A Warm Mission Survey of Single White Dwarfs

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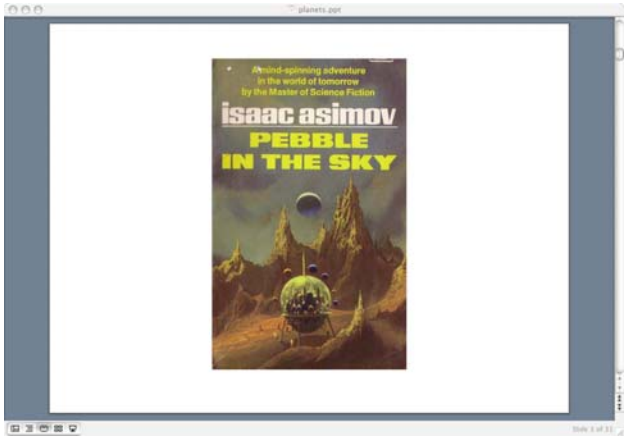
Main Arguments

Asteroid accretion onto white dwarfs is a plausible model to account for atmospheric abundances and an infrared excess.

We can use white dwarfs to learn about extrasolar planetary systems.

Ultimate Goal?



Brief History and Current Status

- 1987: IR excess around G29-38 (dust?)
- 2005: IR excess discovered around GD 362
- Now: 9 WDs have an IR excess; 2 with circumstellar silicate emission
- Now: 2 WDs have gas disks
- Now: 6 WDs exhibit carbon-deficient accretion
- Now: 1 CSPN (Helix Nebula) with IR excess

Metals in White Dwarf Photospheres

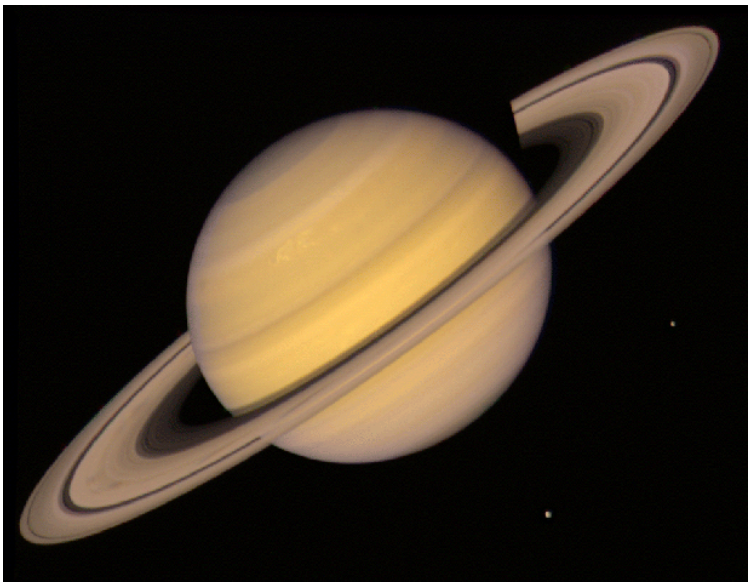
- T < 20,000 K, no radiative levitation, gravitional settling, no metals in atmosphere
- Good theory for ~80% of WDs; n(Ca)/n(H) as low as 10^{-12} in contrast to Sun where n(Ca)/n(H) = 2 10^{-6}
- BUT: 20% cool WDs have detected metals: some external source is required

Proposed Scenario:

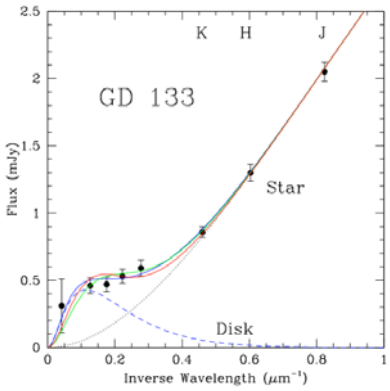
- Asteroid's orbit perturbed so that it passes within tidal radius of the white dwarf
- Asteroid shredded into dust to form a flat distribution like Saturn's rings
- Dust produces infrared excess
- Accretion from ring pollutes stellar atmosphere

Asteroidal Pollution for ~2% of WDs with an IR Excess

- WDs with large values of dM/dt (accretion) have an excess
- Interstellar accretion for WDs with small values of dM/dt??

