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Debris discs around nearby solar analogues

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ABSTRACT

An unbiased search for debris discs around nearby Sun-like stars is reported. 13 G-dwarfs at 12–15 parsec distance were searched at 850 μm wavelength, and a disc is confirmed around HD 30495. The estimated dust mass is 0.008 $M_\oplus$ with a net limit $\lesssim$0.0025 $M_\oplus$ for the average disc of the other stars. The results suggest there is not a large missed population of substantial cold discs around Sun-like stars – HD 30495 is a bright rather than unusually cool disc, and may belong to a few hundred Myr old population of greater dust luminosity. The far-infrared and millimetre survey data for Sun-like stars are well fitted by either steady state or stirred models, provided that typical comet belts are comparable in size to that in the Solar system.

Key words: circumstellar matter – planetary systems: formation.

1 INTRODUCTION

Debris discs represent the fallout of collisions of comets or asteroids around main-sequence stars. Showers of dust particles are continually regenerated, and these orbiting grains produce thermal emission from the mid-infrared to the millimetre, depending on the distances of the particles from the host star and so their equilibrium temperatures. The Sun's Kuiper belt of comets would be a very faint example of the phenomenon if viewed externally, but much brighter exosystems are known, which must be supported by belts of colliding bodies that are more populated and/or more perturbed.

A number of (sub)millimetre surveys have looked at nearby solar analogues to see if massive belts of comets could be common (Wyatt, Dent & Greaves 2003; Holmes et al. 2003; Liu et al. 2004; Carpenter 2005; Najita & Williams 2005; Williams & Andrews 2006). The debris is expected to be cool if these belts lie at tens of au outwards and are heated by stars of $\sim$1 $L_\odot$, so long wavelength emission is expected. Discs were detected with moderate frequency for stars a few hundred Myr old, but no new detections were made for ages comparable to the Sun's 4.5 Gyr. However, the sampling of mature stars is poor and the larger studies have only reached sensitivities of a few mJy around 1 mm (Matthews et al. 2007).

Thus, the prevalence of cool dust around solar analogues remains unknown. Of particular interest are a few examples of discs of Sun-like stars with dust thought to be cooler than 40 K (Holmes et al. 2003; Wyatt et al. 2003; Najita & Williams 2005; Liseau et al. 2008). These could have escaped detection in the recent *Spitzer* 24–70 μm surveys that have discovered new debris discs around Sun-like stars, as such cold dust has low contrast with the stellar photosphere. Large cool discs are interesting as they may still be evolving – Kenyon & Bromley (2008, equation 41) predict that for discs exceeding 200 au in radius, 1000 km bodies would form later than the Sun's present age of 4.5 Gyr, and these could create late debris showers by perturbing the comet belt. Debris is in fact seen in systems as old as 10 Gyr, in the nearby case of τ Ceti (Greaves et al. 2004).

We have thus searched a small sample of local solar analogues to look for cold debris. This is the first such unbiased survey in the submillimetre – based only on distance, without pre-selection from stellar age, multiplicity or evidence of far-infrared excess – and is a pre-cursor to the Submillimetre Common-User Bolometer Array 2 (SCUBA-2) Legacy Survey of nearby stars (Matthews et al. 2007). Here, we present the results on masses of cold dust around nearby G-dwarfs and make some comparisons with recent models.

2 SURVEY DATA

The SCUBA camera on the 15 m James Clerk Maxwell Telescope (JCMT) was used to survey G-dwarf (luminosity class V or IV–V) stars at distances of 10–15 pc. The initial selection was made from the NStars Spectra online catalogue,[1] yielding 29 stars. Eliminating four objects unsuitable for the JCMT in Hawaii (with Dec. $<-40°$) and 11 sources clashing in scheduling with a cosmology programme (RA around 0–4, 9–15 h) left 14 targets. All of these were observed except for HD 75732 (55 Cnc) which already has a deep SCUBA limit (Jayawardhana et al. 2002). The distance range[2] of the final 13

[1] http://nstars.nau.edu/, http://stellar.phys.appstate.edu/

[2] At closer distances, there are 12 further G-dwarfs, but these were omitted because any large discs would overfill the effective photometric beam. These stars include one known debris disc, HD 10700 (τ Ceti), and debris candidate HD 131156 (Decin et al. 2003; Holmes et al. 2003).

