SKIRT + INLA

Accelerating MCRT Simulations with Bayesian Inference

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PhD Brief

- **Objectives:**
  - Explore influence of magnetic fields, scattering and dust in the linear polarization of galaxies;
  - Extract and understand dust properties and distributions to correct systematics in extinction laws

- **Methods**
  1. Data reduction and analysis
  2. Apply Bayesian inference and other statistical learning methods
  3. Model the observed galaxies using MCRT models
  4. Compare with models with observations

Modeling with MCRT - Monte Carlo Radiative Transfer

Mattila, 1970

- Define an emitting body and a dust structure
- Simulate the emission of N photons by the body and their interaction with the dust
- Check the photon maps for different wavelengths

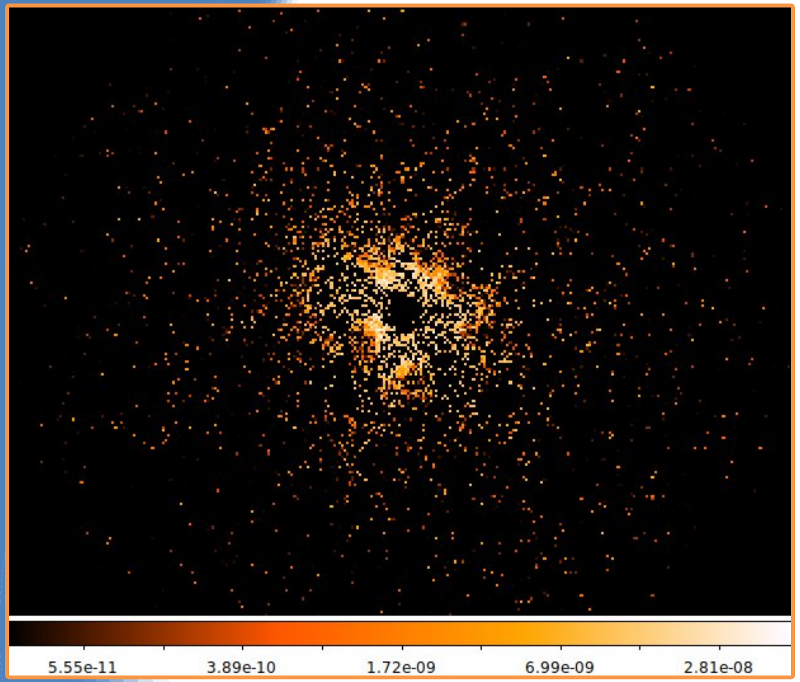
SKIRT

Baes et al., 2011

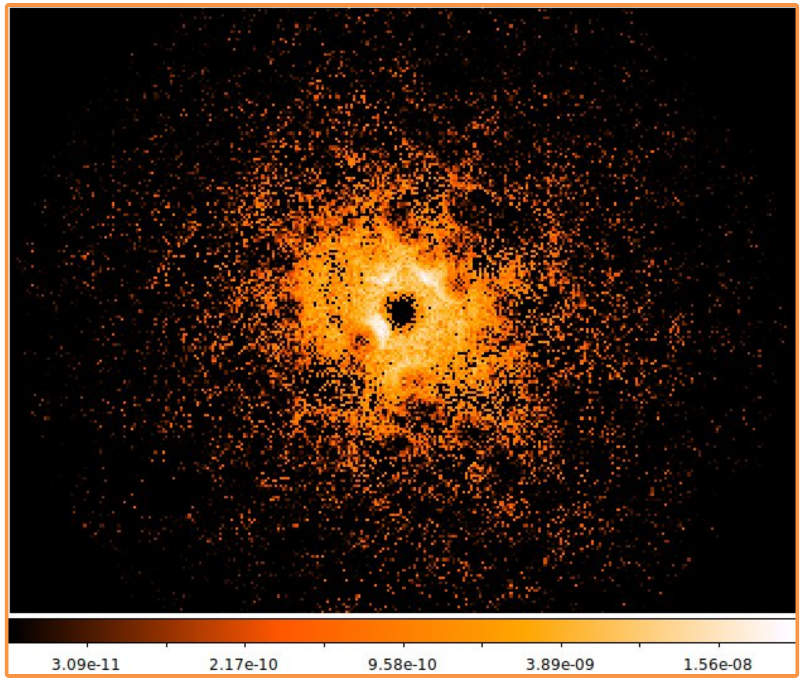
- MCRT suite that has tunable body and dust distribution templates
- Easier to simulate distinct scenes from different perspectives
- Simulates K photons per wavelength bin

