

MID-INFRARED IMAGING OF CANDIDATE VEGA-LIKE SYSTEMS

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ABSTRACT

We have conducted deep mid-infrared imaging of a relatively nearby sample of candidate Vega-like stars using the OSCIR instrument on the Cerro Tololo Inter-American Observatory 4 m and Keck II 10 m telescopes. Our discovery of a spatially resolved disk around HR 4796A has already been reported in 1998 by Jayawardhana et al. Here we present imaging observations of the other members of the sample, including the discovery that only the primary in the HD 35187 binary system appears to harbor a substantial circumstellar disk and the possible detection of extended disk emission around 49 Ceti. We derive global properties of the dust disks, place constraints on their sizes, and discuss several interesting cases in detail. Although our targets are believed to be main-sequence stars, we note that several have large infrared excesses compared with prototype Vega-like systems and may therefore be somewhat younger. The disk size constraints we derive, in many cases, imply emission from relatively large ($\gtrsim 10 \mu\text{m}$) particles at mid-infrared wavelengths.

Key words: binaries: general — circumstellar matter — planetary systems — stars: early-type — stars: pre-main-sequence

1. INTRODUCTION

Early in its mission, the *Infrared Astronomy Satellite* (*IRAS*) detected thermal emission from solid grains with temperatures of 50–125 K and fractional luminosities (L_{dust}/L_*) in the range 10^{-5} – 10^{-3} around four main-sequence stars: Vega, Fomalhaut, β Pictoris, and ϵ Eridani. Coronagraphic observations of β Pic revealed that the grains do indeed lie in a disk, perhaps associated with a young planetary system (Smith & Terrile 1984). Subsequent surveys of *IRAS* data revealed over 100 other main-sequence stars of all spectral classes with far-infrared excesses indicative of circumstellar disks (Aumann 1985; Sadakane & Nishida 1986; Walker & Wolstencroft 1988; Jascheck et al. 1991; Oudmaijer et al. 1992; Cheng et al. 1992; Backman & Paresce 1993; Mannings & Barlow 1998).

In most “Vega-like” systems, the dust grains responsible for the infrared emission are thought to be continually replenished by collisions and sublimation of larger bodies, because the timescales for grain destruction by Poynting-Robertson (PR) drag and ice sublimation are much shorter than the stellar main-sequence lifetimes (Nakano 1988; Backman & Paresce 1993). In other words, the disks around

main-sequence stars are likely to be debris disks rather than protoplanetary structures. These optically thin debris disks contain much less dust (and gas) than the massive optically thick structures observed around young pre-main-sequence stars (e.g., Strom et al. 1989; Beckwith et al. 1990). Recent high-resolution submillimeter images of the four prototype debris disks confirm the presence of inner disk cavities, which may persist because of planets within the central void consuming or perturbing grains inbound under the influence of the PR drag (Holland et al. 1998; Greaves et al. 1998).

Over the past two years, we have conducted deep mid-infrared imaging of a relatively nearby sample of candidate Vega-like stars. Our goals are to study the diversity of debris disks and to explore possible evolutionary effects. Imaging at 18 and $10 \mu\text{m}$, with an angular resolution of $1''$ or better, is extremely valuable for confirming *IRAS*-detected excesses, constraining disk global properties, and estimating the typical grain sizes from measurements of the emission temperature and scale (e.g., Jura et al. 1993, 1995).

Our discovery of a spatially resolved disk around HR 4796A has already been reported (Jayawardhana et al. 1998; Telesco et al. 2000). Its low-mass binary companion, at a projected distance of 500 AU, is estimated to be 8 ± 3 Myr old, an age comparable to the timescale expected for planet formation (Strom, Edwards, & Skrutskie 1993; Podosek & Cassen 1994). Interestingly, the HR 4796A disk does have an inner cavity of solar system dimensions, and the disk dust mass is estimated to be only $\sim 1 M_{\text{Earth}}$. It is likely that circumstellar disks evolve from massive, optically thick, actively accreting structures to low-mass optically thin structures with inner holes in about 10 Myr and that the disk evolution is closely linked to planet formation (Jayawardhana et al. 1999a, 1999b, 2001; Jayawardhana 2000, and references therein).

Here we present imaging observations of the other members of the sample, including the discovery that only the primary in the HD 35187 binary system appears to harbor a substantial circumstellar disk and the possible detection of extended disk emission around 49 Ceti. We

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derive global properties of the dust disks, place constraints on their sizes, and discuss several interesting cases in detail.

2. OBSERVATIONS

Our sample consists of 11 nearby main-sequence stars with known *IRAS* excess at mid- and/or far-infrared wavelengths. The primary criteria for selection were proximity, spectral type (biased toward early types), and brightness in the mid-infrared. Table 1 lists the adopted stellar properties for the 11 objects.