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Table 1. Star and disc properties.

Star (HD)	Flux (mJy)	Dust mass ($M_\oplus$)	Type	Distance (pc)	Age (Gyr)	[Fe/H]	Notes
30495	5.6 ± 1.7	0.008	G3 V	13.3	0.45	+0.01	*ISO* and *Spitzer* disc
34411	$+0.6 \pm 2.2$	$\leq$0.009	G0 V	12.6	4	+0.12	
72905	$+1.7 \pm 1.7$	$\sim$0.002*	G1.5 V	14.3	0.15(–0.5)	–	*Spitzer* disc (*mass if dust at 60 K)
140538	-1.1 ± 1.4	$\leq$0.007	G5 V	14.7	4	+0.08	$m_V = 12$ companion at 4 arcsec
141004	$+1.7 \pm 2.4$	$\leq$0.008	G0 V	11.8	3–6	+0.05	
144579	-1.8 ± 1.2	$\leq$0.006	G8 V	14.4	6	−0.69	$m_V = 14$ companion at 70 arcsec
146233	-1.5 ± 2.1	$\leq$0.010	G1 V	14.0	4	+0.03	'Solar twin' (Soubiran & Triaud 2004)
147513	$+0.8 \pm 2.0$	$\leq$0.008	G3/5 V	12.9	(0.5–)0.6	+0.09	Planet of $\geq 1\ M_{\mathrm{Jup}}$ (Mayor et al. 2004) White dwarf companion at 345 arcsec
157214	-1.2 ± 1.2	$\leq$0.006	G0 V	14.4	4	−0.36	
160269	$+0.8 \pm 1.7$	$\leq$0.008	G0 V	14.1	(0.5?)	–	Triple: K3 V, M1 V at 1.5, 740 arcsec
172051	$(+7.6 \pm 2.1)$	–	G5 V	13.0	4	−0.26	
176051	-0.7 ± 1.4	$\leq$0.008	G0 V	15.0	2.5	–	$m_V = 8$ companion at 1.2 arcsec
196761	$+1.5 \pm 1.3$	$\leq$0.007	G8/K0 V	14.6	5	−0.28	
75732	$\sim 0 \pm 0.4$	$\leq$0.002	G8 V	12.5	8	+0.31	SCUBA data: Jayawardhana et al. (2002) five planets of $\geq$0.03–3.8 M_{Jup} (Fischer et al. 2007) $m_V = 13$ companion at 85 arcsec

Note. The mean and 1σ error from 3σ-clipped photometry at 850 μm are quoted except for the summed flux of HD 30495. Dust masses and 3σ limits are for 60 K grains with emissivity of 1 cm^2 g^{-1}; HD 72905 is scaled from HD 30495 assuming the millimetre flux ratio equals the 70 μm excess-flux ratio of 0.25 (Trilling et al. 2008). HD 172051 is background contaminated (see the text), so no mass is given. Spectral type and multiplicity information are from the NStars data base, and metallicities (log abundance of iron versus solar) are from Valenti & Fischer (2005). Stellar ages are from Barnes (2007) or via the same gyrochronology method using $B - V$ and estimated rotation periods from Wright et al. (2004); bracketed values of 0.5 Gyr are for candidate members of the UMa moving group (King et al. 2003).

targets was actually narrower, only 12–15 pc, making very uniform sensitivity to dust mass possible.

Because the survey is unbiased apart from co-ordinate bounds, the stars have typical G-dwarf properties (Table 1). Six of the stars are in multiple systems where any comet belts could be perturbed (Trilling et al. 2007), and two have known giant planets. The stellar metallicities are one-fifth to twice solar, and the stellar ages span the main-sequence range for G-dwarfs. These ages adopt the accurately calibrated gyrochronology (spin-down) method of Barnes (2007) with most having similar estimates from isochrones or chromospheric activity (Nordstrom et al. 2004; Wright et al. 2004; Takeda et al. 2007). Most of the stars are a few Gyr old, with a slight enhancement of sub-Gyr objects compared to a random population with $\sim$10 Gyr lifetimes, due to the existence of local associations. In particular, HD 160269, 72905 and 147513 are possible members of the 0.5 Gyr old Ursa Major moving group (King et al. 2003).

