 | K99 | 26.8 | 0.3 | 10.0 | 0.1 | 3.32 | 0.05 | N | N |
| [PZ99]     | J155716.6-252918 | M0 | K99 | 60.2 | 0.7 | 22.3 | 0.1 | 7.01 | 0.09 | N | N |
| [PZ99]     | J155750.0-230508 | M0 | K99 | 40.2 | 0.5 | 15.2 | 0.1 | 4.80 | 0.06 | N | N |
| [PZ99]     | J155812.7-232835 | G2 | K99 | 117.7 | 1.4 | 43.1 | 0.3 | 15.9 | 0.1 | N | N |
| [PZ99]     | J160000.7-250941 | G0 | K99 | 56.7 | 0.7 | 20.3 | 0.1 | 6.63 | 0.04 | N | N |
| [PZ99]     | J160013.3-218180 | M0 | K99 | 33.5 | 0.4 | 12.6 | 0.1 | 4.39 | 0.08 | N | N |
| [PZ99]     | J160031.3-202705 | M1 | K99 | 64.0 | 0.8 | 24.1 | 0.2 | 7.76 | 0.04 | N | N |
| Source            | SpT | SpT Ref | IRAC 4.5µm \( \nu \) (mJy) | IRAC 8µm \( \nu \) (mJy) | IRS 16µm \( \nu \) (mJy) | Excess? |
|-------------------|-----|---------|-----------------------------|-----------------------------|-----------------------------|--------|
|                   |     |         | \( S_\nu \) (mJy) | \( \sigma \) (mJy) | \( S_\nu \) (mJy) | \( \sigma \) (mJy) | \( S_\nu \) (mJy) | \( \sigma \) (mJy) | \( S_\nu \) (mJy) | \( \sigma \) (mJy) | \( S_\nu \) (mJy) | \( \sigma \) (mJy) | \( S_\nu \) (mJy) | \( \sigma \) (mJy) | \( S_\nu \) (mJy) | \( \sigma \) (mJy) | \( S_\nu \) (mJy) | \( \sigma \) (mJy) | \( S_\nu \) (mJy) | \( \sigma \) (mJy) | \( S_\nu \) (mJy) | \( \sigma \) (mJy) | \( S_\nu \) (mJy) | \( \sigma \) (mJy) |
| [PZ99] J160042.8-212737 | K7  | K99 | 53.6 0.7   | 20.3 0.1 | 6.29 0.05 | N      | N                |
| [PZ99] J160108.0-211318 | M0  | K99 | 66.0 0.8   | 25.3 0.2 | 8.04 0.06 | N      | N                |
| [PZ99] J160147.4-204945 | M0  | K99 | 82.3 1.0   | 31.4 0.2 | 10.0 0.1  | N      | N                |
| [PZ99] J160200.3-222123 | M1  | K99 | 64.0 0.8   | 24.1 0.2 | 8.03 0.06 | N      | N                |
| [PZ99] J160239.1-254208 | K7  | P98 | 46.3 0.6   | 17.4 0.1 | 5.52 0.08 | N      | N                |
| [PZ99] J160251.2-240156 | K4  | K99 | 50.5 0.6   | 19.1 0.1 | 6.01 0.04 | N      | N                |
| [PZ99] J160354.9-203137 | M0  | K99 | 76.6 0.9   | 28.7 0.2 | 9.27 0.06 | N      | N                |
| [PZ99] J160357.6-203105 | K5  | K99 | 191.9 2.3  | 106.4 0.7 | 292.7 1.7 | Y      | Y                |
| [PZ99] J160421.7-213028 | K2  | K99 | 62.7 0.8   | 26.3 0.2 | 26.8 0.2  | Y      | Y                |
| [PZ99] J160539.1-215200 | M1  | K99 | 32.6 0.4   | 12.4 0.1 | 4.21 0.05 | N      | N                |
| [PZ99] J160612.5-203647 | K5  | K99 | 61.9 0.8   | 24.2 0.2 | 7.12 0.05 | N      | N                |
| [PZ99] J160654.4-241610 | M3  | P98 | 61.7 0.8   | 23.1 0.2 | 6.99 0.05 | N      | N                |
| [PZ99] J160703.9-191132 | M1  | K99 | 47.5 0.6   | 17.9 0.1 | 5.72 0.06 | N      | N                |
| [PZ99] J160831.4-180241 | M0  | P98 | 54.2 0.7   | 20.8 0.1 | 6.41 0.06 | N      | N                |
| [PZ99] J160856.7-203346 | K5  | P98 | 73.5 0.9   | 28.1 0.2 | 9.68 0.05 | N      | N                |
| [PZ99] J160930.3-20459 | M0  | P98 | 54.4 0.7   | 20.8 0.1 | 6.66 0.04 | N      | N                |
| [PZ99] J161302.7-225744 | K4  | P98 | 84.4 1.0   | 31.5 0.2 | 10.0 0.2  | N      | N                |
| [PZ99] J161933.9-222828 | K0  | P98 | 77.6 0.9   | 30.3 0.2 | 8.60 0.05 | N      | N                |
| RX J1548.0-2908    | G9  | K99 | 66.2 0.8   | 24.4 0.2 | 7.30 0.06 | N      | N                |
| RX J1550.0-2312    | M2  | K99 | 61.8 0.8   | 22.9 0.2 | 7.32 0.04 | N      | N                |
| RX J1550.9-2534    | F9  | K99 | 127.9 1.6  | 45.9 0.3 | 13.7 0.1  | N      | N                |
| RX J1554.0-2920    | M0  | K99 | 68.4 0.8   | 25.4 0.2 | 8.04 0.05 | N      | N                |
| RX J1558.1-2405A   | K4  | K99 | 52.9 0.6   | 19.8 0.1 | 5.98 0.04 | N      | N                |
| RX J1600.7-2343    | M2  | K99 | 21.7 0.3   | 7.84 0.05 | 2.48 0.04 | N      | N                |
| RX J1602.8-2401A   | K0  | K99 | 155.1 1.9  | 59.7 0.4 | 18.0 0.1  | N      | N                |
| RX J1603.6-2245    | G9  | MML | 242.2 3.0  | 87.9 0.8 | 28.0 0.2  | N      | N                |
| ScoPMS 13          | M1.5V | W94 | 65.7 0.8   | 24.5 0.2 | 7.49 0.07 | N      | N                |
| ScoPMS 17          | M1V  | W94 | 60.8 0.7   | 23.5 0.2 | 12.4 0.3  | N      | N                |
| ScoPMS 23          | K5IV | W94 | 118.1 1.4  | 43.7 0.3 | 13.7 0.1  | N      | N                |
| ScoPMS 28          | M1V  | W94 | 31.9 0.4   | 12.1 0.1 | 3.61 0.06 | N      | N                |
| ScoPMS 29          | M2V  | W94 | 49.3 0.6   | 18.5 0.1 | 5.91 0.06 | N      | N                |
| ScoPMS 31          | M0.5V | W94 | 133.7 1.6  | 64.6 0.4 | 153.3 0.9 | Y      | Y                |
| ScoPMS 32          | M3V  | W94 | 21.3 0.3   | 7.92 0.07 | 2.57 0.05 | N      | N                |
Table 1—Continued

