Images of the Extended Outer Regions of the Debris Ring around HR 4796 A*

THALMANN, Christian[1], DOMINIK, Carsten[1], JANSON, Markus[2], BUENZLI, Esther[3], WISNIEWSKI, John[4]
BRANDT, Timothy[5], KNAPP, Gillian[5], TURNER, Edwin[5], MORO-MARTIN, Amaya[6], SCHNEIDER, Glenn[7]
USUDA, Tomonori[8], EGNER, Sebastian[8], TERADA, Hiroshi[8], TOMONO, Daigo[8], TAKAMI, Hideki[8]
GOLOTA, Taras[8], GUYON, Olivier[8], HAYANO, Yutaka[8], HAYASHI, Masahiko[8], HAYASHI, Saeko[8], ISHII, Miki[8]
NISHIMURA, Tetsuo[8], PYO, Tae-Soo[8], TAKATO, Naruhisa[8], KUDO, Tomoyuki[8], CARSON, Joseph[9]
MCELWAIN, Michael[10], GRADY, Carol[10], ABE, Lyu[11], GOTO, Miwa[12], HENNING, Thomas[12], BRANDER, Wolfgang[12]
FELDT, Markus[12], HODDAP, Klaus[13], SERABYN, Eugene[14], TAKAMI, Michihiro[15], FUKUE, Tsubasa[8]
HASHIMOTO, Jun[8], IYE, Masanori[8], KANDORI, Ryo[8], KUSAKABE, Nobuhiko[8], MATSUO, Taro[8]
MIYAMA, Syoken[8], MORINO, Jun-ichi[8], SUZUKI, Ryuji[8], SUTO, Hirohi[8], TAMURA, Motohide[8]
KUZUHARA, Masayuki[16], TAKAHASHI, Yasuhiro[16], WATANABE, Makoto[17], YAMADA, Toru[18]

1: University of Amsterdam, 2: University of Toronto, 3: Institute for Astronomy, 4: University of Washington, 5: Princeton University, 6: CAB-CSIC/INTA, 7: The University of Arizona, 8: NAOJ, 9: College of Charleston, 10: Goddard Space Flight Center, 11: University of Nice, 12: Max Planck Institute for Astronomy, 13: University of Hawaii, 14: Jet Propulsion Laboratory, 15: Institute of Astronomy and Astrophysics, 16: Univesity of Tokyo, 17: Hokkaido University, 18: Tohoku University

Vega-type debris disks were first identified by infrared (IR) excesses around nearby main sequence stars [1]. The dust content of these second-generation disk systems is believed to be continuously replenished via collisional breakup of remnant planetesimals [2]. Since the imaging of the β Pic system [3], nearly two dozen nearby debris disks have been spatially resoved. The morphological appearance of resolved debris disks is predicted by several mechanisms, e.g., interactions between dust in the disk and nearby planets [4].

We present high-contrast images of HR 4796A taken with Subaru/HiCIAO in *H*-band, resolving the debris disk in scattered light[4]. HR 4796A is a young (~8–10 Myr; [5]), nearby (72.8 ± 1.7 pc; [6]), A0V-type star first identified as a debris disk system from an IR excess observed with IRAS [7]. The application of specialized angular differential imaging methods (ADI) allows us to trace the inner edge of the disk with high precision, and reveals a pair of "streamers" extending radially outwards from the ansae. Using a simple disk model with a power-law surface brightness profile, we demonstrate that the observed streamers can be understood as part of the smoothly tapered outer boundary of the debris disk, which is most visible at the ansae. Our observations are consistent with the expected result of a narrow planetesimal ring being ground up in a collisional .Based on data collected at the Subaru Telescope, which is operated by the National Astronomical Observatory of Japan. cascade, yielding dust with a wide range of grain sizes. Radiation forces leave large grains in the ring and push smaller grains onto elliptical, or even hyperbolic trajectories. We measure and characterize the disks surface brightness profile, and confirm the previously suspected offset of the disks center from the stars position along the rings major axis. Furthermore, we present first evidence for an offset along the minor axis. Such offsets are commonly viewed as signposts for the presence of unseen planets within a disks cavity. Our images also offer new constraints on the presence of companions down to the planetary mass regime (~9 $M_{\rm Jup}$ at 0″.5, ~3 $M_{\rm Jup}$ at 1″).

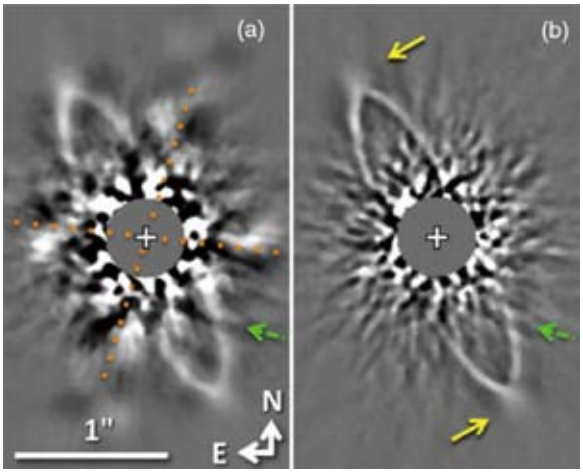

Figure 1: High-contrast images of the HR 4796 A debris disk. White plussigns mark the star's location. The saturated central area is masked in gray. (a) Subaru HiCIAO *H*-band data after reduction with simple ADI (subtraction of a median background) and median smoothing on a scale of 5 pixels (=48 mas ~1 λ/D). Orange dotted lines mark the mean of the spider diffraction pattern. The stretch is linear between $\pm 3 \times 10^{-5}$ times the stellar peak flux. (b) The same after ADI reduction with the LOCI algorithm, using conservative settings (optimization region area of 10,000 PSF footprints). Note the "streamers" extending radially out from the ansae (yellow arrows). Linear stretch of $\pm 1.5 \times 10^{-5}$.

* Based on data collected at the Subaru Telescope, which is operated by the National Astronomical Observatory of Japan.

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