During three observing runs in 1999, we have obtained deep mid-infrared images of the candidate stars using the OSCIR instrument on the 4 m Blanco telescope at Cerro Tololo Inter-American Observatory (CTIO) and the 10 m Keck II telescope. The log of our observations is given in Table 2. OSCIR is a mid-infrared imager/spectrometer built

at the University of Florida,⁷ using a 128×128 Si:As blocked impurity band (BIB) detector developed by Boeing.

On the CTIO 4 m telescope, OSCIR has a plate scale of $0''.183 \text{ pixel}^{-1}$, which gives a field of view of $23'' \times 23''$. Our observations were made using the standard chop-nod technique with a chop frequency of 5 Hz and a throw of $23''$ in declination. On Keck II, its plate scale is $0''.062 \text{ pixel}^{-1}$, providing a $7''.9 \times 7''.9$ field of view. Here we used a chop frequency of 4 Hz and a throw of $8''$. Images were obtained in the *N* ($10.8 \mu\text{m}$) band for 10 of the 11 targets in our sample and in the IHW18 ($18.2 \mu\text{m}$) band for nine objects.

⁷ Additional information on OSCIR is available at <http://www.astro.ufl.edu/iag>.

TABLE 1
OBSERVATIONAL PROPERTIES AND ADOPTED PARAMETERS OF TARGET STARS^a

HD	HR	Other Name	Sp. Type	<i>V</i>	Distance (pc)	<i>T</i> _* (K)	<i>R</i> _* (cm)
9672	451	49 Ceti	A1 V	5.62	61	9230	1.6×10^{11}
35187A ^b .....	...	...	A7 V	8.73	150	7850	1.1×10^{11}
35187B ^b .....	...	...	A2 V	8.59	150	8970	1.5×10^{11}
38678	1998	14 Lep	A2 V	3.55	21	8970	1.5×10^{11}
74956	3485	δ Vel	A1 V	1.95	24	9230	1.6×10^{11}
102647	4534	β Leo	A3 V	2.14	11	8720	1.4×10^{11}
135344 ^c .....	...	...	F8 V	8.63	84	6200	8.0×10^{10}
143006 ^c .....	...	BD-22 4059	G5 V	10.18	82	5770	6.4×10^{10}
155826	6398	...	F7 V	5.96	31	6280	8.3×10^{10}
158643	6519	51 Oph	B9.5 V	4.81	131	10000	1.7×10^{11}
163296 .....	...	Hen 3-1524	A1 V	6.87	122	9230	1.6×10^{11}
169142 ^c .....	...	...	A5 V	8.15	145	8200	1.2×10^{11}

^a Spectral type, *V* magnitude and distance are from SIMBAD database, unless otherwise noted. *T*_{*} and *R*_{*} for a given spectral type are based on Allen 2000.

^b Spectral type, *V* magnitude and distance are from Dunkin & Crawford 1998.

^c Spectral type, *V* magnitude and distance are from Sylvester et al. 1996.

TABLE 2
LOG OF OBSERVATIONS

UT Date	Telescope	Target	Filter	On-Source Integration (s)	Flux Standards
1999 Feb 24	CTIO 4 m	HD 74956	N	600	γ Ret, λ Vel
1999 Feb 24	CTIO 4 m	HD 74956	IHW18	600	γ Ret, λ Vel
1999 Feb 25	CTIO 4 m	HD 38678	N	600	γ Ret, γ Cru
1999 Feb 26	CTIO 4 m	HD 35187	K	300	λ Vel
1999 Feb 26	CTIO 4 m	HD 35187	M	211	λ Vel
1999 Feb 26	CTIO 4 m	HD 35187	N	150	α Tau, λ Vel
1999 Feb 26	CTIO 4 m	HD 35187	IHW18	600	α Tau, λ Vel
1999 Feb 27	CTIO 4 m	HD 102647	IHW18	100	α CMa, γ Cru
1999 Feb 27	CTIO 4 m	HD 102647	N	300	α CMa, γ Cru
1999 May 3	Keck II	HD 135344	IHW18	900	μ UMa, α Boo
1999 May 3	Keck II	HD 135344	N	120	μ UMa, α Boo
1999 May 3	Keck II	HD 143006	IHW18	600	α Boo, η Sgr
1999 May 3	Keck II	HD 143006	N	600	α Boo, η Sgr
1999 May 3	Keck II	HD 155826	IHW18	600	α Boo, η Sgr
1999 May 3	Keck II	HD 155826	N	60	α Boo, η Sgr
1999 May 3	Keck II	HD 163296	IHW18	300	η Sgr, γ Aql
1999 May 3	Keck II	HD 163296	N	300	η Sgr, γ Aql
1999 May 3	Keck II	51 Oph	IHW18	600	η Sgr, γ Aql
1999 May 4	Keck II	HD 169142	N	600	α Boo, γ Aql
1999 May 4	Keck II	HD 169142	IHW18	600	α Boo, γ Aql
1999 Nov 20	Keck II	49 Ceti	N	120	β Peg, α Ari

