Probing for Exoplanets Hiding in Dusty Debris Disks III: Disk Imaging, Characterization, and Exploration with HST/STIS Multi-Roll Coronagraphy - Completing the Survey

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SUMMARY of HST/GO 12228 PROGRAM GOALS

With HST/STIS PSF-template subtracted coronagraphy of a well-selected sample of 11 starlight-scattering CS debris disks:

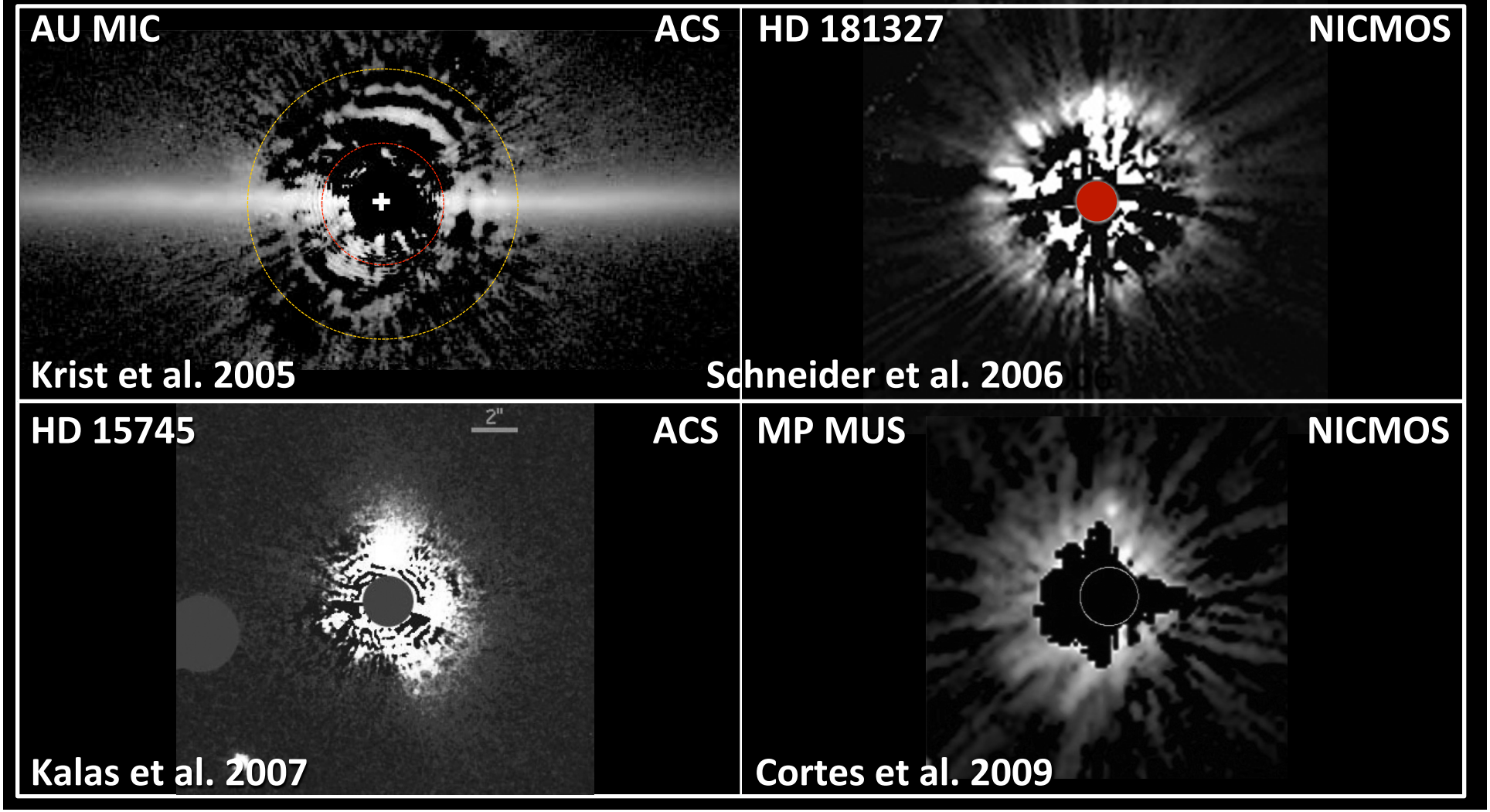
1. Study the spatial distribution of the CS dust over a wide range of stellocentric distances, as close as 0.3", to inform on the possible existence and properties of unseen co-orbital planetary mass bodies, and dynamical ***disk/planet interactions***.

