A *Spitzer* Survey for Debris Disks in Binary Star Systems. J.A. Stansberry[1], K.R. Stapelfeldt[2], D.T. Trilling[1], K.Y. Su[1], G.H. Rieke[1], C. Chen[3]. [1]Steward Observatory, University of Arizona, Tucson AZ 85721 (stansber@as.arizona.edu), [2]JPL, 4800 Oak Grove Dr., Pasadena CA 91109, [2]NOAO, 950 N. Cherry Av., Tucson AZ 85719 .

Introduction: We have completed a photometric survey of 69 nearby binary stars using the Multiband Imaging Photometer for *Spitzer* (MIPS). The purpose of the survey was to look for excess thermal emission from dusty debris disks in such systems, and to sample a range of physical separations to probe whether that had a measurable impact on the occurrence of debris disks. Here we report initial results from the survey; and expect to submit a paper in the near future. It is clear that disks do occur in young binary systems (*e.g.* [1], [2]), and that those disks lead, in some cases, to the formation of planets (*e.g.* [3, [4]).

This study is one of several *Spitzer* Guaranteed Time surveys for debris disks around nearby stars. Taken together, these surveys probe the occurrence of debris disks as a function of spectral type/mass, age, and multiplicity, and the presence of planets. Results from other components of this group of surveys are presented at this conference by Su *et al.*, Stapelfeldt *et al.*, Trilling *et al.*, Marengo *et al.*, Muzerolle *et al.*, Siegler *et al.*, Velusamy *et al.*, and Young *et al.* Related results stemming from the FEPS legacy survey are presented by Kim *et al.*, Silverstone *et al.*, Pascucci *et al.*, and Bouwman *et al.*

Sample: Our sample consists of 69 binary systems within *75 pc* of the Sun. *Spectral types* (from SIMBAD) are in the range *A3V – F8V*. Where possible we used the spectral type, or the magnitude contrast, of the companion to limit our survey to companions of type K2 or earlier. This was done in order to limit the mass-ratio of the system. We chose to limit the range of *physical separations* of the components to *0 – 200 AU*. The *ages* of the systems for which we have information (2/3 of the total at the moment) are in the range *0.9 – 2 Gy*.

Observations and Data Analysis: All targets were observed at *wavelengths of 24 and 70 μm*. The data were taken in in photometry mode, which images an area roughly 5'x5', and dithers the target at many positions on the array. The photometric repeatability on calibrators observed in this way is about 2% at 24 μm, and about 5% at 70 μm. The absolute calibration of the two bands is currently thought to be 5% and 15%. All data were reduced, calibrated, and mosaicked using the MIPS instrument team data analysis tools [5].

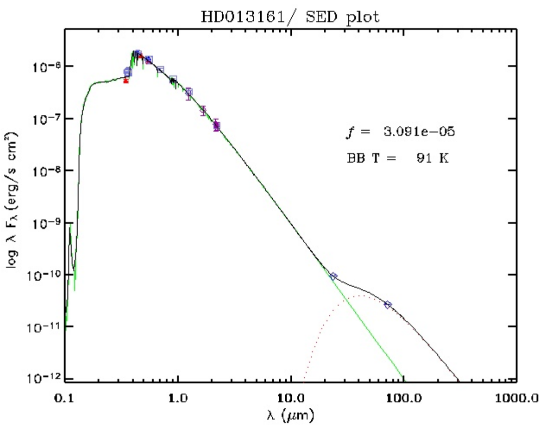
Fluxes were measured using aperture photometry with the IDL routing aper. Typical aperture sizes extended to the first Airy minimum of the PSF, with a sky annulus that excluded the first Airy maximum. At 24 μm the PSF FWHM is 6.5", and at 70μm it is 20". The apparent separations for all but 2 of our target systems are smaller than the 24 μm FWHM, so we measure *system integrated fluxes*.

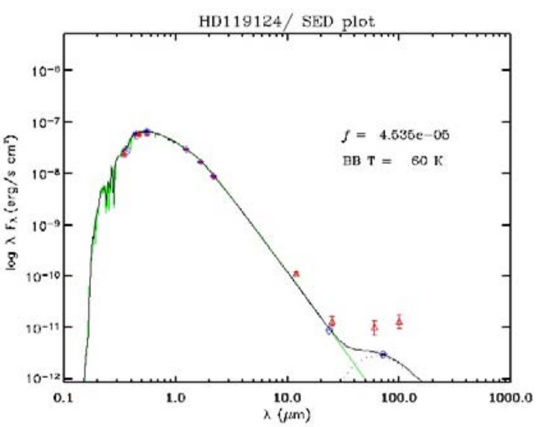
Photospheric Predictions: In order to look for excess thermal emission from dust in these systems, it is necessary to predict how bright the photospheres are in our bands. We used Kurucz models fitted to available UV – near-IR photometry to make these predictions. Near-IR photometry is particularly useful for this, so we combined 2MASS JHK magnitudes into a single "super-K" data point using the standard IR colors for our stars from [6]. We checked our Kurucz model predictions by extrapolating these super-K magnitudes to 24 μm, and found excellent agreement between the two methods. The intrinsic SNR of our detections, the accuracy of the absolute calibration, and our ability to predict photospheric fluxes in the MIPS bands all limit our ability to detect excess emission due to dust. Taking all of these factors into account, we feel that we can confidently identify excess emission at 20% above the photosphere at 24 μm, and at 50% above the photosphere at 70 μm.

