Benchmark tests for Disk Configurations

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How to test RT Codes

- Compare RT code output with analytical solutions
  ONLY FOR SIMPLE CASES!

- Compare solutions of well defined problems by several independent codes

Pascucci et al. (submitted to A&A)

- MC3D (Wolf et al. 1999)
- MCTRANSF (Lopez et al. 1995)
- RADMC and RADICAL-VET (Dullemond & Turolla 2000)
- STEINRAY (Steinacker et al. 2002)

Temperature & SED

Model Parameters

- Central point-like star (BB) : solar type

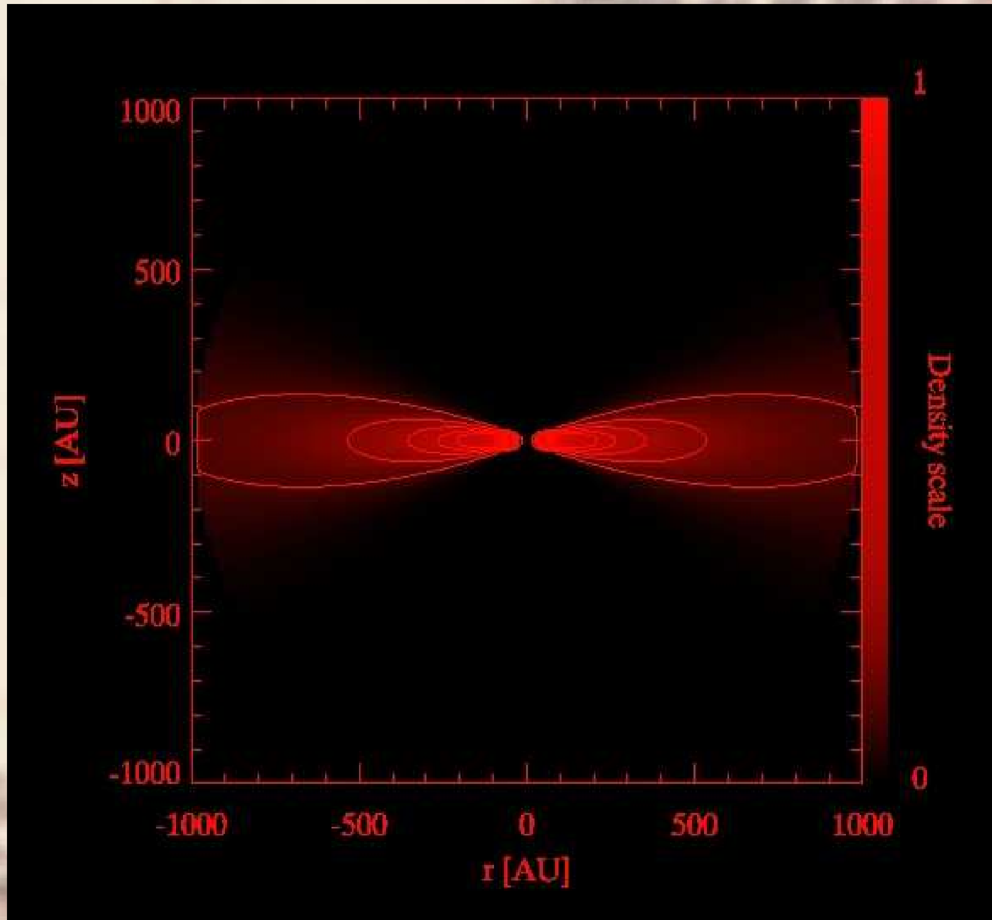
- Circumstellar disk with inner cavity free of dust
  - Disk size: R_{in} = 1 AU & R_{out} = 1000 AU
  - Density similar to Chiang & Goldreich (1997,1999)
  - Midplane opacity τ(550nm) = 0.1, 1, 10, 100 which implies dust masses from 10^{-7} to 10^{-4} $M_\odot$

- Spherical astronomical silicates
  - Radius = 0.12 μm (Draine & Lee 1984)
  - Isotropic scattering

Density Structure

$$\rho(\mathbf{r},\mathbf{z}) = a \times \mathbf{r}^{-\alpha} \times \exp(-b \times ((\mathbf{z}/\mathbf{r})^{\beta})^2)$$

With $\alpha = 1$ **&** $\beta = 1.125$



Density structure perpendicular to the disk midplane and centered on the star for the model $\tau_v = 1$(M_d = $10^{-6}\ M_\odot$). Lower contour = 0.1% of the maximum. Higher contour = 0.48% of the maximum.

