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James Webb Space Telescope reveals the diversity of obscuring dust in nearby active galactic nuclei: Nuclear isolation of MIRI/MRS datacubes and spectral fitting

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Abstract

Instead of the classical active galactic nuclei (AGN) torus, ground- and space-based infrared observations suggest a combination of an equatorial disk and a polar-extended component perpendicular to it. However, the debate on the ubiquity of a polar dusty extended structure remains. We investigate the capabilities of the mid-infrared instrument (MIRI) of JWST to advance our knowledge of AGN dust using the spectral fitting technique on an AGN collection of 21 nearby ($z < 0.05$) AGN (7 type-1 and 14 type-2 Seyferts) observations obtained with the medium resolution spectroscopy (MRS) mode.

This collection includes publicly available AGN and data from the collaboration of Galactic Activity, Torus, and Outflow Survey (GATOS). Thanks to the well-characterized and stable point spread function (PSF), we developed a tool named MRSPSFisol that decomposes MRS cubes into point-like and extended contributions. The extended data cube, a byproduct of this procedure, is used to obtain a template to further isolate the nuclear component when performing the spectral fitting. We found statistically good fits for 12 targets with current AGN dust models.

The model that provides good fits ($\chi^2/\text{dof} < 2$) for all of them assumes a combination of clumpy and smooth distribution of dust in a flare-disk geometry where the dust grain size is a free parameter. Still, two and one AGN statistically prefer the polar and the classical clumpy torus model, respectively. None of the currently available models can reproduce approximately 40% of the targets, likely due to the extreme silicate features not well reproduced by the models and signatures of water-ice and aliphatic hydrocarbon absorption features in most targets. New models exploring, for instance, new chemistry, larger optical depth, or larger tori are needed to explain the complexity of AGN dust continuum emission observed by JWST.