TABLE 3
MID-INFRARED FLUX MEASUREMENTS

Name	<i>N</i> Flux (Jy)	IHW18 Flux (Jy)
49 Ceti.....	$0.25 \pm 20\%$	...
51 Oph.....	...	$8.95 \pm 20\%$
HD 35187 ^a	$3.40 \pm 10\%$	$5.80 \pm 10\%$
HD 38678.....	$1.80 \pm 10\%$	...
HD 74956.....	$6.46 \pm 10\%$	$2.93 \pm 10\%$
HD 102647.....	$5.30 \pm 10\%$	$1.50 \pm 10\%$
HD 135344.....	$1.29 \pm 10\%$	$2.59 \pm 10\%$
HD 143006.....	$0.84 \pm 10\%$	$1.85 \pm 10\%$
HD 155826.....	$2.78 \pm 10\%$	$3.90 \pm 10\%$
HD 163296.....	$20.70 \pm 10\%$	$16.77 \pm 20\%$
HD 169142.....	$2.37 \pm 10\%$	$7.86 \pm 10\%$

^a The total flux for the binary.

3. RESULTS

In Table 3, we present the measured fluxes in the *N* and IHW18 bands for the entire sample. Within the 10% errors, our measurements are consistent with published ground-based near-infrared and *IRAS* 12 and 25 μm fluxes, ruling out the possibility that *IRAS*-detected excesses are due to contamination from unrelated sources within the large *IRAS* beam. None of the objects clearly shows spatially resolved emission in our images.

Figure 1 presents normalized scans through our targets and the PSF stars; in cases where the target and/or the PSF appeared asymmetric, the scan shown is along the “major axis.” Most targets are indistinguishable from point sources, except possibly 49 Ceti, HD 169142, and HD 135344 (at 18 μm). None of the three is obviously elongated, and particu-

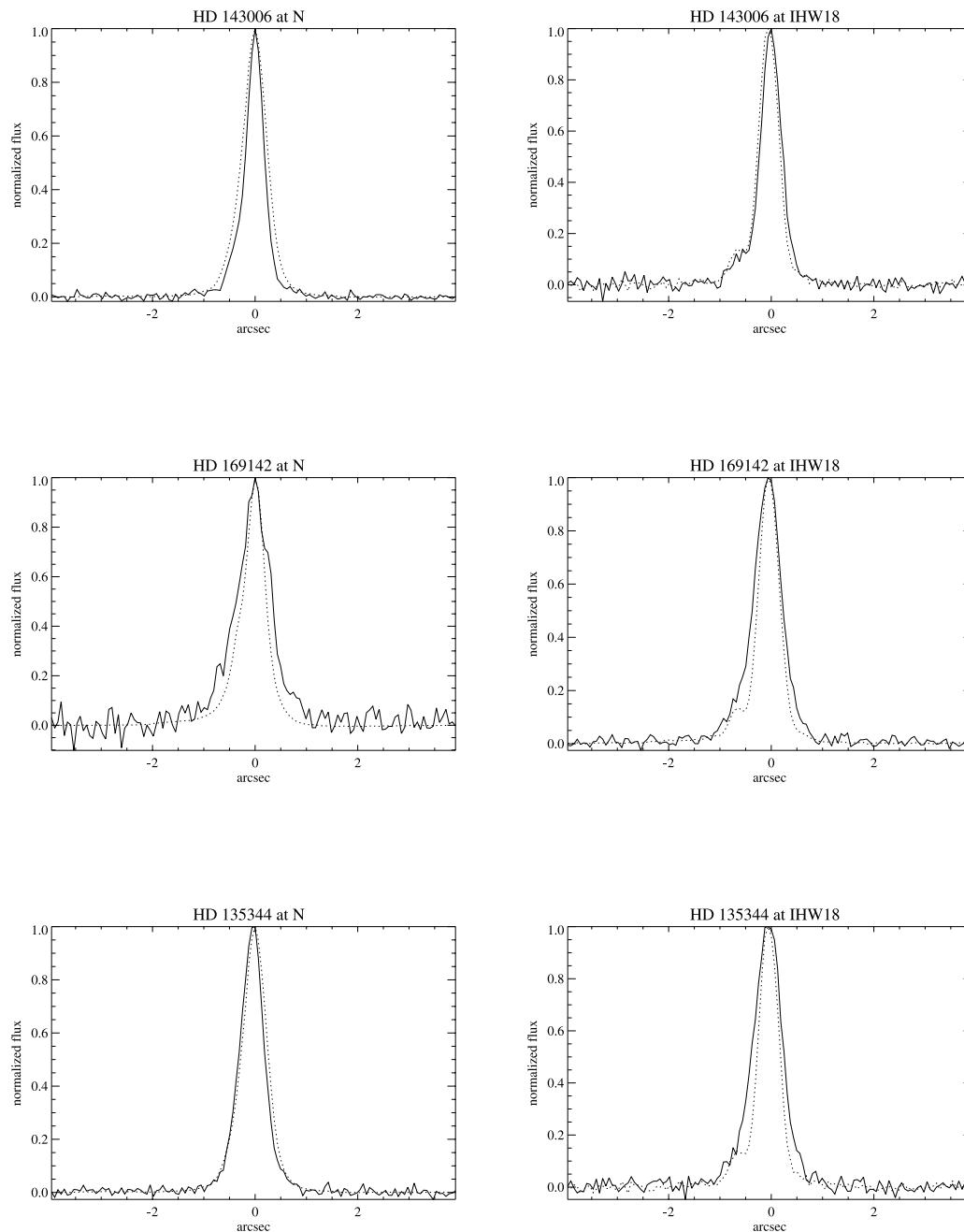


FIG. 1.—Scans through the target sources and the PSF stars. In all plots, the target is represented by the solid line and the PSF star by the dashed line.

