COMET C/2013 A1 AS SEEN WITH THE HERSCHEL SPACE OBSERVATORY

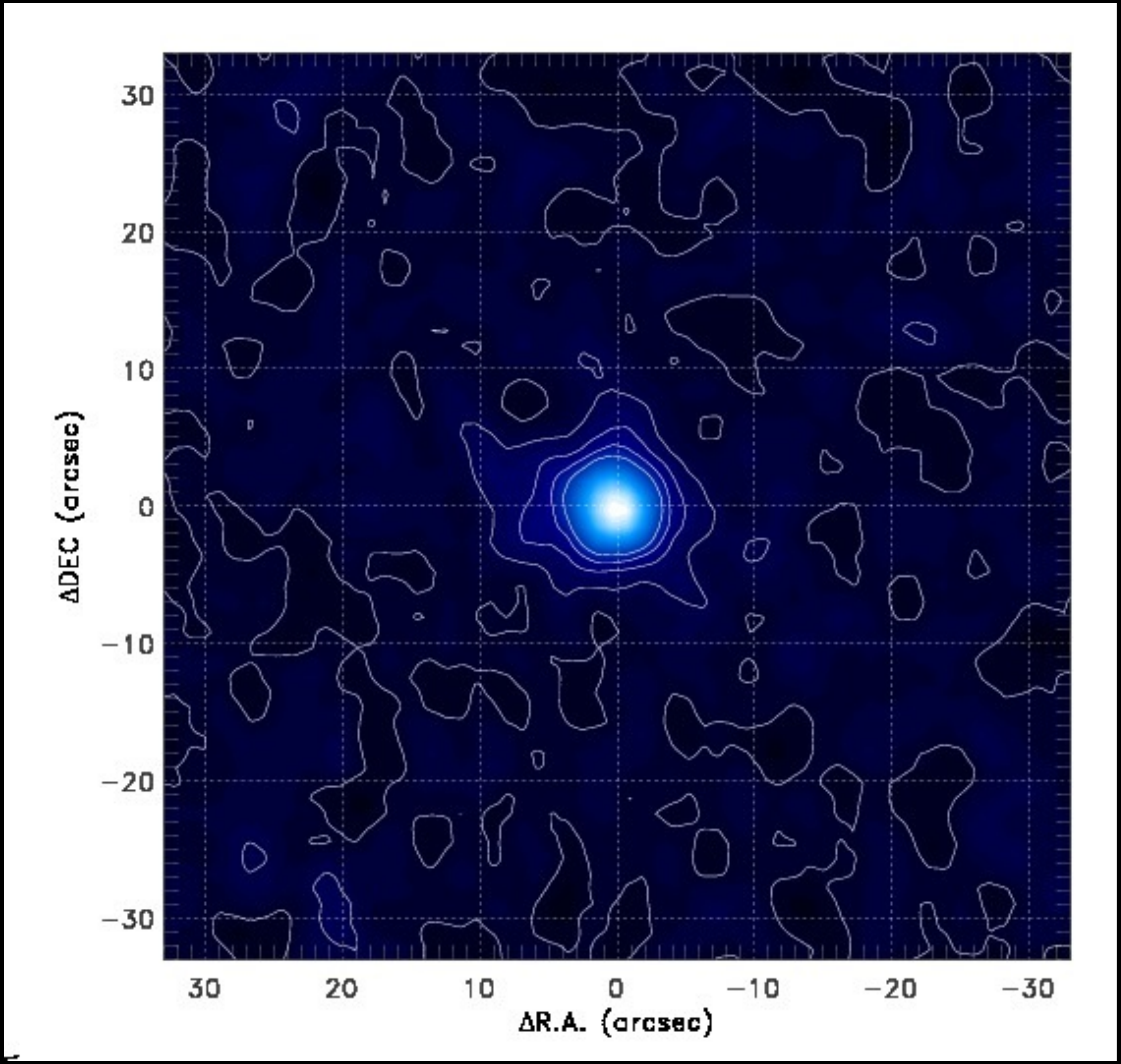
CS. KISS[1], TH.G. MUELLER[2], M. KIDGER[3], P. MATTISSON[4]