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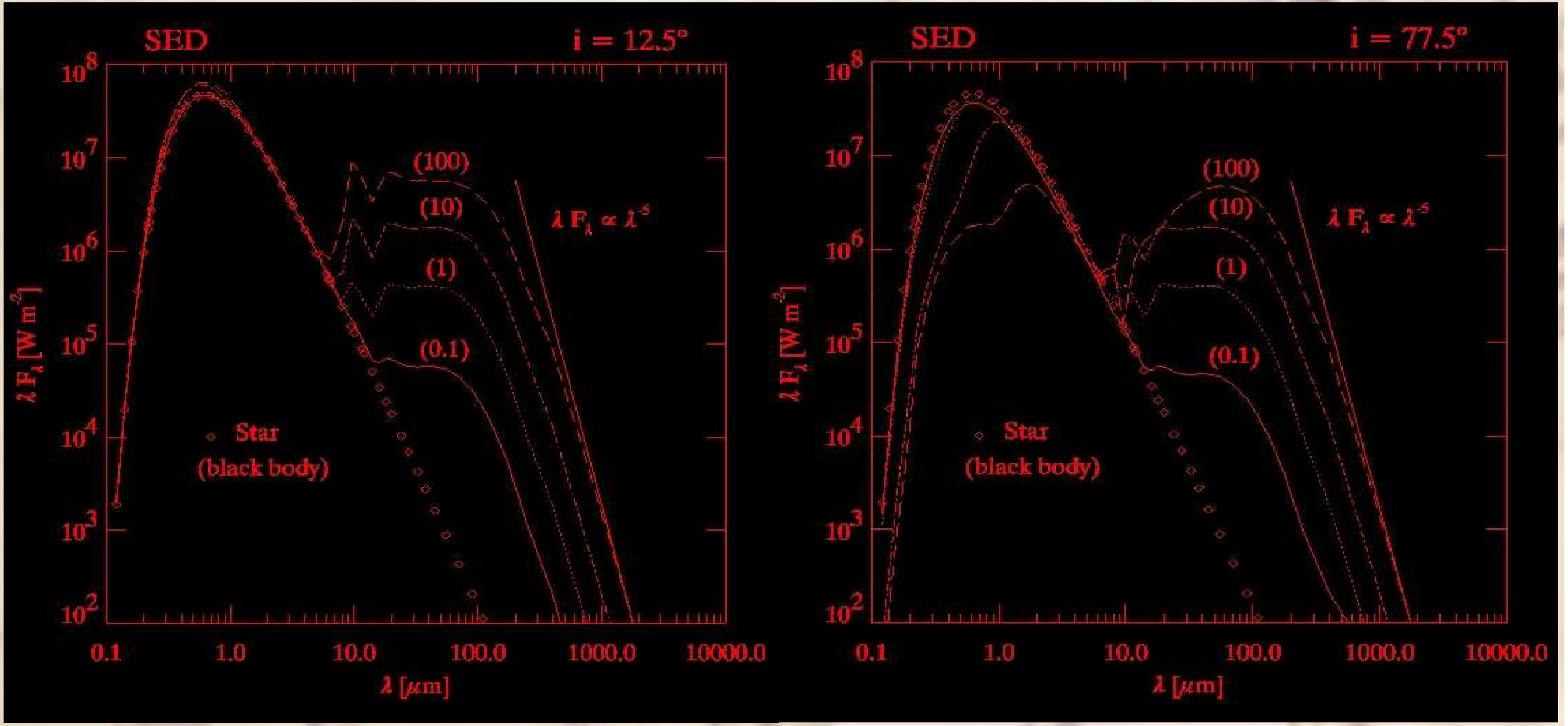
What has been done

- Code comparison of radial and vertical Temperature:
  Radial T: 2.5°, 25° and 45° from the disk midplane
  Vertical T: 2, 50 and 500 AU from the star