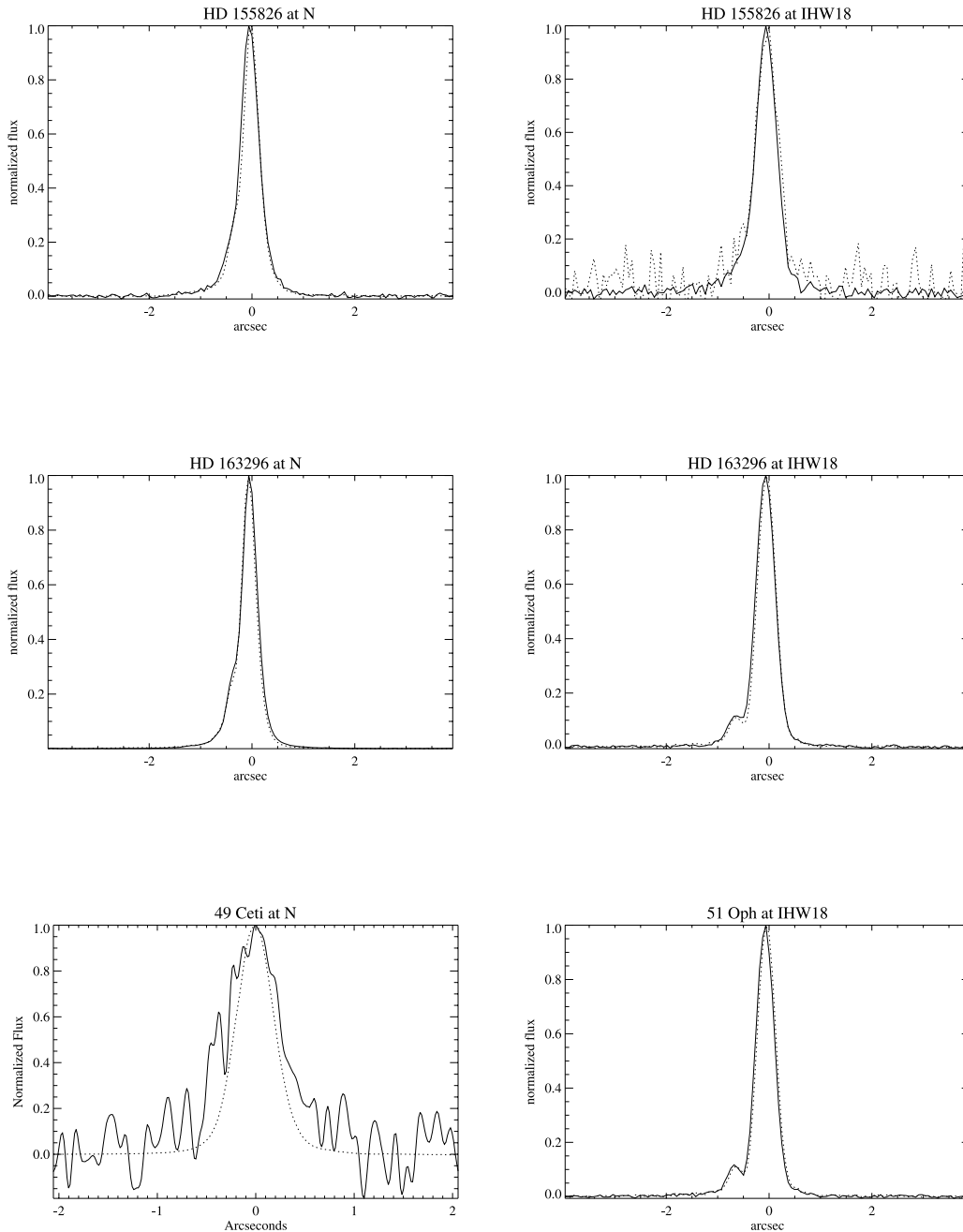


FIG. 1.—Continued

larly in the case of HD 169142 and HD 135344 the larger full-width at half-maximum may be the result of seeing effects because the integration time on the source was *much* longer than that on the PSF star. We discuss 49 Ceti in some detail in § 4.2.