Results: The figures below show Kurucz models fitted as just described for two systems that display excess far-IR thermal emission from dust.

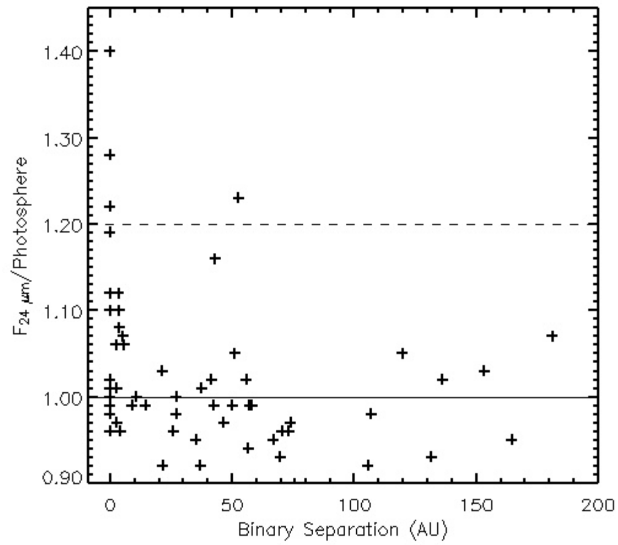
HD 13161: The physical separation is < 5AU (it is a spectroscopic binary, located 38 pc from the Sun). Its dust emission is characterized by a weak 24 μm excess (28% above the photosphere), and a strong 70 μm excess (about a factor of 10 above the photosphere. Error bars, which are very small on this scale, represent only the intrinsic SNR of the detection, and not the uncertainty in the absolute calibration. The excess emission can be represented by a c. 100K blackbody, indicating that the dust is located roughly 10 – 20 AU from the stars: this dust is likely to be in a circumbinary ring.

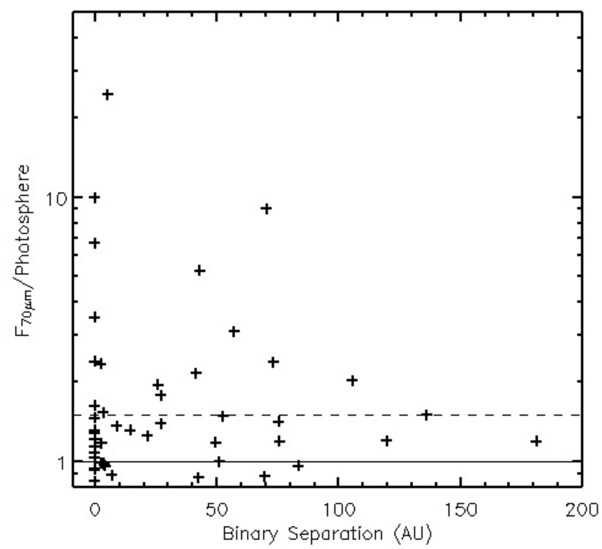
HD 119124: The physical separation is 71 AU (it is a visual binary located 25 pc from the Sun). It lacks any 24 µm excess, but has a strong excess at 70 µm (9 times above photospheric). The emission can be represented by a 60K or colder blackbody, indicated that the dust could be located about 40 AU from one of the stars, or could be in a circumbinary ring. The fractional luminosity of the disk is estimated to be $3x10^{-5}$ of the combined luminosity of the stars. The *Spitzer* photometry for this star also show a marked difference from th IRAS photometry, with our fluxes being considerably lower than the comparable IRAS data.





The next figure summarizes the ratio between our observed fluxes for the binary systems and the predicted fluxes for just the photospheres. At 24 µm we claim an excess detection when the ratio of the observed to predicted flux is > 1.2, and at 70 µm when it is in excess of 1.5. Note that the y axis on the 24um plot is linear, while that on the 70um plot is logarithmic. A feature which does not stand out particularly on these plots, but is one of the most interesting results of our study is the lack of any excess emission from dust in systems with separations in the range 5 – 40 AU. While it isn't particularly surpising





that the presence of a stellar companion would interfere with the formation of planetesimals etc. for such separations, what is striking is the sharpness of the boundaries of this apparent exclusion zone for the formation of planetoids and presumably planets) in binary systems.

References: [1] Prato *et al.* (2003) ApJ 584, 853. [2] Jensen and Mathieu (1997) AJ 114, 301. [3] Eggenberger *et al.* (2004) A&A 417, 353. [4] Patience *et al.* (2002) AJ 581, 654. [5] Gordon *et al.* (2004) PASP 117, 503. [6] A. Tokunaga (2000) in *Allen's Astrophysical Quantities*, Springer-Verlag, NY.