2.1 Observation methods

The stars were observed in extended photometry mode (Sheret, Dent & Wyatt 2004), which is a compromise in observing speed between staring at one point and full mapping, for a detector array which undersamples the sky. The central SCUBA 850 μm bolometer observed a pattern of points around each star, at offsets of 1 and 7.5 arcsec. With the 15 arcsec (full width half-maximum) diffraction-limited beam, this mode collects a significant fraction of the flux from a disc extending up to 15 arcsec from the star, i.e. up to approximately 200 au radius for stars at 12–15 pc distance.

Integration times were 1.4–3.4 h per star, summing to 36 h and requiring nearly 70 h at the telescope. The observing campaign ran from 2003 July to 2005 May, over 17 nights. All of the stars except two (HD 34411 and 146233) had observations on more than one night. Good to moderate conditions were used, with zenith sky opacities at 850 μm of 0.23 to 0.52. Data reduction was performed using the ORACDR pipeline (Jenness et al. 2002) plus custom IDL routines (Wyatt et al. 2005), including extinction corrections from skydips on each night and applying a flux conversion factor (FCF) of 307 Jy V^{-1} per beam (with a 1σ spread of $\pm$34 Jy V^{-1} per beam over the 13 nights with FCF measurements). This conversion factor was derived from point-like calibrator sources observed using the same extended photometry mode, and is higher than for normal on-source photometry, as two-thirds of the time is spent looking at the half-power points of the calibrator. For any extended discs, the true flux will be underestimated, but less so than for normal photometry because of the greater spatial coverage (Sheret et al. 2004, table 3).

3 RESULTS

The fluxes are listed in Table 1, and each data set was also examined as an image to search for any disc-like structure. No new discoveries were made among the 13 stars observed, but the *Infrared Space Observatory* (*ISO*) and *Spitzer* excess of HD 30495 is confirmed as a debris disc by SCUBA (Fig. 1). The total photometric flux is 5.6 $\pm$ 1.7 mJy (assuming a point-like morphology), to which the photosphere contributes a negligible $\approx$0.15 mJy. The disc is oriented at a position angle of approximately -12°, and adding up all data points in two quadrants around this major axis and within 10 arcsec of the star gives a flux of 4.9 $\pm$ 1.2 mJy, compared to only 0.7 $\pm$ 1.2 mJy for the two minor-axis quadrants. We infer that the disc is seen rather edge-on, and is also marginally extended as the flux density at 7 arcsec along the major axis is 4.8 $\pm$ 2.0 mJy beam^{-1}, similar to 4.3 $\pm$ 2.0 mJy beam^{-1} for the 1 arcsec points. The

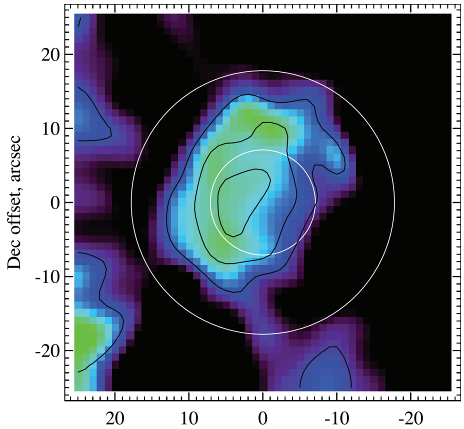

Figure 1. Disc image for HD 30495. Colour scale shows the mean of all measurements within 7 arcsec of the pixel, further smoothed by a 4 arcsec Gaussian. Black contours represent corresponding signal-to-noise ratio (S/N) at levels of 1, 2 and 3. The inner white circle delineates the beam of the central bolometer, and points from here to the outer circle are interpolations, as the first ring of bolometers samples only from this radius, i.e. ≥18 arcsec.

under-sampled data (Fig. 1) may not capture all the disc flux, but the estimate of 5.6 ± 1.7 mJy is roughly consistent with the flux pattern over the quadrants.

