The Resolved Debris Disk around HD 107146

Stanimir Metchev (UCLA)

In collaboration with the Spitzer FEPS, the HST ACS GTO, and the NICMOS GO 10177 teams

HD 107146: a Young Solar Analog with a Debris Disk

- G2 V
- 29 pc
- 80–200 Myr
- IRAS 60µm and 100µm excesses
- $L_{\text{IR}} / L_\odot = 10^{-3}$

Silverstone (2000); Metchev et al. (2004)
The First Resolved G-Star Debris Disk

Summary of Properties

- $i \approx 20^\circ$
- azimuthally symmetric
  - forward scattering
- radial extent: 210 AU
- peak surface density: 130 AU
- inner clearing? (<60 AU)
- characteristic grain size: $\sim 1\ \mu m$
Issues of Interest

- Dust and disk properties
  - number of dust grain populations
    - larger grains in the inner disk?
  - size of inner hole
    - constraints on orbits of potential planets
- Evolutionary state
  - recent collision?

Dust Properties Derived Solely from the SED are Degenerate
Approach: Combine SED and Resolved Images

The Radial Surface Density Profile: a Birth Ring at 130 AU
No Evidence for Distinct Grain Size Populations from the Scattered Light

Radial dependence of the Henyey-Greenstein $g$ parameter

Radial dependence of the $V-I$ and $V-J$ colors

Constraints from SED + IRS Spectrum: Dust at 10 AU

- fitted parameters:
  - $r_{in} = 10.0 \pm 0.2$ AU
  - $a_{min} = 6.5 \pm 0.3$ µm
  - $M_{dust} = 0.18 \pm 0.01 M_{\oplus}$
- fixed parameters:
  - $r_{out} = 210$ AU
  - $n(r) \propto r^{-1}$
  - $a_{max} = 3.1$ mm
  - $n(a) \propto a^{-3.5}$
  - astronomical silicate

SED fit using DSF debris disk modeling tool, courtesy of J. Rodmann (FEPS)
Combined Constraints: Preliminary Results

- fitted parameters:
  - $a_{\text{min}} = 1.6 \pm 0.3 \, \mu m$
  - $M_{\text{dust}} = 0.24 \pm 0.01 M_\oplus$
- fixed parameters:
  - $r_{\text{in}} = 60 \, \text{AU}$
  - $r_{\text{out}} = 210 \, \text{AU}$
  - $n(r) \propto r^3, \propto r^{-2}$
    - break at $r = 130 \, \text{AU}$
  - $a_{\text{max}} = 3.1 \, \text{mm}$
  - $n(a) \propto a^{-3.5}$
  - astronomical silicate

SED fit using DSF debris disk modeling tool, courtesy of J. Rodmann (FEPS)

HD 107146: Conclusions

- new resolved images: 1.1 μm and 70 μm
- excellent opportunity to study a debris disk in detail
- single grain population
  - co-eval, recent collision
- significant decrease in opacity at <10 AU
Combined Constraints:
Preliminary Results

- fitted parameters:
  - $a_{\text{min}} \approx 1 \mu m$
  - $M_{\text{dust}} = 0.3 \, M_\odot$
- fixed parameters:
  - $r_{\text{in}} = 60 \, \text{AU}$
  - $r_{\text{out}} = 210 \, \text{AU}$
  - $n(r) \propto r^3, \propto r^{-2}$
    - break at $r = 130 \, \text{AU}$
  - $a_{\text{max}} = 3.1 \, \text{mm}$
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