[1] KONKOLY OBSERVATORY, BUDAPEST, HUNGARY
[2] MAX-PLANCK-INSTITUT FUER EXTRATERRESTRISCHE PHYSIK, GARCHING, GERMANY
[3] ESA/ESAC, MADRID, SPAIN
[4] NSSA, SWEDEN

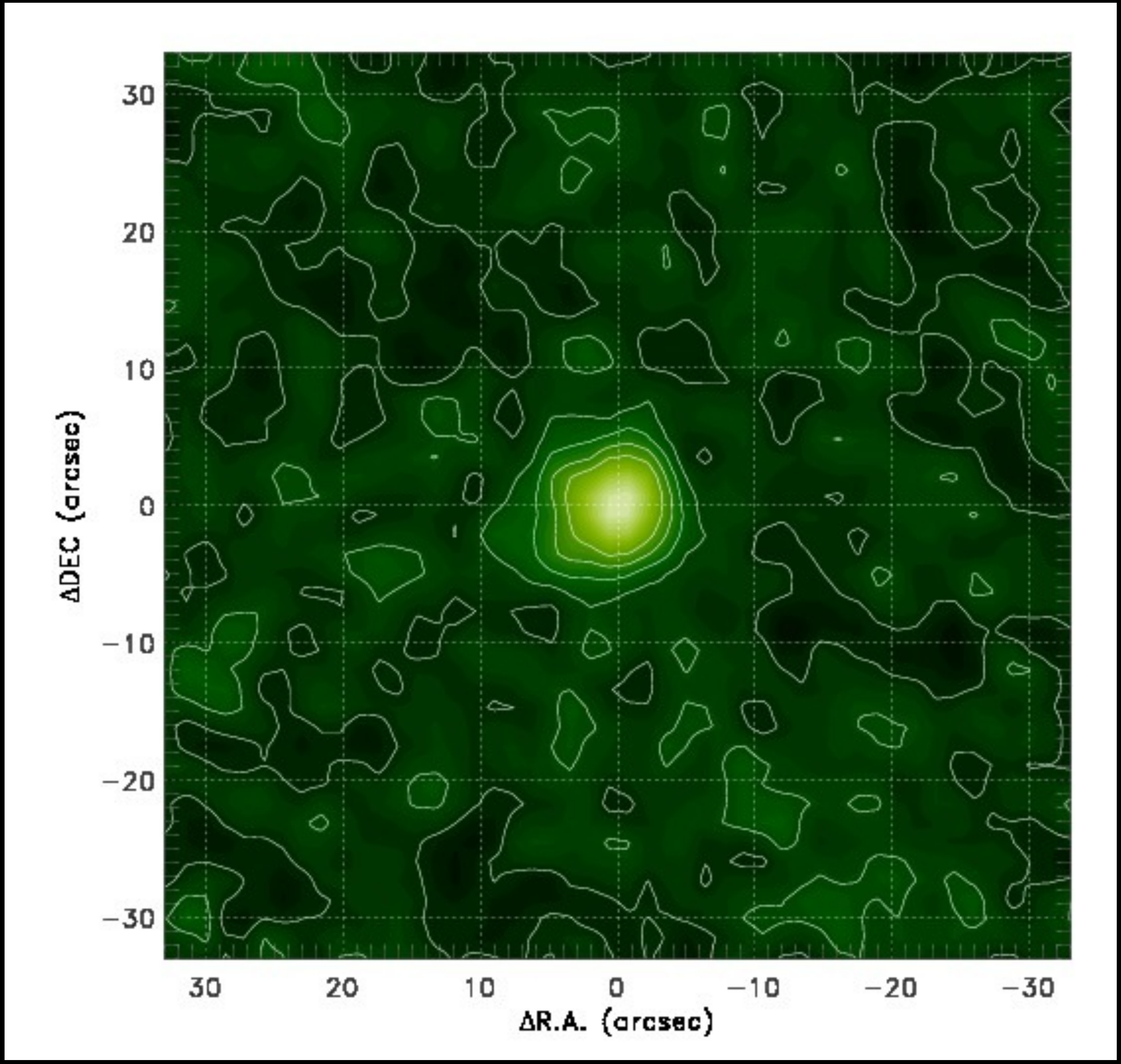
HERSCHEL OBSERVATIONS

- DDT_pmattiss_1 (initated by Peter Mattisson)
- Performed on March 31, 2013, 20:00-23:00 UTC
- PACS camera, 2 AORs (scan/cross-scan) with 70/160um, 2 AORs with 100/160um filter combinations
- Observing geometry: r = 6.47 au, Δ = 6.87 au, α= 7.°98
- Data reduction:
  - Reduced in the co-moving frame with the “usual” “TNOs are Cool!” pipeline (HPF)
  - Both high-pass filter / photProject and JScanam images were produced ⇒ They are fairly identical, we use the HPF images due to the better flux calibration and lower singal-to-noise at 160um
- The comet is easily detected in all bands and seems to show a coma at the shorter wavelengths