SKIRT

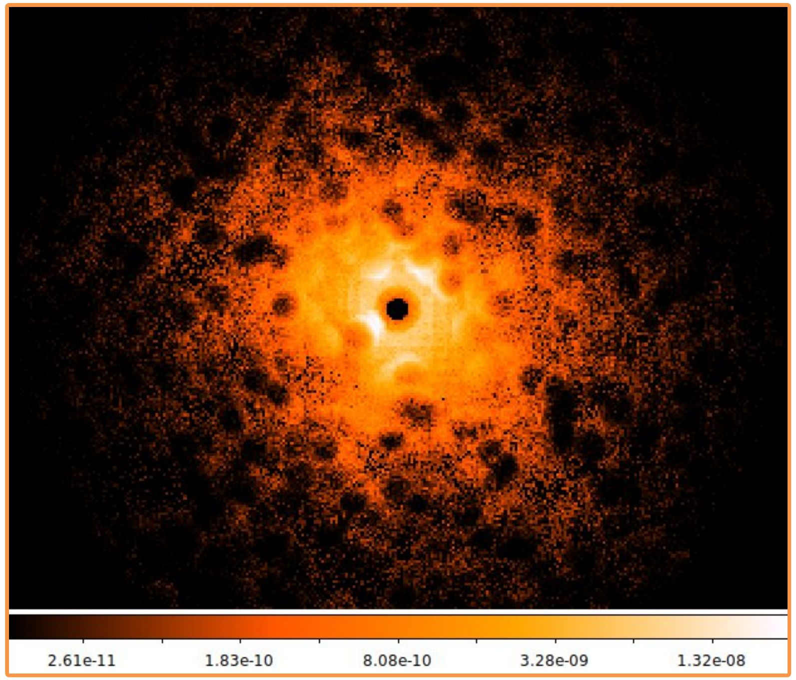
Simulations of face-on AGN, at 9.72 μm (by Marko Stalevski)



