**AAVSO Observing Campaign Proposal**
**Monitoring Stellar Activities in Active Planet Forming Systems**

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## 1. Science Justification

Planetary debris disks were originally discovered serendipitously with IRAS ("the Vega Phenomenon"). They result from collisions among asteroid-sized bodies in planetary systems around other stars, producing clouds of finely divided dust that are heated by the stars and glow in the mid and far infrared. In the solar system, the zodiacal cloud is an example. The Spitzer telescope has been used to study debris disks in detail. A recent surprise from the archival Spitzer data is that some extreme examples have variable mid-infrared emission (e.g., Meng et al. 2012). Based on a limited amount of optical photometry, the stars themselves appear not to vary. Thus, these variations indicate large variations in the rate of dust production, and hence point to violent collisions between large exo-asteroids. The discovery opens the possibility of a leap forward in our understanding of the violent episodes in planet formation, including not only the type of collision that formed our Moon, but also the Late Heavy Bombardment when an orbital resonance between Jupiter and Saturn resulted in reconfiguring the Solar System at an age of about 600 million years.

We are now conducting a program in the Spitzer warm mission to monitor variations in these systems, at a wavelength of 4.5 microns. The emission at this wavelength is at a temperature corresponding to the zone where Venus- and Earth-like planets would form. The results to date for the most intensively monitored

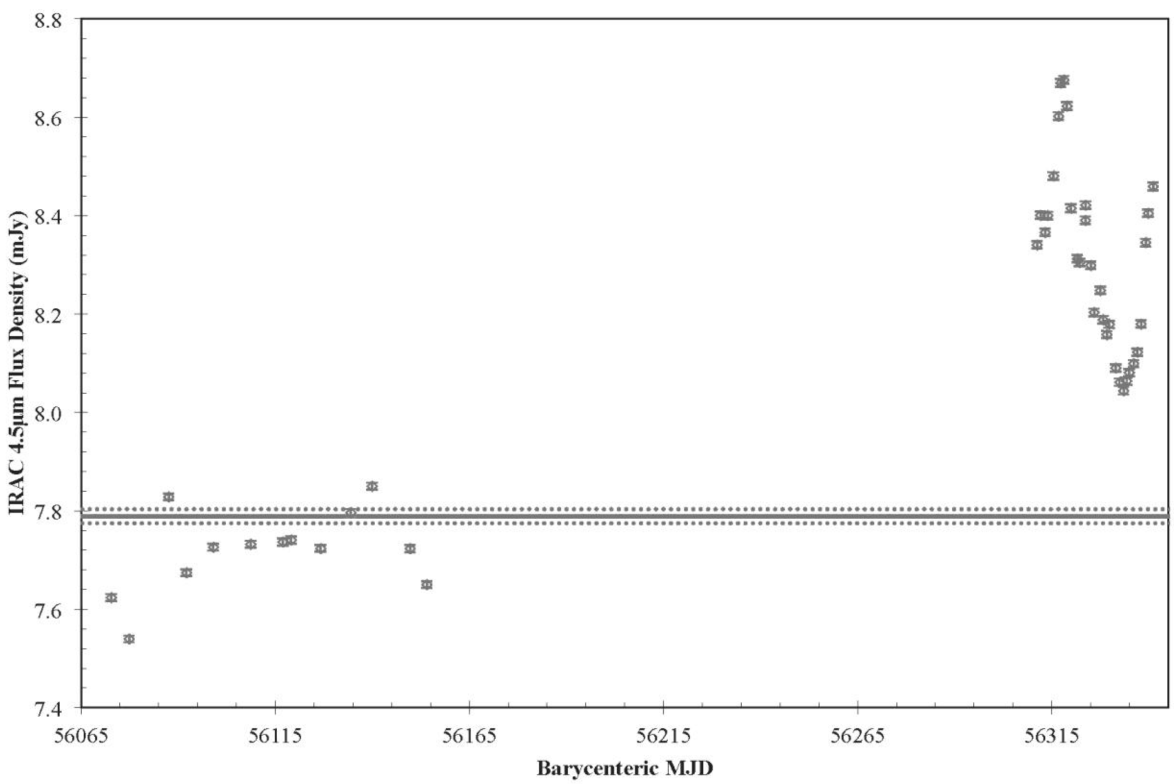


Figure 1. Recent variability of ID8 in NGC 2547 at 4.5 microns. The dashed lines show the error range from comparison star observations and the solid line is the level at the first Spitzer observation.