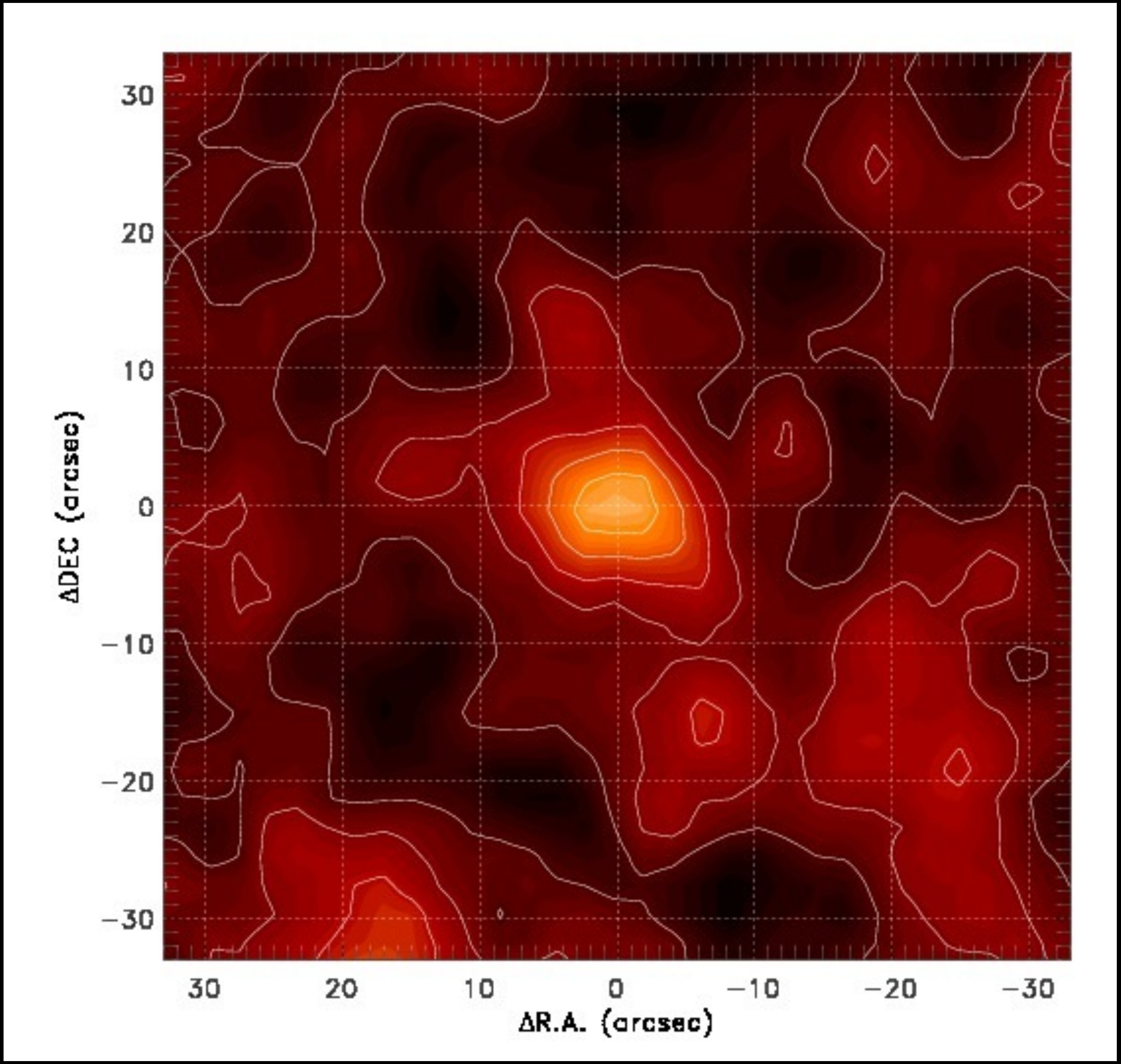
HERSCHEL CONTOUR MAPS — BLUE



HERSCHEL CONTOUR MAPS — GREEN



HERSCHEL CONTOUR MAPS — RED

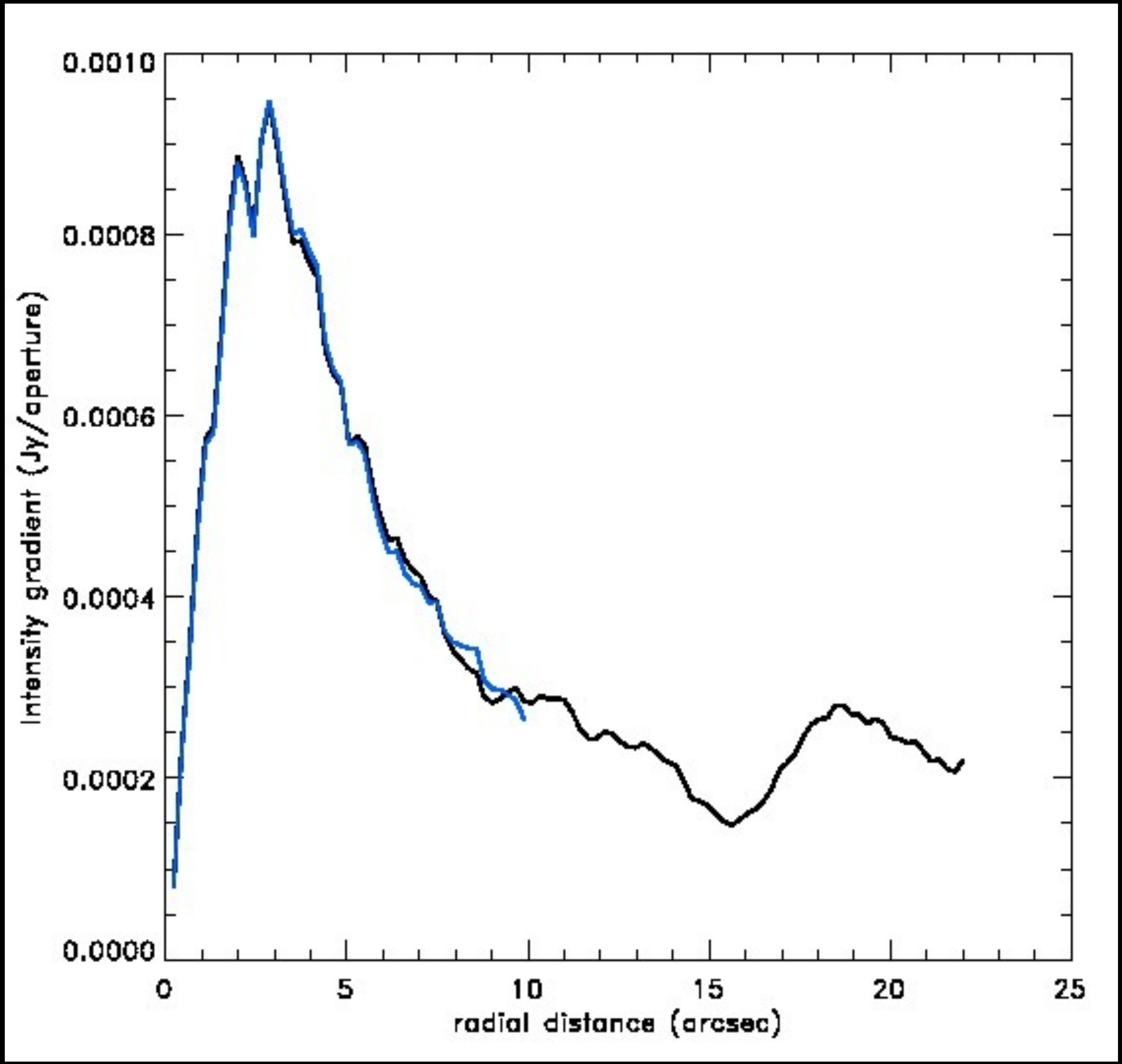


INTENSITY PROFILE FITTING

- Nucleus: $k_n \cdot \delta(0)$
- Coma: $k_c/(1-(\rho/\rho_0)^{\gamma})$
- We use four parameters — k_n, k_c, ρ_0 and γ — to describe an intensity profile model
- The assumed “true” intensity distribution is convolved with the respective PSF of each band to obtain the “apparent” one; the intensity profile is derived from these synthetic images
- The synthetic and observed intensity profiles are compared and the “best fit” is determined with a Levenberg-Marquardt fitter
- The inner ~10” (radius) can be used to fit the intensity profile