We can use comparison with the PSF star to constrain the radius of the mid-infrared emitting region in each target. In addition, we also conducted the following experiment to derive a limit on the mid-infrared disk size: an image of a simple disk model with given inner and outer radii was convolved with the PSF and added to an appropriately scaled point source. The flux in the point source and the disk were determined from the observed stellar and excess emission in the *N* and IHW18 bands. By varying the outer radius, we were able to constrain the maximum radius the

disk could have without appearing to be more extended than the PSF star. Using this test as well as direct inspection of scans shown in Figure 1, we obtained constraints on the disk radii listed in column (6) of Table 4.

4. DISCUSSION

We derived mid-infrared excesses of our sample by subtracting the expected photospheric flux assuming $V-N$ and $V-[12]$ colors given by Kenyon & Hartmann (1995). Then, following Backman & Gillett (1987), we can write the fractional luminosity of dust as $\tau = L_{\text{dust}}/L_*$, where L_{dust} and L_* are the luminosities of the dust and the star, respectively. The τ values derived for our sample, based on long-wavelength excesses, range from $\sim 10^{-6}$ to $\sim 10^{-1}$ (see Table 4). For a flat, optically thick disk, the maximum value

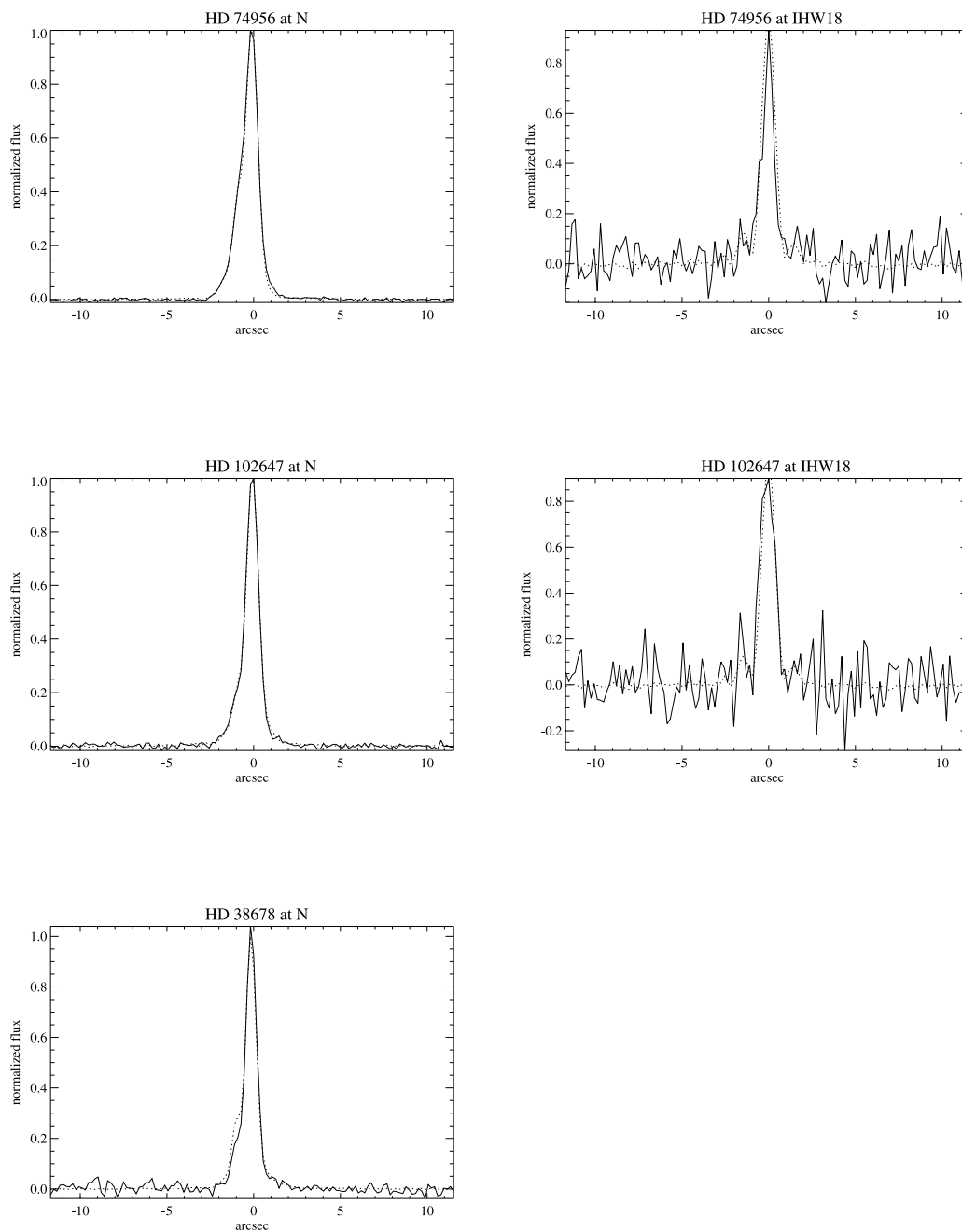


FIG. 1.—Continued

of τ is 0.25 while for a “flared” disk it could be roughly 0.5 (Kenyon & Hartmann 1987). The prototype Vega-like stars have $\tau = 10^{-5}$ – 10^{-3} , implying low optical depths at all wavelengths. A couple of stars in our sample have τ larger than the flat disk maximum. Such large infrared excesses require either an additional source of infrared emission or an alternate geometry for the dust (Sylvester et al. 1996). In fact, the fractional excess luminosities of several stars in our sample are similar to those of Herbig Ae/Be stars and T Tauri stars (Cohen, Emerson, Beichman 1989; Hillenbrand et al. 1992), suggesting that they may be at an evolutionary stage not far removed from these pre-main-sequence objects. (See § 4.1 for a more detailed discussion of one example, HD 35187.)