10^4 photons per bin
~5min



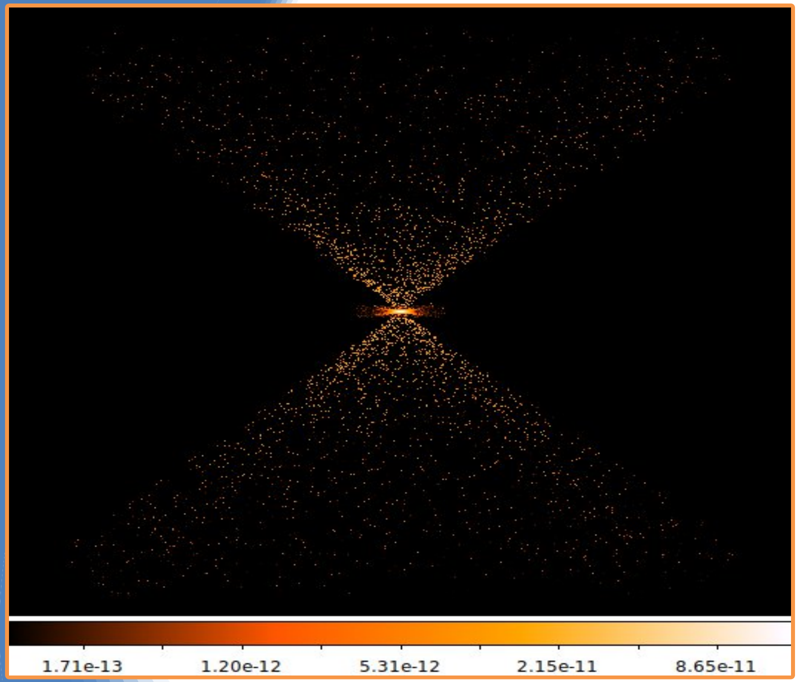
10^5 photons per bin
~6h



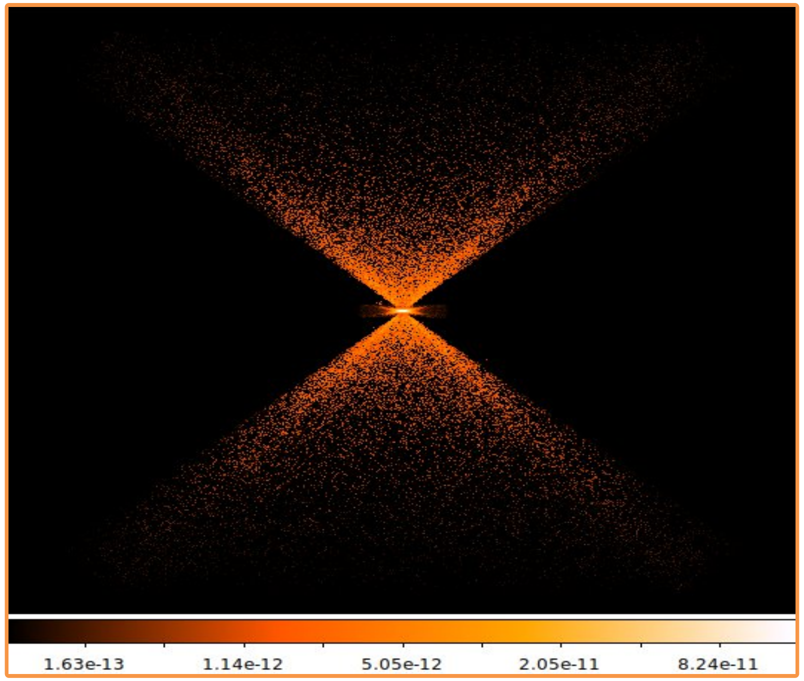
10^6 photons per bin
~2d

SKIRT

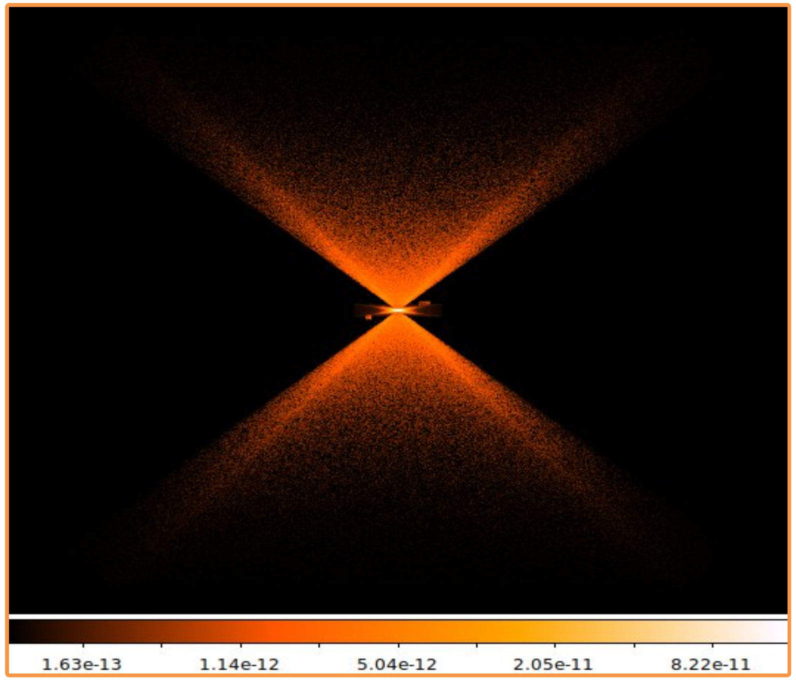
Simulations of edge-on AGN, at 9.82 μm (by Marko Stalevski)