The interpolated image of HD 30495 suggests the major axis covers up to 25 arcsec diameter, which after deconvolution from the 15 arcsec beam implies dust extends out to about 10 arcsec or 130 au radius. In resolved images, $r_{\rm disc} \sim 100$–150 au is typical for F, G and K stars (e.g. Kalas et al. 2006). The rather edge-on orientation is consistent with the estimated stellar inclination, assuming the star and disc are coplanar: from the stellar rotation period, radius and $v \sin i$ (Gaidos, Henry & Henry 2000; Valenti & Fischer 2005), the value of i is approximately 50°–75°.

The spectral energy distribution (SED) for HD 30495 (Fig. 2) implies dust at approximately 57 K, similar to the 70 K estimated by Zuckerman & Song (2004) based on the far-infrared SED. The disc is observed to be larger than the radius of 20 au inferred for a black-body SED (Zuckerman & Song 2004), suggesting some

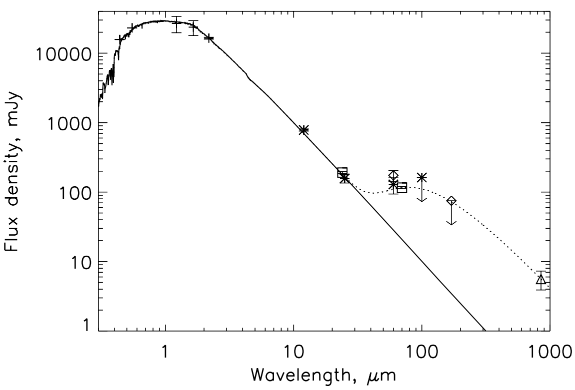

Figure 2. SED for HD 30495. The solid line is a Kurucz model for a G3 star scaled to the Two-Micron All-Sky Survey (2MASS) *K*-band flux, and the dotted line adds a 57 K blackbody with $L_{\rm IR}/L_* = 4 \times 10^{-5}$. The + symbols are *B*, *V* and *JHK* measurements from Tycho and 2MASS; ∗ symbols are *IRAS* fluxes from SCANPI (colour corrected for the photospheric spectrum); diamond and square symbols represent *ISO* and *Spitzer*, respectively. Upper limits are 3σ.

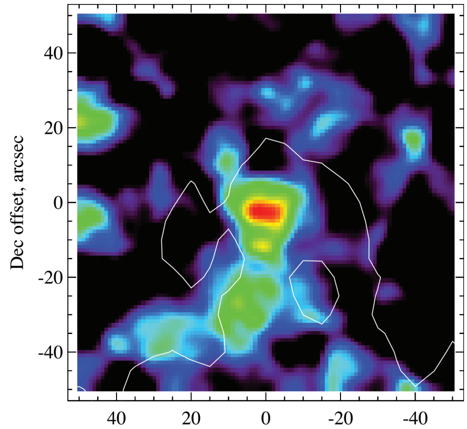

Figure 3. SCUBA image of HD 172051 but in S/N units (for clarity in displaying unevenly sampled data). Colour scale is from 0 to 4, with yellow roughly at 3σ. The white contour (arbitrary level) is from a 70 μm *Spitzer* image of the same region.

greybody emission where particles that are inefficient emitters lie further from the star at equivalent temperatures (e.g. Sheret et al. 2004).

A positive signal was also found towards HD 172051 (Fig. 3). However, the structure is not disc like but more extended, and is approximately matched by a contour from *Spitzer* 70 μm data (Beichman et al. 2006a). In this larger image, widespread emission is seen that extends towards the Galactic plane. Since this star is within 15° of the Galactic Centre, the signal could be from molecular clouds, and there is no compelling evidence of a disc contribution to the flux at either wavelength.

All of our target stars have now been searched with *Spitzer* for debris discs, using Multiband Imaging Photometer for *Spitzer* (MIPS) at 24 and 70 μm wavelengths. (Archived data for HD 140538, 141004, 160269 and 176051 are not yet published but do not show any obvious cool excesses.) Of the 12 objects with SCUBA limits, one has a debris detection: HD 72905 has dust emission over wavelengths of at least 25–70 μm (Beichman et al. 2006b; Bryden et al. 2006; Trilling et al. 2008). This has been interpreted as arising from warm and cool planetesimal belts, with the SCUBA upper limit suggesting $T \gtrsim 40$ K for the cool dust.