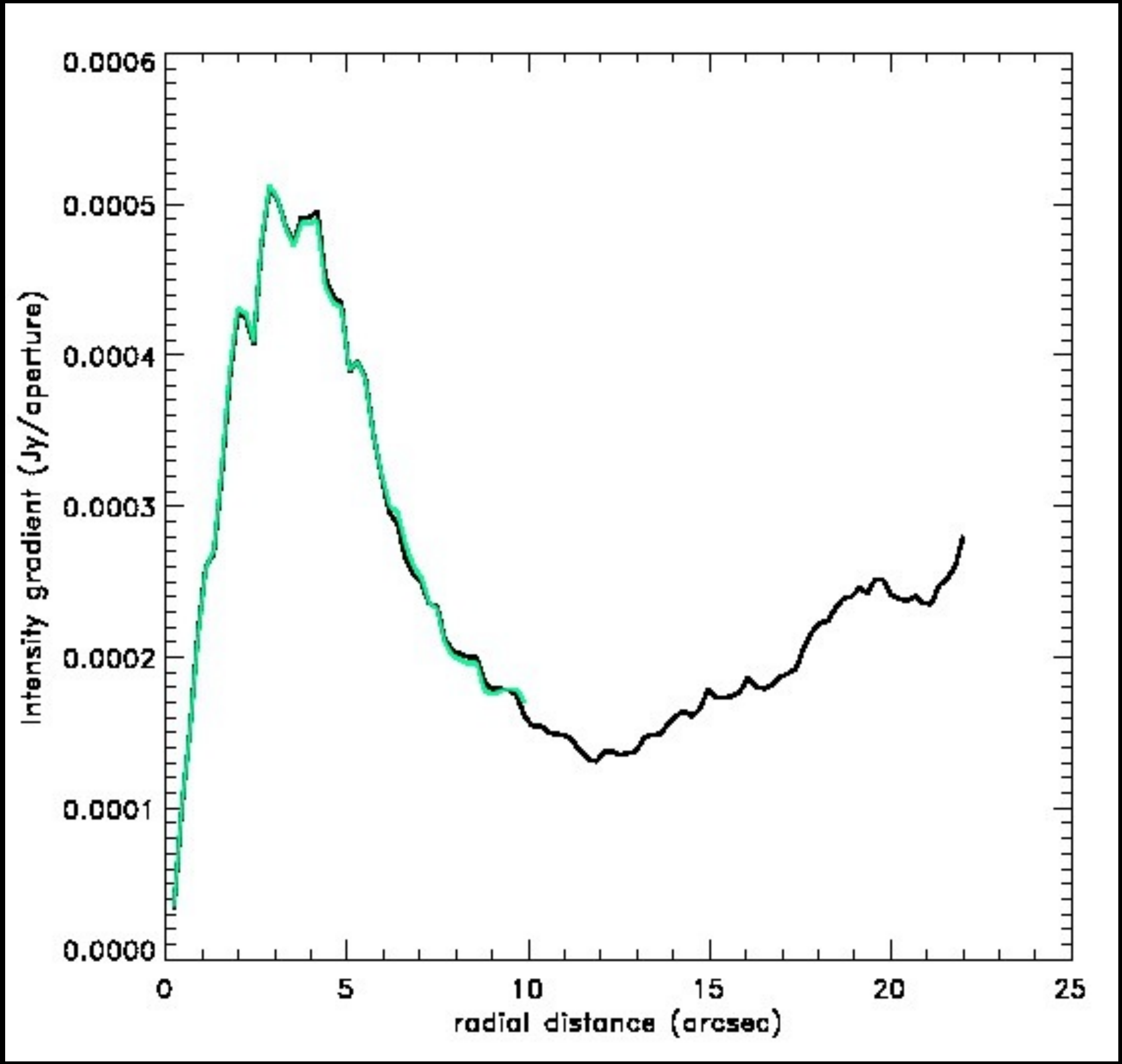
INTENSITY PROFILE RESULTS — BLUE BAND

- Nucleus: k_n = 12.75 mJy
- Coma:
  - k_c = 1.4 10^{-4} mJy/pixel
  - γ = 1.88
  - r_0 = 2.45 pixel
- The blue intensity profile is much wider than a normal PSF, even wider than the green one…