- Code comparison of SEDs:
  three disks inclinations

- For the most optically thin model comparison with the analytical solution

Results I



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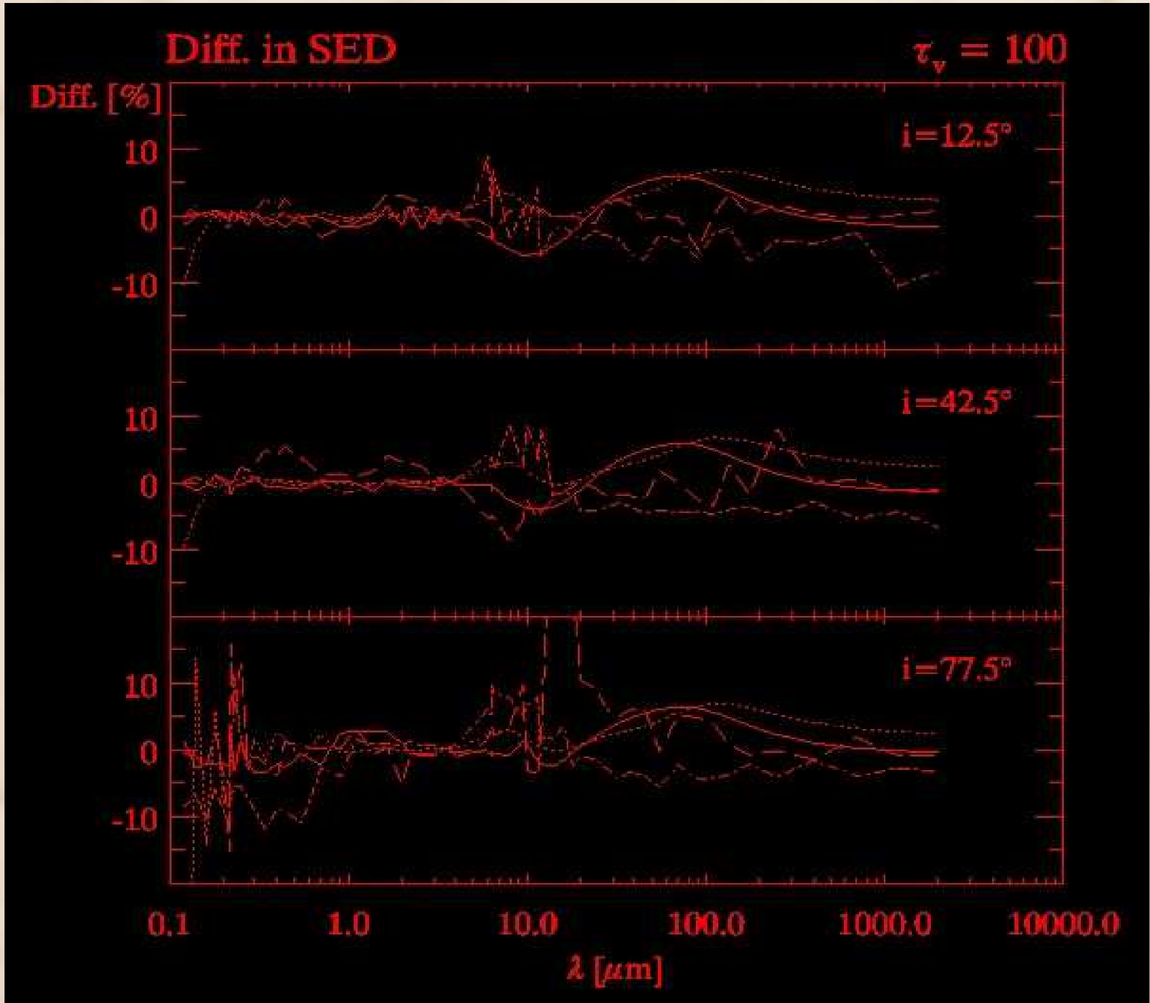
Results II

- τ(550nm) = 0.1 : Δ(T) < 1% Δ(SEDs) < 3%
- τ(550nm) = 1 : Δ(T) < 10% Δ(SEDs) < 10%
- τ(550nm) = 10 : Δ(T) < 10% Δ(SEDs) < 10%
- τ(550nm) = 100 : Δ(T) < 15% Δ(SEDs) < 15% (overall)

Results III



More than 1 week computation time on a computer with at least 1 Gb memory ram for most of the codes!

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What we still want to do

- **Test of spatial resolution:**
  finer grid in vertical and radial direction

- **Test of frequency resolution:**
  compute RT on 2 $\times$ more frequencies

More details in:
http://www.mpia.de/PSF/PSFpages/RT/benchmark.html