3.1 Disc properties

The incidence of cool moderately massive debris discs is not high, since we detect only one example among 13 Sun-like stars (∼8 per cent). HD 30495 appears to be detectable in the submillimetre mainly because the disc is bright (e.g. 95 mJy at 70 μm versus 24 mJy for HD 72905) rather than because it has cold dust that is better matched to long wavelengths.

Table 1 lists the upper limits to debris masses, assuming an emissivity of 1 cm^2 g^{-1} and 60 K grains as for HD 30495 (adopting e.g. the 40 K lower limit from HD 72905 would increase the masses by 50 per cent). For the majority of the G-dwarfs, any debris must be below a level of about 0.01 $M_\oplus$ or about a lunar mass. Somewhat larger masses could exist in very distant cold dust belts without exceeding either SCUBA or *Spitzer* upper limits.

Lower mass limits can be reached by co-adding the data for 10 fields without disc or background emission (Table 1), yielding a net 850 μm flux of −0.3 ± 0.5 mJy. Thus, no dust (or photospheric emission) is found on average around these 10 stars. The 3σ dust upper limit of 1.5 mJy implies that the mean disc around these stars comprises less than 0.0025 $M_\oplus$, for 60 K grains and representative distance ≈14 pc. This limit is below the dust masses for nearly all the sub-mm-detected debris discs around Sun-like hosts (Wyatt 2008), while the 0.008 $M_\oplus$ of material around HD 30495 is within the typical range of a few thousandths to a tenth of an Earth mass of dust (Wyatt 2008, fig. 3). There is a marginally positive signal of +2.0 ± 0.9 mJy for all the four sub-Gyr sources averaged together, versus a null signal of −0.6 ± 0.6 mJy for eight older objects, suggesting a possible decline of dustiness with age, as discussed further below.

The disc luminosities and limits here are similar to those from far-infrared data. Converting the 850 μm fluxes to fractional luminosities (Beichman et al. 2006a, equation 4), $L_{\rm dust}/L_*$ is 4×10^{-5} for HD 30495, similar to HD 72905 at 3×10^{-5} (Beichman et al. 2006b), while the SCUBA limits for the older stars correspond to $\lesssim 2$–6×10^{-5}. For the co-add of the 10 blank SCUBA fields, $L_{\rm dust}/L_*$ is $\lesssim 1 \times 10^{-5}$ for a typical stellar effective temperature of 5800 K.

4 DISCUSSION

The SCUBA survey has shown that the debris disc population cannot be greatly boosted by previously missed cold discs of moderate mass. Only one disc was found in an unbiased sample of 13 nearby solar analogues, and the dust temperature of around 60 K is high enough to also yield prominent far-infrared excesses for this star (Habing et al. 2001; Trilling et al. 2008). Combining the new SCUBA results with earlier millimetre surveys for debris around FGK dwarfs (Wyatt et al. 2003; Holmes et al. 2003; Sheret et al. 2004; Najita & Williams 2005; Williams & Andrews 2006), in total 33 Sun-like stars $\gtrsim$ 150 Myr old have now been observed, spanning the epoch after terrestrial planet formation (e.g. the latest age of Earth completion; Touboul et al. 2007) up to the end of the main sequence. There are seven debris candidates[3] and five also have confirmed far-infrared excesses. The far-infrared to millimetre fluxes have been fitted successfully with grain temperatures ranging from 50 to 100 K, so there is no indication of additional debris in very cold and distant comet belts for these stars. Thus, although there are some systems with evidence of dust below 40 K (e.g. Wyatt et al. 2003), this appears to be uncommon around solar analogues.

Most millimetre detections have been made towards young stars. Dividing the 33 objects into two broad age bins of width 1 dex around 500 Myr and 5 Gyr (to reduce the effects of uncertain dating), there are up to six debris detections (two tentative) out of 13 stars in the younger group, compared to only 1/20 in the older set. With Poisson counting errors, the detection rate then nominally declines from (30–45) ± (15–20) to 5 ± 5 per cent for stars an order of magnitude older. However, the counts are skewed because some projects targeted more young stars and/or prior debris candidates. Hence, the true incidences are likely to be lower, and the trend with time may be partly forced by deeper searches towards targets thought more likely to yield detections. For example, four of the seven young prior debris candidates have possible millimetre detections, but these were also some of the deepest observations made in the respective surveys (Holmes et al. 2003; Sheret et al. 2004; Williams & Andrews 2006). In general, a decline of dustiness with age is plausible, especially as the fraction of prior debris candidates (≈55 per cent) happens to be the same in both the young and old samples, reducing one source of bias. Also, the oldest millimetre detection is HD 48682 at only ∼3 Gyr, suggesting that stars several Gyr old may tend to be millimetre faint.