2. Provide spatially resolved optical imaging photometry into the interior regions of these disks to better constrain the disk ***grain properties*** and radial segregation of grain populations with stellocentric distance (and thus temperature) dependencies.

3. ***LEGACY:*** Provide the highest quality, and most complete, foundational HST data sets for this seminal set of spatially resolvable light-scattering debris disks for future investigations (e.g. JWST, Herschel, ALMA, CARMA; EXCEDE – session 305.02).

PRIOR HST CORONAGRAPHY of CIRCUMSTELLAR (CS) DISKS

has given us some remarkable images, but have been limited in depth, inner working angle, and "polluted" with artifacts from non-optimal PSF-subtractions. *Some examples…*



The HST/GO 12228 OBSERVATION STRATEGY

Simultaneously go CLOSE, DEEP and CLEAN

- Total of 8 orbits per science target: 6 disk orbits (total integration time ~ 12 ksec), 2 PSF template orbits
- Two sets of four *sequential* orbits at two epochs with nominal roll in each set differing by ± 90° (subject to Guide Star and other HST constraints).
- At each epoch observe disk target in 3 orbits differing from nominal roll by [-30° , 0°, +30°] (subject to Guide Star & HST constraints).
- Contemporaneously observe color/attitude/roll matched PSF star equally bright or brighter, ($\Delta|B-V|$ & $\Delta|V-R| < 0.1$) within 10° of a disk target and within 30° of disk-target nominal roll.
- Interleave orbits as: Target(-30°), Target(0°), PSF, Target(+30°) w.r.t. nominal roll.

The HST/GO 12228 OBSERVATION STRATEGY

Simultaneously go CLOSE, DEEP and CLEAN

- Within each orbit observe at occulting Wedge A positions 0.6 *and* 1.0.
- "CLOSE" Wedge 0.6: Multiple (~ 10 – 20) "short" exposures for 1/3 of visibility period, $\leq$ 90% full-well from stellar flux at wedge edge.
- "DEEP" Wedge 1.0: Multiple (~ 3-4) 10x – 20x longer exposures for 2/3 of visibility period (saturating near Wedge 1.0 edge).
- "CLEAN" Reduction: Exposure/Orbit/Wedge-optimized PSF calibrations/subtractions. Rigorous intra/inter orbit co-alignment/co-rotation. *Data-derived*, artifact rejection masks optimized for each image prior to 12-image (6-roll, 2-wedge position) combinations.

The HST/GO 12228 TARGET SAMPLE

Diversity in stellar ages, types, and with *a priori* known light-scattering disks

