

The Infrared Nuclear Emission of Seyfert Galaxies on Parsec Scales: Testing the Clumpy Torus Models

C. Ramos Almeida¹, N. A. Levenson², J. M. Rodríguez Espinosa¹,
A. Alonso Herrero³, A. Asensio Ramos¹, J. T. Radomski⁴,
C. Packham⁵, R. S. Fisher⁶, and C. M. Telesco⁵

¹Instituto de Astrofísica de Canarias, ²University of Kentucky, ³Instituto de Estructura de la Materia, ⁴Gemini South Observatory, ⁵University of Florida, and ⁶Gemini North Observatory
Email: cra@iac.es

Keywords. galaxies: active, galaxies: nuclei, galaxies: Seyfert, infrared: galaxies

We present subarcsecond resolution mid-infrared (mid-IR) photometry in the range from 8 to 20 μm of 18 nearby Seyfert galaxies, reporting high spatial resolution nuclear fluxes for the entire sample (see Table 3 of Ramos Almeida *et al.* 2009). We construct spectral energy distributions (SEDs) that the AGN dominates, relatively uncontaminated by starlight, adding near-IR measurements from the literature at similar angular resolution. We find that the IR SEDs of intermediate-type Seyferts are flatter and present higher 10 to 18 μm ratios than those of Seyfert 2 (Sy2) galaxies.

We fit the SEDs with the clumpy torus models of Nenkova *et al.* (2008) using the in-house-developed BayesClumpy tool (Asensio Ramos & Ramos Almeida 2009). We find that the clumpy models reproduce the high spatial resolution measurements. Regardless of the Seyfert type, even with high spatial resolution data, near- to mid-IR SED fitting poorly constrains the radial extent of the torus. Because the outer torus contains the coolest material, high angular resolution measurements at wavelengths longer than 15 μm are needed to reveal significant variations in the torus size. For the Sy2 galaxies, we find that edge-on geometries are more probable than face-on views, with a number of clouds along equatorial rays of $N_0 = 5\text{--}15$ and large values of the torus width ($\sigma = [50^\circ, 75^\circ]$). For the intermediate-type Seyferts, N_0 , σ , and the inclination angle of the torus are lower than those of the Sy2 nuclei. *This would imply that the observed differences between type 1 and type 2 AGNs would not be due to orientation effects only, but to different covering factors in their tori.* However, due to the limited size of the sample analyzed, these differences are not statistically significant, and a larger sample is needed to confirm it.

The columns of material responsible for the X-ray absorption are larger than those inferred from the model fits for most of the galaxies, which is consistent with X-ray absorbing gas being located within the dust sublimation radius, whereas the mid-IR flux arises from an area farther from the accretion disk. The fits yield both the bolometric luminosity of the intrinsic AGN and the torus-integrated luminosity, from which we derive the reprocessing efficiency of the torus. In the models, the outer radial extent of the torus scales with the AGN luminosity, and we find the tori to be confined to scales less than 5 pc (see Table 9 of Ramos Almeida *et al.* 2009).

References

- Asensio Ramos, A. & Ramos Almeida, C. 2009, *ApJ*, 696, 2075
Nenkova, M., Sirocky, M. M., Nikutta, R., Ivezić, Z., & Elitzur, M. 2008, *ApJ*, 685, 160
Ramos Almeida, C., *et al.* 2009, *ApJ*, 702, 1127