The long-wavelength excesses of all our targets can be fitted fairly well by a single-temperature blackbody; the dust temperatures derived from such fits are listed in column (3) of Table 4. A single-temperature fit, implying a single radial location for the material, is of course only schematic. Many combinations of radial density and grain size distributions can produce an SED that resembles portions of a Planck curve (Backman & Paresce 1993). Nevertheless, it is interesting to note that all but one of the objects have a dominant dust component with derived temperatures in the 70–150 K range. The exception is 51 Oph, which appears to harbor primarily hot circumstellar dust with a temperature of $\gtrsim 500$ K; we discuss it in more detail in § 4.3. Several of the other systems also require an addi-

TABLE 4
DERIVED PROPERTIES OF DUST DISKS

Name	τ	T_{dust} (K)	$D(p=0)$ (AU)	$D(p=1)$ (AU)	Radius Limit (AU)
(1)	(2)	(3)	(4)	(5)	(5)
49 Ceti	1.1×10^{-3}	70	92	1065	~ 90
51 Oph	2.8×10^{-2}	500	2	10	$\lesssim 65$
HD 35187	1.6×10^{-1}	150	18	138	$\lesssim 200$
HD 38678	7.1×10^{-5}	140	20	164	$\lesssim 30$
HD 74956	8.6×10^{-6}	140	23	188	$\lesssim 25$
HD 102647	1.9×10^{-5}	120	25	210	$\lesssim 20$
HD 135344	2.7×10^{-1}	110	9	64	$\lesssim 60$
HD 143006	3.7×10^{-1}	120	5	35	$\lesssim 50$
HD 155826	6.5×10^{-4}	110	9	68	$\lesssim 20$
HD 163296	9.8×10^{-2}	120	32	277	$\lesssim 60$
HD 169142	2.5×10^{-1}	95	30	277	$\lesssim 150$

tional warmer component to account for all of the excess at $\lambda < 12 \mu\text{m}$. The SEDs for two such cases are shown in Figure 2.

We can use our data in combination with the *IRAS* measurements to constrain the location and size of the dust particles in these Vega-like systems. If the grain emissivity varies as ν^p , where $p = 0$ corresponds to blackbody emission from large grains and $p = 1$ corresponds to emission from small grains, then, following Jura et al. (1993), we can write that at a distance from the star D , the grains reach a temperature T_{gr} , given by the relationship

$$D = 0.5R_*(T_*/T_{\text{gr}})^{(2+0.5p)}, \quad (1)$$

where R_* and T_* are the radius and temperature of the central star, respectively. This relation ignores dust scattering. We list the derived disk radii assuming $p = 0$ and $p = 1$ in columns (4) and (5) of Table 4. The radius limits from our imaging, listed in column (6), rule out $p = 1$ grains in most cases, and are consistent with the hypothesis that the grains act as blackbodies at wavelengths $\lesssim 60 \mu\text{m}$. However, realistic models of debris disks must include a distribution of grain sizes and compositions. Detailed modeling of the HR 4796A disk, for example, implies 2–3 μm

grains (Telesco et al. 2000) as well as a population of much larger particles (Augereau et al. 1999). In β Pic, the spectral form of the silicate feature suggests the presence of 2–3 μm grains (e.g., Aitken et al. 1993), while far-infrared/submillimeter fluxes provide evidence for larger grains (e.g., Zuckerman & Becklin 1993).

Notes on three particularly interesting objects follow.

4.1. HD 35187

HD 35187 (SAO 77144) is an A2/A7 binary at a distance of 150 ± 55 pc in Taurus. The *Hipparcos* catalog has (surprisingly) assigned the identifier “B” to the A2 star, which is the brighter, more northerly component; Dunkin & Crawford (1998) followed the same nomenclature, and we will too in order to avoid confusion. The two stars are separated by 1".39 with a position angle of 192° , and have similar V magnitudes ($V_B = 8.6$, $V_A = 8.7$).