example are shown in Figure 1. Now that we know that this emission from the debris disks can vary on timescales of a few days, it is imperative to monitor the behavior of the outputs of the stars themselves (e.g., by observing them at the V band) on a similar timescale to be sure that their heating of the dust remains constant and that the 4.5 micron variations result from changes in the amount of dust in the debris disk, not in its heating by the host star. If indeed the host stars remain constant in output, then the variations at 4.5 microns will provide demanding constraints on our current ideas for the formation of terrestrial planets.

We request help from the AAVSO for this monitoring. In the northern hemisphere, the capabilities provided through the AAVSO appear to be unique for this purpose, where we need frequent observation of relatively bright stars. Given the rate at which variations occur, we need data points every day or few days. The desired time coverage is two periods for each of the targets, corresponding to the two visibility windows with Spitzer, each lasting 40 - 50 days. The observations will be challenging since the stars are not too far from the sun (an unavoidable situation given the viewing constraints for Spitzer). They will need to be observed with low elevation angles during the twilight. Given that the stars are relatively bright, we hope that this issue can be overcome.

**2. Targets**

We have three targets for the campaign, i.e. BD+20 307, HD 15407A, and HD 23514. All the stars are fairly bright in the visible wavelengths. The coordinates, basic photometry, and desired time coverages are

BD+20 307
RA = 01h 54m 50.341s; Dec = +21d 18m 22.55s (J2000.0)
B = 9.5, V = 9.0, R = 8.7
Desired Time Coverage: ASAP - April 21; September 24 - November 17

HD 15407A
RA = 02h 30m 50.646s; Dec = +55d 32m 54.35s (J2000.0)
B = 7.4, V = 7.0, R = 6.7
Desired Time Coverage: ASAP - May 14; October 14 - December 18

HD 23514
RA = 03h 46m 38.396s; Dec = +22d 55m 11.29s (J2000.0)
B = 9.9, V = 9.5, R = 9.2
Desired Time Coverage: March 26 - May 17; October 21 - December 14

Given the challenges for the observations, we request single-band observations at V. We also have identified nearby stars that should be within the field of view of a CCD imager, so only a single pointing of the telescope will be required and we will be able to obtain the information we need by relative photometry. The comparison stars are listed below; given that we want to monitor to an accuracy of 1 - 2%, they will need to be observed to to a ratio of signal to noise of about 100.

For BD+20 307. a star at
01h 54m 45.78s, +21d 16m 55.1s (J2000)
V = 12.45
separation on the sky: 1.8 arcmin, magnitude difference 3.4

There is a brighter comparison at
01h 54m 27.38s, +21d 10m 46.7s (J2000)
V = 10.75
separation on the sky 9.3 arcmin, magnitude difference 1.75

For HD 15407A, HD 15407B at
02h 30m 48.6s, +55d 33m 06.4s
V = 9.60
separation on the sky: 21 arcsec, magnitude difference 2.7

For HD 23514 (BD+22 550), a star (BD+22 552) at
03h 46m 47.06s, +22d 54m 52.43s (J2000)
V = 10.76
separation on the sky, 2 arcmin; magnitude difference 1.3

**3. Acknowledgement**

We would be grateful to all observers who contribute to this campaign. Continuous monitoring over the desired time coverage will be especially appreciated. We would like to make observers who did a significant amount of meaningful work co-authors of the resulting papers.

**4. Reference**

Meng, H. Y. A., Rieke, G. H., et al. 2012, ApJL, 751, 17: " Variability of the Infrared Excess of Extreme Debris Disks"