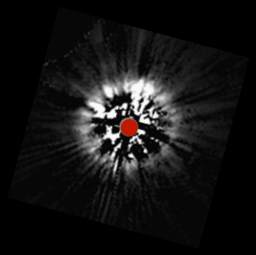
TARGET	Bmag	B-V	Spec	Distance(pc)	Age(Myr)	HST Initial Imaging
PDS 66	11.36	+1.01	K1Ve	~86	13 ± 7	NIC Cortes et al 2009
HD 32297	8.33	+0.20	A0V	112.4 ± 10.7	~ 10	NIC Schneider et al 2005
HD 15115	7.15	+0.35	F2	45.2 ± 1.3	12 (?)	ACS Kalas et al 2007a
HD 181327	7.51	+0.48	F6V	51.8 ± 1.7	12 — 20	NIC Schneider et al 2006 ACS
AU MIC	10.05	+1.44	M1Ve	9.9 ± 0.1	12 (+8, -4)	ACS† Krist et al 2005
HD 61005	8.93	+0.71	G8V	34.4 ± 1.1	90 ± 40	NIC Hines et al 2006
HD 107146	7.69	+0.62	G2V	27.5 ± 0.4	80 – 200	ACS Ardila et al 2004/05
HD 92945	7.69	+0.89	K1V	21.4 ± 0.3	80 – 300	ACS Golimowski et al 2011
HD 15745	7.82	+0.32	F2V	63.5 ± 2.4	~100 (?)	ACS Kalas et al 2007b
HD 139664	5.04	+0.40	F2V	17.5 ± 0.2	300 (+700, -200)	ACS Kalas et al 2006
HD 53143	7.61	+0.80	G9V	18.3 ± 0.1	1000 ± 300	ACS Kalas et al 2006b

†*AU MIC: ground-based discovery imaging: Kalas et al 2004.*

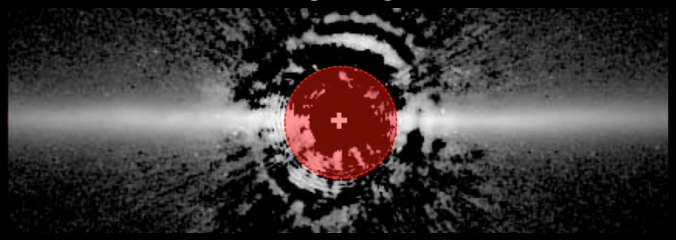
The HST/GO 12228 Family Portrait

(previous ACS & NICMOS imaging)