10^4 photons per bin
~5min



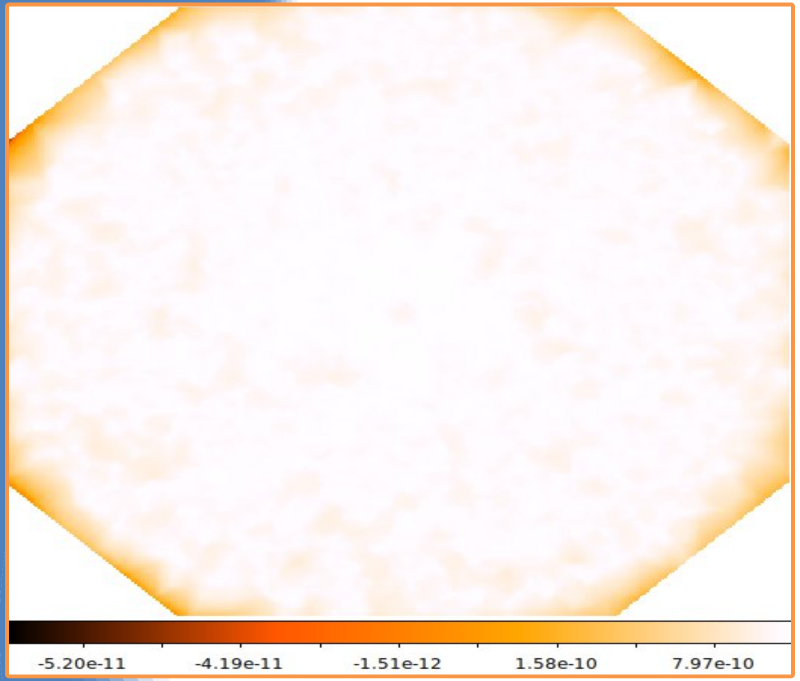
10^5 photons per bin
~6h



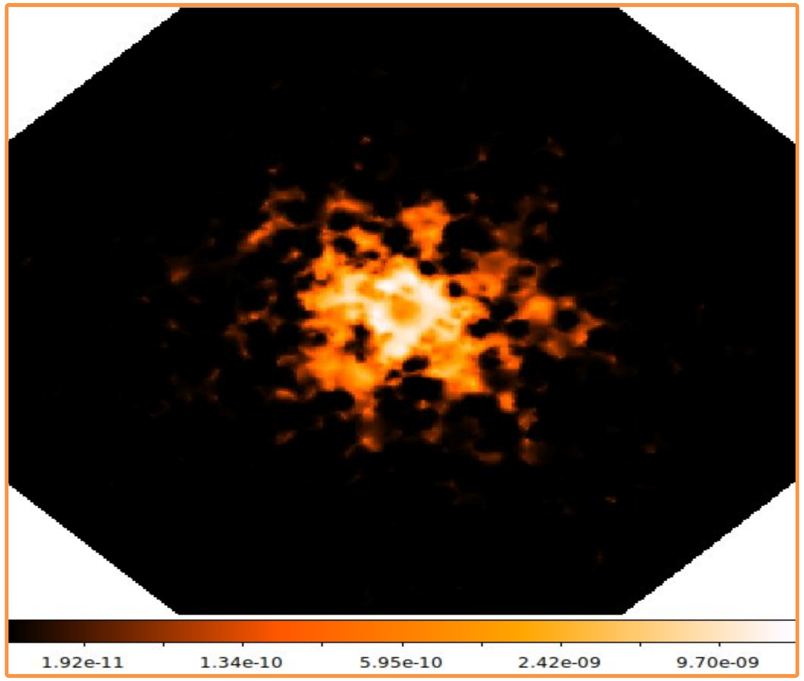
10^6 photons per bin
~2d

SKIRT + INLA

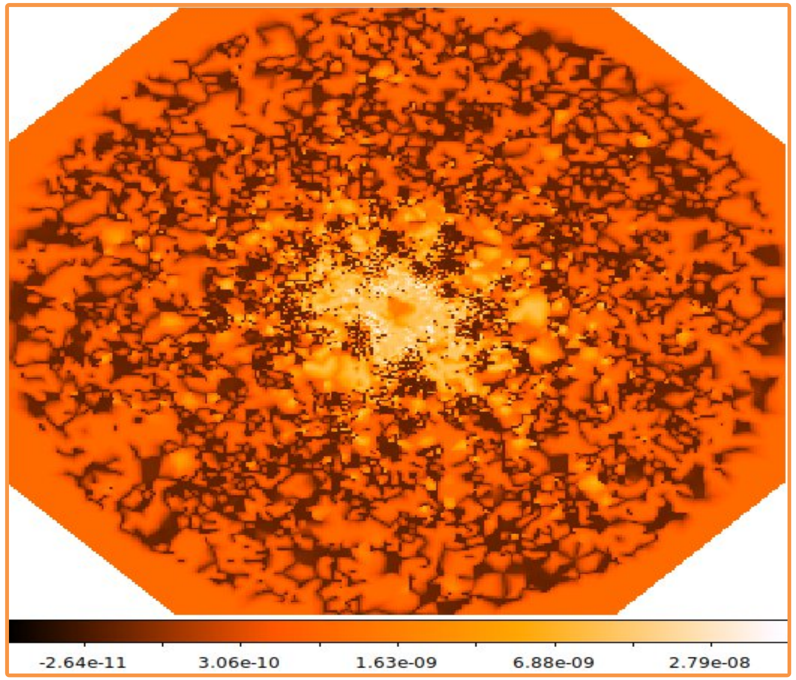
Upscaling face-on AGN, at 9.72 μm, with INLA