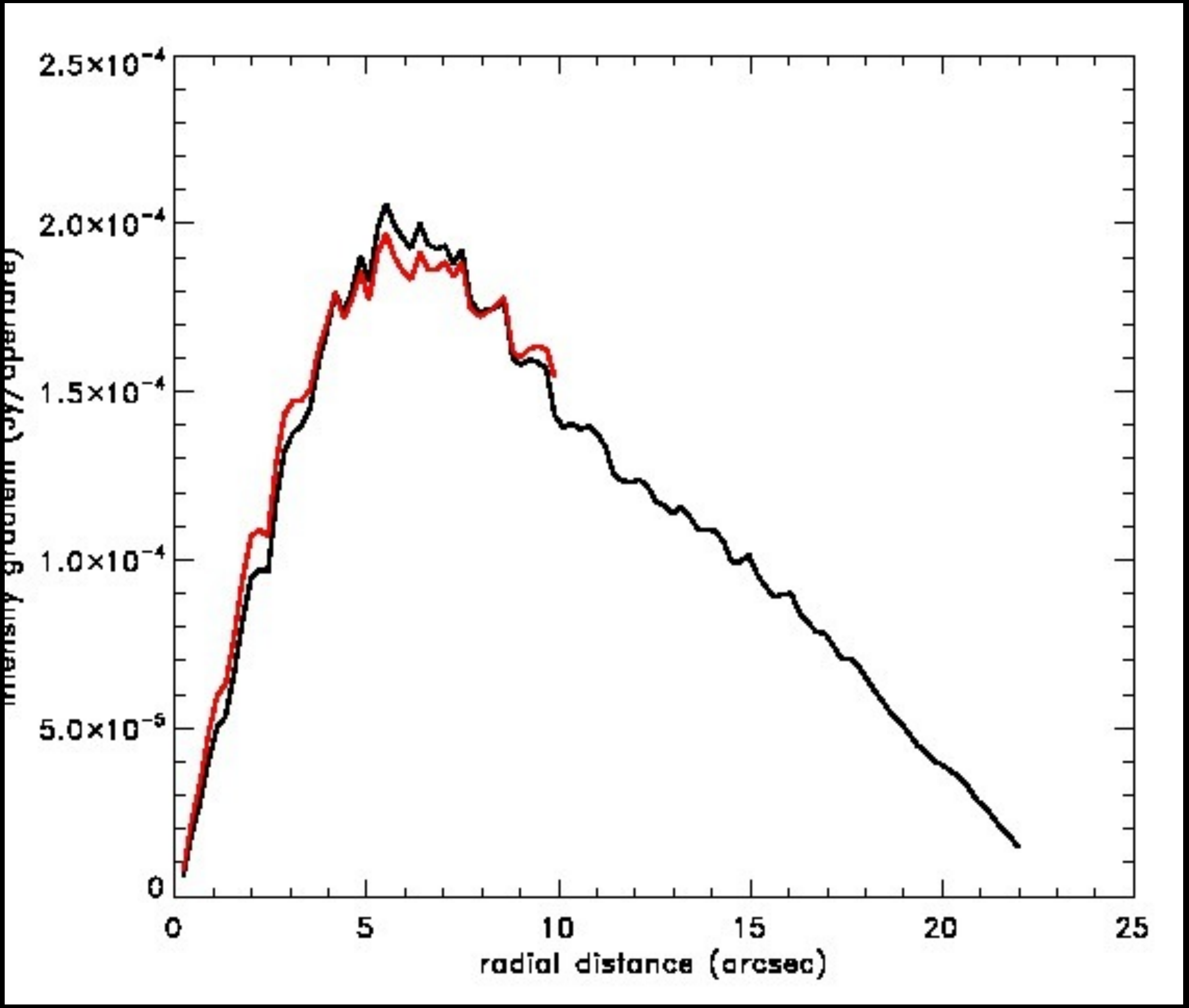
INTENSITY PROFILE RESULTS — GREEN BAND

- Nucleus: k_n = 8.3 mJy
- Coma:
  - k_c = 1.2 10^{-4} Jy/pixel
  - γ = 2.15
  - r_0 = 2.73 pixel