One hypothesis is that high debris levels could be associated with an early epoch while lower levels of dust do not have such behaviour – e.g. Greaves & Wyatt (2003) noted that bright (*IRAS* detected) debris is marginally more common among G-dwarfs under 1 Gyr old compared to older stars. To re-assess this hypothesis, we looked at far-infrared surveys of Sun-like stars and compiled literature results into the same broad age bins around 500 Myr and 5 Gyr (Fig. 4). Earlier observations with *ISO* of stars in the 500-Myr-old UMa moving group (Spangler et al. 2001) were added to improve the statistics in the young bin; there are three far-infrared debris detections (for HD 125451, 139798, 184960) among 14 additional Sun-like stars observed. Fig. 4 confirms that dust luminosity derived from far-infrared excess is on average somewhat higher in the younger group. The millimetre systems also appear to be representative of this luminous young group, with the four robust detections with good dust temperature estimates yielding $L_{\rm dust}/L_{\rm star} \approx 5$–$8 \times 10^{-5}$ from the millimetre fluxes.

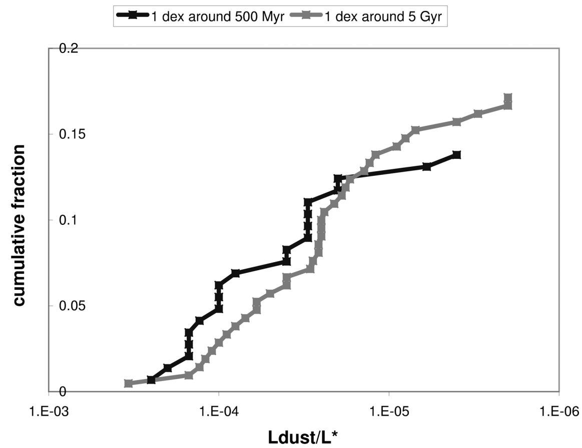

Figure 4. Cumulative $L_{\rm dust}/L_*$ from far-infrared data for Sun-like stars, in 1 dex wide bins at 500 Myr and 5 Gyr containing 139 and 210 stars, respectively. Data are from the age-selected FEPS project (Carpenter et al. 2008) and volume-limited surveys (Beichman et al. 2006a; Trilling et al. 2008) with *Spitzer* plus an *ISO* search of the UMa moving group (see the text). Some luminosities are lower limits (e.g. single-wavelength detection), and low values are incomplete, especially for *ISO*/FEPS at $\lesssim 10^{-5}$, contributing ≈80 and 20 per cent of targets in the young and old bins, respectively.

4.1 Comparison to models

In general, the Sun-like stars observed in millimetre surveys do not show cold dust, nor are there debris detections later than about 3 Gyr. This suggests that large late-evolving comet belts are uncommon, such as those that could be stirred by formation of distant dwarf planets at several Gyr ages (Kenyon & Bromley 2008). While there are examples of both very large discs (Williams et al. 2004; Liseau et al. 2008) and very old debris hosts (Greaves et al. 2004), neither appears to be the norm among Sun-like stars observed at millimetre wavelengths.

To determine typical disc properties, we compare recent (semi-) analytical models that predict the evolution of debris with time

[3] These stars are HD 8907, 30495, 38393, 48682, 109085, 131156 and 206893. HD 38393, 131156 and 206893 are only at ≈2.5σ–3σ confidence in the millimetre and the first two having *ISO* excesses not confirmed by *Spitzer*. Other Sun-like stars from individual studies also have millimetre debris detections (see Wyatt 2008 for a summary).

under various scenarios (Dominik & Decin 2003; Löhne, Krivov & Rodmann 2007; Wyatt et al. 2007; Kenyon & Bromley 2008; Krivov et al. 2008); see Wyatt (2008) for a summary.