Regular input
~2min



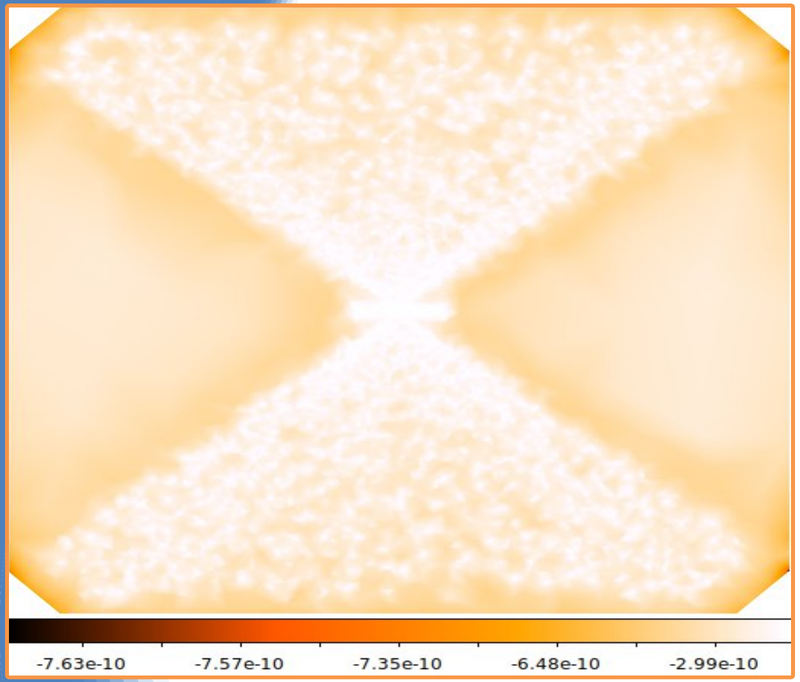
Log_{10} of input
~2min



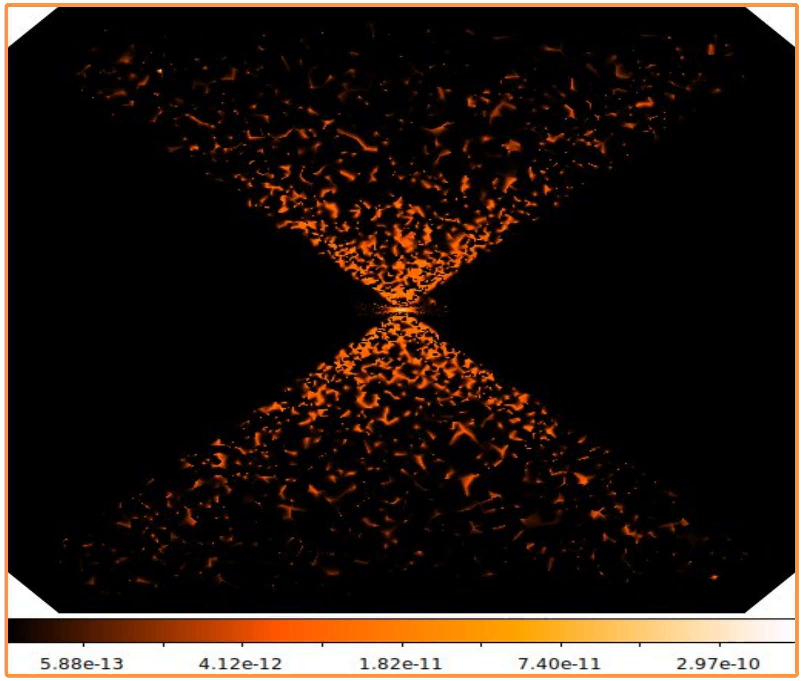
Normalized input