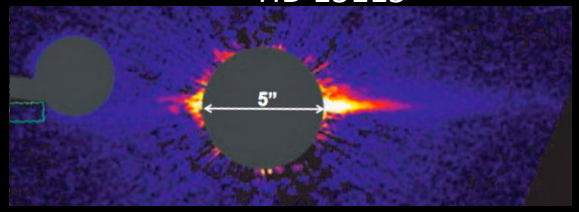
HD 181327



AU MIC

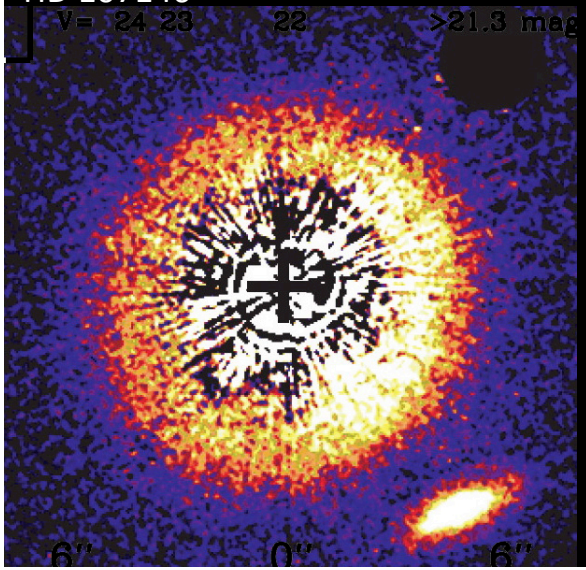


HD 15115

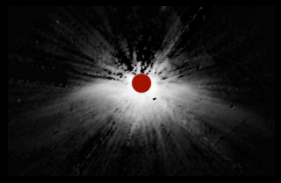


HD 32297

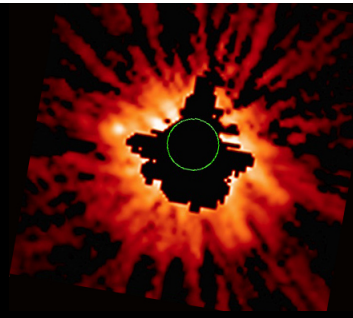
HD 107146



HD 61005



MP MUS



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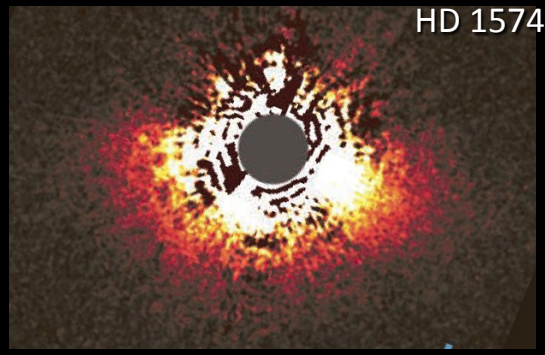

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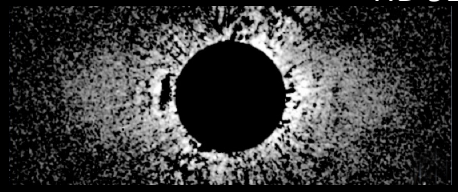
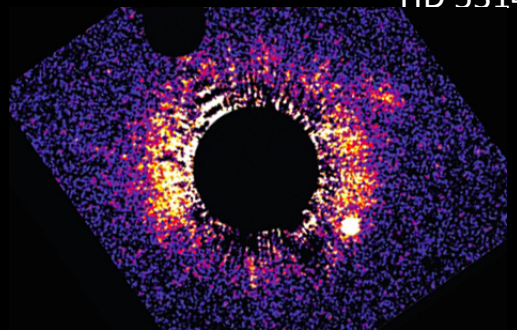