(i) In *steady state* evolution, the fractional luminosity of debris declines slowly as the parent population of planetesimals is ground to dust that is blown out of the system. The dust is brightest early on and then fades after a time that is shortest in compact and/or massive discs, because of the greater planetesimal collision rates. Examples of models that fit the present data well (Wyatt 2008, fig. 5) are discs of 30 au radius with initial masses up to 1 $M_\oplus$ in colliding bodies. If the majority are lower mass systems (e.g. 0.1 $M_\oplus$) then these are never detected as $L_{\rm dust}/L_{\rm star}$ is always below 10^{-5}, while the highest mass discs have $L_{\rm dust}/L_{\rm star}$ of a few 10^{-5} at around 500 Myr but declining to $<10^{-5}$ after around 3 Gyr. These trends match most features of the data, including greater dust luminosity in the sub-Gyr stars.

(ii) In contrast, in models where the planetesimals are *stirred* by gradually forming larger bodies (from 1000 km sizes up to giant planets), debris can brighten from an early low state and then fade at a similar rate to steady-state models. These systems tend to be more luminous than we observe unless the initial disc mass is much less than in the Minimum Mass Solar Nebula (Wyatt 2008, fig. 5). For millimetre and far-infrared debris detections to be made mainly for younger stars, discs should generally be compact, e.g. 70 au in radius (Kenyon & Bromley 2008, fig. 16), as larger discs will stay bright beyond 1 Gyr.

(iii) Finally, in discs stirred by *migration* of giant planets, there can be an abrupt dust shower as these bodies cross an orbital resonance with the comet belt, and very little debris later as the belt is depleted. Gomes et al. (2005) find that the migration of Jupiter and Saturn could have stirred the Kuiper belt thus causing the late heavy bombardment of the Earth at around 0.7 Gyr, while Thommes et al. (2008) simulate this for different planetary system architectures and find equivalent events before ∼0.3 Gyr. However, this is unlikely to be a general phenomenon as debris would not be seen at all at few Gyr ages when the comet belts would be severely depleted. Further, the 70 μm excess is predicted to increase only slightly during such events and the dusty episode would last $\lesssim$20 Myr (Booth et al. 2009). Thus, at most a few per cent of stars in the ∼500 Myr bin should be undergoing heavy bombardment episodes when observed, and even fewer if only up to ≈20 per cent of Sun-like stars host giant planets (Cumming et al. 2008).

4.2 Disc populations

In general, the low debris incidence at all ages and the mild decline in luminosity at a few Gyr require initial planetesimal discs of low mass, and of radius similar to the ≈50 au of the Solar system. The stirred models have a distinctive brightening at early times ($\sim 10^{7-8}$ yr) that the steady-state models do not, and the somewhat raised incidence of 70 μm excesses among Formation and Evolution of Planetary Systems (FEPS) stars at $10^{7.5-8}$ yr (Hillenbrand et al. 2008, ∼20 per cent) could favour this class of interpretations. Bright debris systems undergoing resonance crossing in planetary migration are likely to be too few to be observed as a distinct subset among current surveys.

Resolved debris discs of Sun-like stars (Kalas et al. 2006; Wyatt 2008) are probably unusually large if most systems possess Solar system sized comet belts. For five precise (G2 V) solar analogues, the fitted disc radii are ∼100–200 au (Krivov et al. 2008), also suggesting that the larger, more luminous, discs currently dominate the detected population. To place the Sun's compact, low-dust, Kuiper belt more accurately within the context of extrasolar debris systems requires deeper observations, and the results here are preliminary given the small sample size. The SCUBA survey was the first unbiased exploration of G-dwarfs in the submillimetre, and the upcoming SCUBA-2 survey (Matthews et al. 2007) will observe 100 G-dwarfs (as well as equal numbers of A, F, K and M stars), and address the models and evolutionary time-scales in more detail.

5 CONCLUSIONS

This small unbiased survey for debris around solar analogues suggests that cold bright dust belts are rare, especially for stars of typical few Gyr ages. The majority of stars should begin with insubstantial comet belts of dimensions similar to the Sun's Kuiper belt, with moderate dust luminosity only for about the first Gyr of main-sequence lifetime. If these systems fade slowly with time as predicted in models, counterparts of Sun-like age should be detectable in the far-infrared to submillimetre with near-future SCUBA-2 and Herschel observations.

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