| Source          | SpT  | SpT Ref | IRAC 4.5μm<sup>a</sup> | IRAC 8μm<sup>b</sup> | IRS 16μm<sup>c,d</sup> | Excess? |
|-----------------|------|---------|-------------------------|-----------------------|-------------------------|---------|
|                 |      |         | S<sub>ν</sub> (mJy) | σ (mJy) | S<sub>ν</sub> (mJy) | σ (mJy) | S<sub>ν</sub> (mJy) | σ (mJy) |
| ScoPMS 45       | K5IV | W94     | 78.5                   | 1.0                  | 30.7                    | 0.2     | 9.66                  | 0.06    |
| HD 142361       | G3V  | H88     | 292.7                  | 3.6                  | 107.7                   | 0.8     | ...                   | ...     |
| HD 146516       | G0IV | W94     | 129.3                  | 1.6                  | 46.8                    | 0.3     | ...                   | ...     |
| [PZ99] J155847.8-175800 | K3   | P98     | 93.2                   | 1.1                  | 35.3                    | 0.2     | ...                   | ...     |
| [PZ99] J160814.7-190833 | K2   | P98     | 84.7                   | 1.0                  | 31.7                    | 0.2     | ...                   | ...     |
| [PZ99] J161318.6-221248 | G9   | P98     | 204.7                  | 2.5                  | 76.8                    | 0.5     | ...                   | ...     |
| [PZ99] J161329.3-231106 | K1   | P98     | 87.8                   | 1.1                  | 33.4                    | 0.2     | ...                   | ...     |
| [PZ99] J161402.1-230101 | G4   | P98     | 75.3                   | 0.9                  | 28.2                    | 0.2     | ...                   | ...     |
| [PZ99] J161411.0-230536 | K0   | P98     | 401.9                  | 4.9                  | 363.5                   | 2.4     | ...                   | ...     |
| [PZ99] J161459.2-275023 | G5   | P98     | 63.3                   | 0.8                  | 23.8                    | 0.2     | ...                   | ...     |
| [PZ99] J161618.0-233947 | G7   | P98     | 106.5                  | 1.3                  | 40.1                    | 0.3     | ...                   | ...     |
| RX J1541.1-2656 | G7   | P98     | 51.1                   | 0.6                  | 19.0                    | 0.1     | ...                   | ...     |
| RX J1600.6-2159 | G9   | P98     | 85.2                   | 1.0                  | 31.4                    | 0.2     | ...                   | ...     |
| ScoPMS 21       | K1IV | P98     | 76.1                   | 0.9                  | 28.7                    | 0.2     | ...                   | ...     |
| ScoPMS 27       | K2IV | P98     | 116.9                  | 1.4                  | 43.9                    | 0.3     | ...                   | ...     |

<sup>a</sup>IRAC 4.5μm photometry measured using a flux calibration factor of 0.1388 MJy/sr per DN/s.<br><sup>b</sup>IRAC 8μm photometry measured using a flux calibration factor of 0.2021 MJy/sr per DN/s.<br><sup>c</sup>IRS 16μm PUI photometry measured using a flux calibration factor of 0.01375 MJy/sr per e<sup>−</sup>/s.<br><sup>d</sup>Saturated sources are listed as “sat”<br><sup>e</sup>Aperture curve of growth deviates from a point source by more than 4%.<br><sup>f</sup>Saturated sources are listed as “sat”<br><sup>g</sup>Saturated sources are listed as “sat”

References. — H82: Houk (1982); H88: Houk & Smith-Moore (1988); K99: Kunkel (1999); K00: Köhler et al. (2000); MML: Mamajek, Meyer, & Liebert, unpublished; P98: Preibisch et al. (1998); P01: Preibisch et al. (2001); P02: Preibisch et al. (2002); W94: Walter et al. (1994)