Our near- and mid-infrared images make it possible for the first time to directly determine which star in the pair harbors the excess emission detected by *IRAS*. In the near-infrared, where the radiation is primarily photospheric, HD 35187B and HD 35187A have a flux ratio of ~ 1.6 . At 4.8, 10.8, and 18.2 μm , the primary becomes increasingly domi-

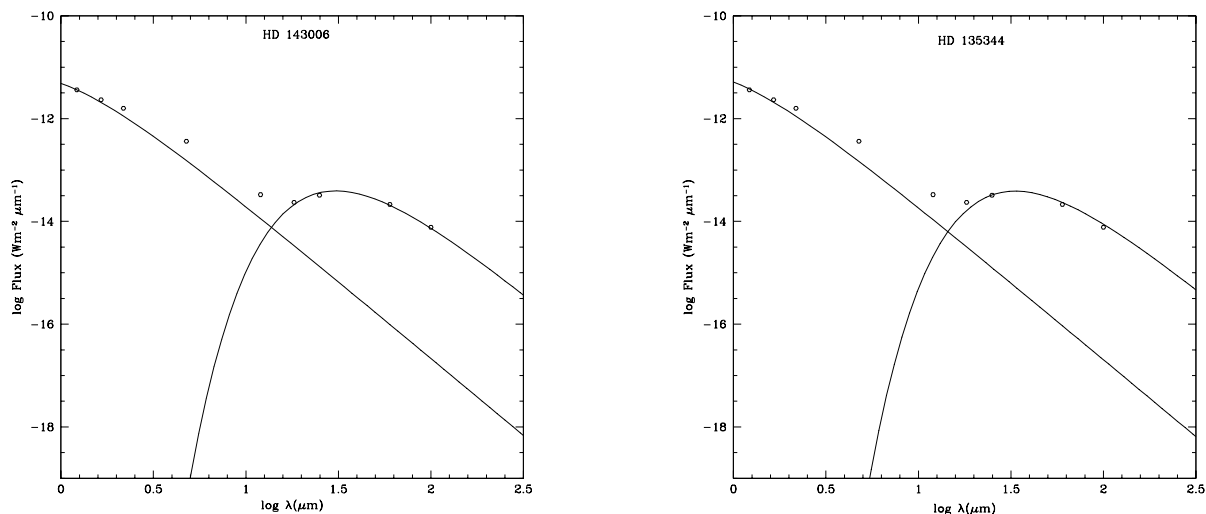


FIG. 2.—Spectral energy distributions of HD 143006 (left) and HD 135344 (right), with single-temperature blackbody fits to the photospheric emission and the far-infrared excess.

nant over the secondary, suggesting that most of the circumstellar dust in the system resides around HD 35187B.

This result is consistent with that of Dunkin & Crawford (1998) who obtained spatially resolved optical spectra of the individual stars. They detected net H α emission, circumstellar absorption lines, and significant circumstellar extinction for HD 35187B only, and they first suggested that the observed infrared excess is due to a disk surrounding the primary (B) alone.

Such “mixed” binary systems, where one star appears to have a circumstellar disk but the other does not, are rare among low-mass pre-main-sequence binaries (Prato & Simon 1997). However, a few examples have been found, particularly in systems which may be in transition from actively accreting classical T Tauri stage to passive remnant disks (e.g., Jayawardhana et al. 1999a).

The present disk configuration in HD 35187 could be either due to the details of binary formation or to the evolutionary histories of disks. Smoothed-particle hydrodynamics (SPH) simulations by Bate & Bonnell (1997) show that the fractions of infalling material that are captured by each protostar and the fraction that forms a circumbinary disk depend on the binary’s mass ratio and the parent cloud’s specific angular momentum, j_{infall} . For accretion with low j_{infall} , most of the infalling material is captured by the primary. For gas with intermediate j_{infall} , the fraction captured by the primary decreases and that captured by the secondary increases. For higher j_{infall} , more and more gas goes into a circumbinary disk instead of circumstellar disks. Thus, it could be that infall from a low- j_{infall} cloud led to a more massive disk around the primary in HD 35187. However, given their roughly equal masses (2.1 vs. 1.7 M_{\odot} ; Dunkin & Crawford 1998), it is not clear why one star would capture much more material than the other. One possibility is that, as protostars, the two components had very different masses, with what is now the primary accumulating most of its mass at the end of accretion. Another possibility is that there is a very low-mass, so far undetected close companion around HD 35187A, which accelerated the depletion of its disk.

There is some ambiguity about the evolutionary status of HD 35187. It has been classified as a Herbig Ae pair by some authors (Böhm & Catala 1995; Grady et al. 1996) and as a Vega-like system by others (Walker & Wolstencroft 1988; Sylvester et al. 1996). Both components of HD 35187 satisfy most of the criteria for Herbig Ae/Be stars, which are considered to be the higher mass counterparts to young T Tauri stars. The observed fractional infrared luminosity (L_{IR}/L_{*}) of 0.16 is also comparable to those of other well-known Herbig Ae/Be stars. On the other hand, both stars in the HD 35187 system lie very close to the zero-age main sequence on the Hertzsprung-Russell (H-R) diagram, at a *Hipparcos* distance of 150 pc (Dunkin & Crawford 1998). Furthermore, the SED of the system (Sylvester et al. 1996) reveals a dip near 10 μm , similar to that reported by Waelkens, Bogaert, & Walters (1994) for their sample of evolved Herbig Ae/Be stars. (Our flux measurements confirm a dip at 10 μm in the HD 35187 system: our *N*-band flux is only $3.4 \pm 10\%$ Jy compared with the *IRAS* 12 μm flux of 5.39 Jy.) Thus, HD 35187 is likely to be at an intermediate age between young Herbig Ae/Be stars and older “classical” Vega-like sources. This conclusion is consistent with its apparent age of 10 Myr, based on H-R diagram evolutionary tracks (Dunkin & Crawford 1998), and places it at an

interesting epoch in disk evolution (see Jayawardhana et al. 1999b).