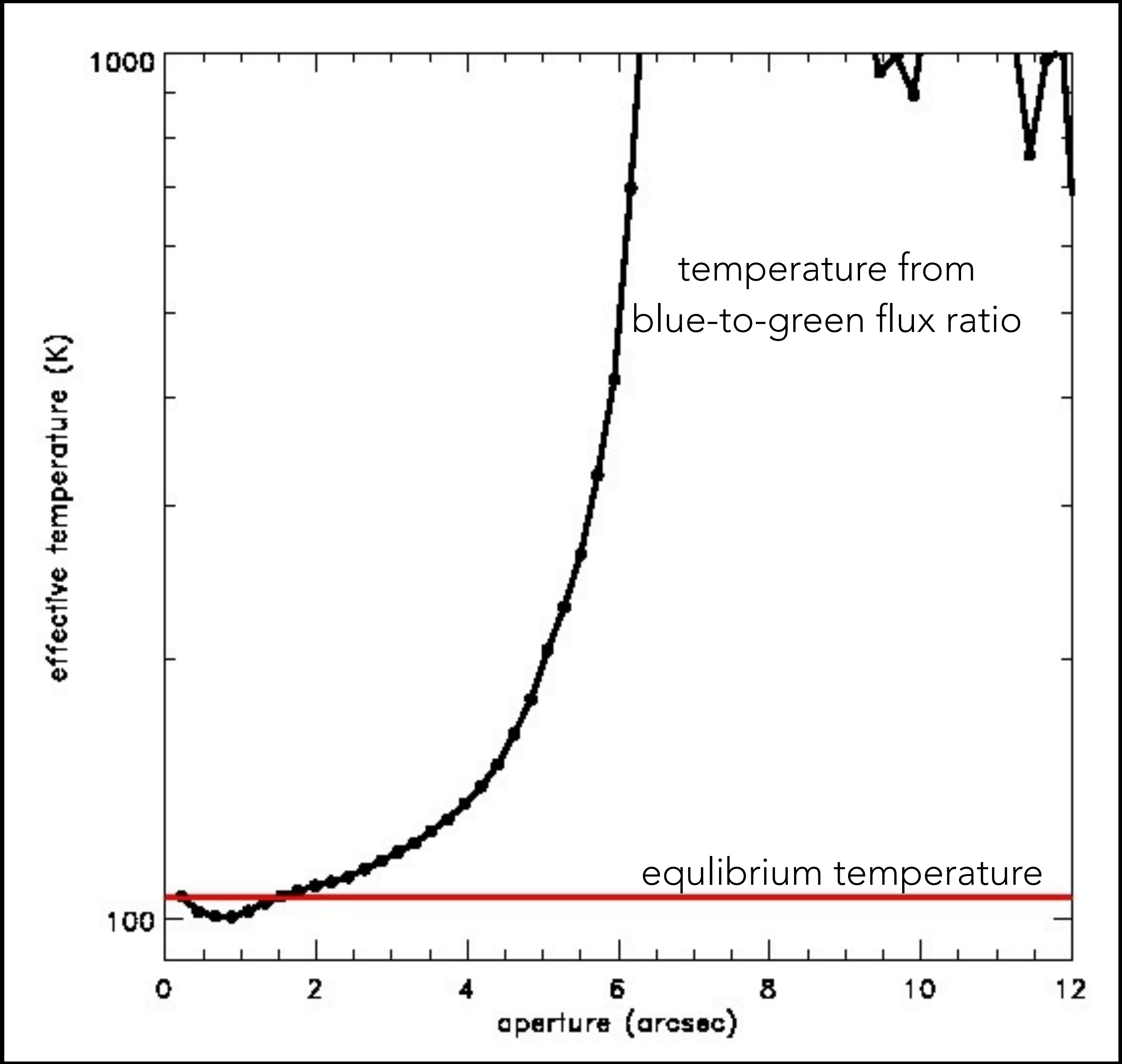
INTENSITY PROFILE RESULTS — RED BAND

- Nucleus: k_n = 6.0 mJy
- Coma:
    - k_c = 7.7 10^{-4} mJy/pixel
    - γ = 3.37
    - r_0 = 0.88 pixel
- Due to the wider PSF, it is difficult to distinguish between the PSF and coma contributions within the in 10” of the profile
- Further out, the image is dominated by background emission



DUST TEMPERATURE

- Let's assume diffuse dust in the inner part (nucleus or inner coma), too.
- In the nucleus/inner coma the dust temperature — assuming black body radiation, **β** = 0 — is roughly equivalent to equilibrium dust temperature of T = 280[K] (r/1au), indicating the presence of large dust grains here
- In the coma, the flux ratios indicate a higher temperature and/or **β**>0, i.e. the presence of smaller grains



DUST MASS / SIZE OF THE NUCLEUS ESTIMATES

- Assuming that the total emission of the inner component is originated from a ***solid*** nucleus, its size should be ~22km, much larger then calculated e.g. from water production measurements (~700m)

- If the full emission of the inner component is originated from large dust particles — from a region smaller than ~10000 km, otherwise it would be visible in the intensity profile — the mass of these large dust particles can be estimated by:

  - assuming black body radiation with T = 110 K

  - M = $\Delta^2 F_\nu / (\kappa_{abs} B_\nu(T))$, with κ_{abs} = 5.96 $m^2\ kg^{-1}$ (at 70um)

  - The calculated dust mass is $1.1 \cdot 10^8$ kg, equivalent to the mass of a ~60m sized body

- An upper limit on the coma mass:

  - Can be obtained using a black body estimate, but with a higher dust temperature of ~180K (obtained from 70 and 100um flux ratio in the outer component), based on the previous equation

  - M = $4.8 \cdot 10^7$ kg, about half of the mass of the inner component