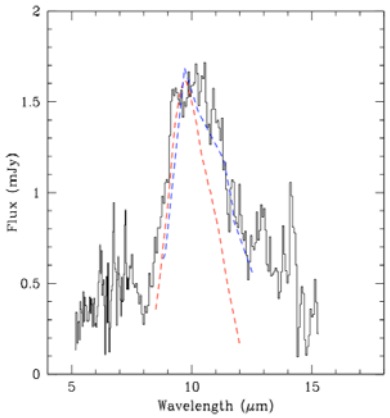


SED for GD 133



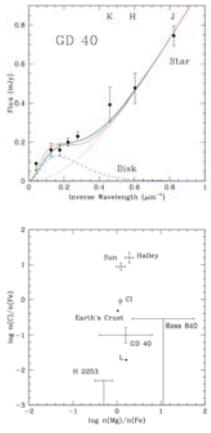
- T(in) = 800 -1200 K
- T(out) = 300 - 600 K
- Cos(i) = 0.2 - 0.8
- R*/D = 7.0 10^{-12}
- T* = 12,200 K
- IR excess ~0.5% of total flux

Spitzer IRS Spectrum of GD 362



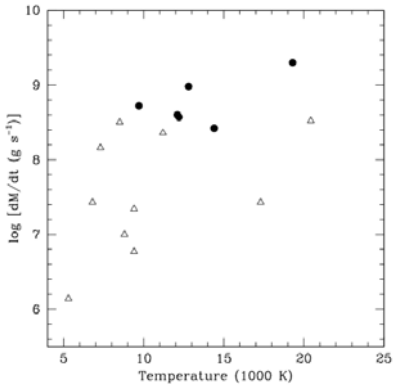
- Black = Data
- Red = Interstellar spectrum (taken from absorption)
- Blue = spectrum of BD +20 307, 650 K dust around a main-sequence solar-type star

GD 40: An Externally-Polluted White Dwarf



- Infrared Excess from disk
- More iron than carbon; very unlike the Sun but similar to the Earth or chondrites

H-Rich WDs With IR Excesses



- Solid dot: IR excess
- Open triangle: No excess
- All stars with an excess are polluted with relatively high dM/dt
- Zodiacal light: dM/dt = 3 10^6 g s^{-1}

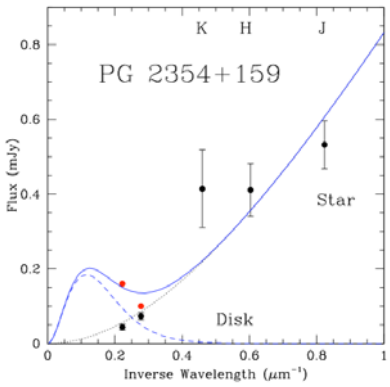
Why perform a warm mission Survey?

- How often do stars with T < 10,000 have an IR excess?
- Do dM/dt and IR excess correlate?
- Is there a correlation of IR excess with WD mass?
- Do He-rich and H-rich have different kinds of disks?
- Can we correlate IR excess and elemental composition in the photosphere?
- Do the IR excess and circumstellar gas correlate?

Survey

- Currently ~200 WDs observed with IRAC
- Extend to ~1475 WDs in 2MASS
- Goal: measure 0.1 mJy at 3.6 and 4.5 microns
- 300 hours of telescope time

Why not WISE?



- Black = 2MASS + IRAC
- Red = estimated WISE upper limits
- Current results rule out excess
- WISE upper limits not so convincing