4.2. 49 Ceti

49 Ceti was first identified as a candidate Vega-like source by Sadakane & Nishida (1986) when they searched the *IRAS* point-source catalog for Bright Star Catalog (BSC) members with significant 60 μm excess. As Jura et al. (1993) have pointed out, of the ~ 1500 A-type stars in the BSC only three have $L_{\text{IR}}/L_{*} > 10^{-3}$. One is 49 Ceti, and the other two are β Pictoris and HR 4796A, both of which have spatially resolved debris disks. Given its illustrious company and its relative proximity at 61 pc, 49 Ceti is naturally a prime target for any disk search. However, the low flux levels in the mid-infrared (F12 = 0.33 Jy, F25 < 0.41 Jy) make it a challenge to detect an extended disk; for example, if the observed *N*-band excess were distributed in a 100 AU radius disk, its surface brightness would be less than 2.5 mJy arcsec $^{-2}$, allowing at best a ~ 1 σ detection in our 120 s observation.

Our *N*-band image of 49 Ceti does not exhibit any obvious elongation, but there is tentative evidence for extended emission. Figure 1 shows normalized scans through 49 Ceti and the PSF star. The difference in the width of the source and the PSF star suggest that emission from 49 Ceti may be marginally resolved. It is possible that the effect is due to seeing. However, none of the other targets observed on the same night shows a similar effect (Fisher 2001). The observed source size is consistent with a $r \sim 50$ AU (i.e., $p \sim 0$) disk (see Table 4).

Recently Guild, Koerner, & Sargent (1999) have independently detected low-level extended emission at 18 μm around 49 Ceti. They derive an angular size of 1".5, consistent with our 10 μm observation, and a position angle of 40°, which is not well constrained by our data.

4.3. 51 Oph

51 Oph is a B9.5 Ve star with an unusually large mid-infrared excess; in fact, its *IRAS* 12 μm excess is 3.9 mag compared with 0.96 mag for β Pic (Coté & Waters 1987; Waters, Coté, & Geballe 1988). Based on similarities between the optical and ultraviolet lines from circumstellar gas around β Pic and 51 Oph, Grady & Silvis (1993) have suggested that the disk around 51 Oph should also be seen edge-on. However, 51 Oph is now known to be 6.8 times farther away than β Pic (i.e., 131 vs. 19.3 pc), and there is no definitive evidence yet that 51 Oph’s circumstellar dust is in a disk rather than a shell.

No extended disk is detected in our deep 18 μm image of 51 Oph at Keck, consistent with the pointlike appearance at 10 μm in observations reported by Lagage & Pantin (1994). Our data indicate that the surface brightness 1" from the center in all directions would have to be less than 2% of the peak flux. Mid-infrared spectroscopy has revealed that the 10 μm excess is in 51 Oph is resolved into a prominent, broad silicate emission feature that would seem to be associated with hot ($\gtrsim 500$ K), small dust particles (Fajardo-Acosta et al. 1993; Lynch et al. 1994). Our imaging observations, combined with the fact that the *IRAS* SED drops rapidly beyond 25 μm , strengthen the case for hot dust in close proximity ($r \lesssim 5$ AU) to the star, rather than a β Pic-like disk extending to well over 100 AU. Recently van den Ancker et al. (2001) have detected hot molecular gas and partially crystalline silicate dust in a spectrum of 51

Oph obtained by the *Infrared Space Observatory*, again highly unusual for a Vega-like system. One possibility, as van den Ancker et al. point out, is that 51 Oph is a Be star which underwent a recent episode of mass loss.

5. SUMMARY

We have carried out deep mid-infrared imaging observations of a sample of nearby main-sequence stars with *IRAS*-detected excess emission. We clearly resolve an extended disk in only one case (Jayawardhana et al. 1998). For 11 other systems, we derive constraints on the global properties of presumed dust disks, including fractional dust luminosity, characteristic temperature, disk size, and grain emissivity. Several systems in our sample have large infrared excesses compared with prototype Vega-like systems

and may therefore be somewhat younger. 51 Oph is unusual in having primarily a hot ($\gtrsim 500$ K) dust component. In the A2/A7 binary HD 35187, we find that only the primary harbors substantial dust emission. We may have marginally resolved the disk around 49 Ceti, but more sensitive observations are required for confirmation.

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