HD 139664

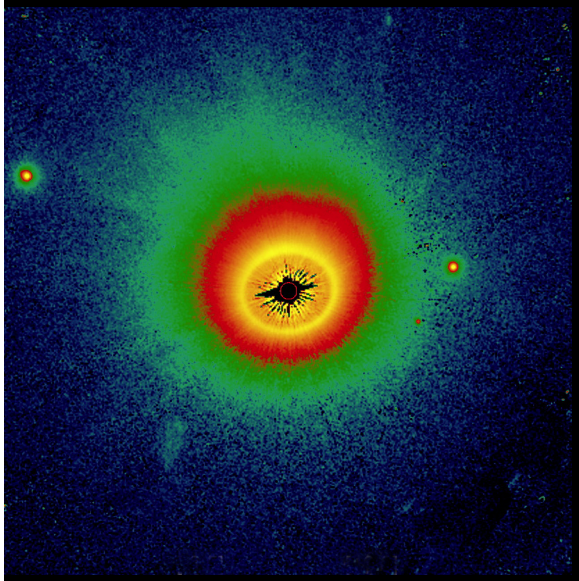
HD 53143



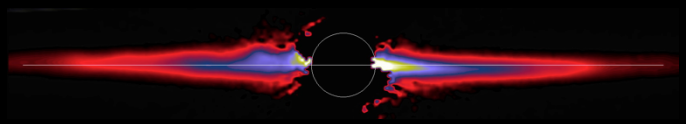
The HST/GO 12228 Family Portrait

New STIS imaging enabling new studies with old frinds

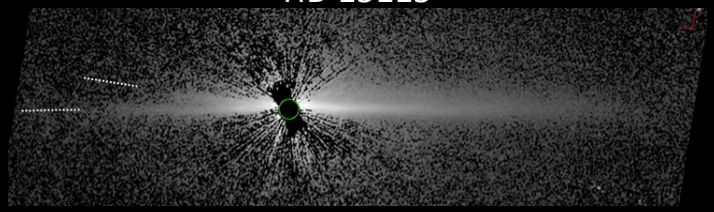
HD 181327



AU MIC

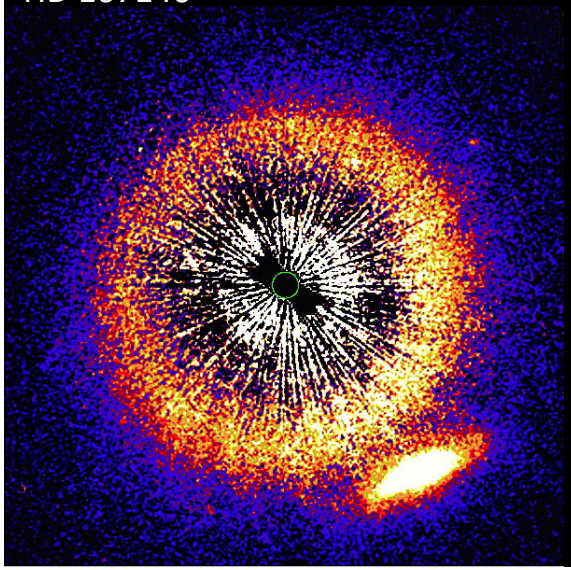


HD 15115

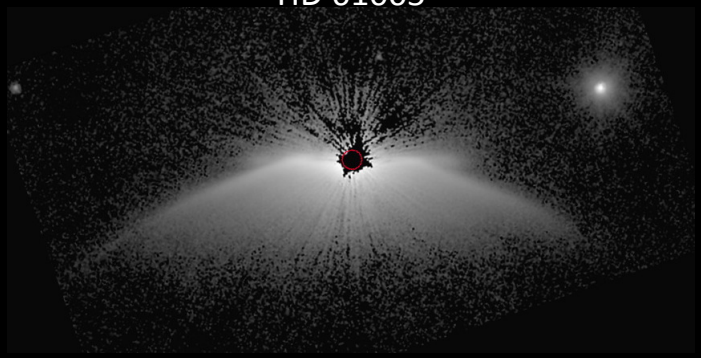


HD 32297

HD 107146



HD 61005



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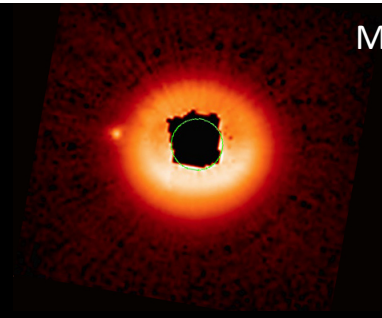

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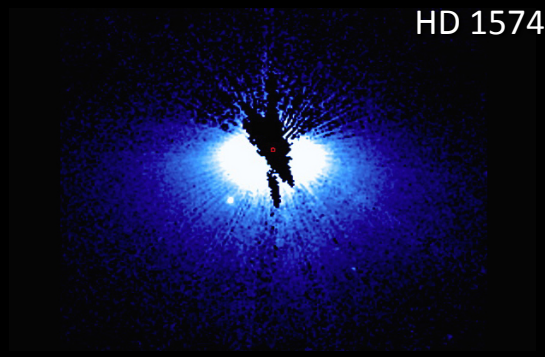

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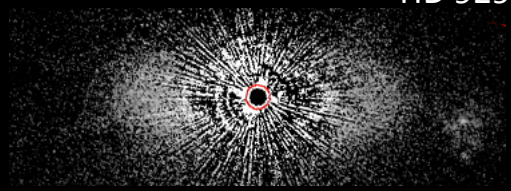
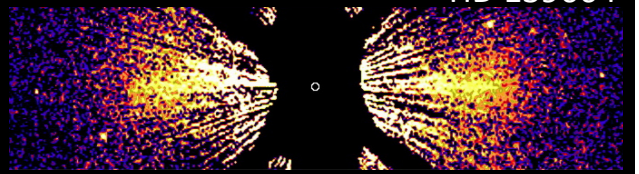


HD 139664



HD 53143