~2min

SKIRT + INLA

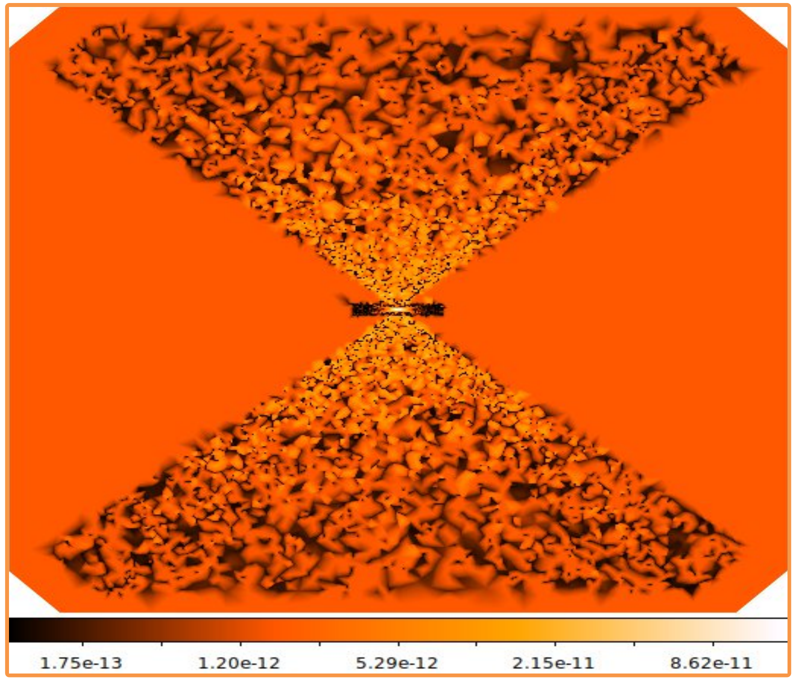
Upscaling edge-on AGN, at 9.82 μm, with INLA



Regular input
~2min



Log_{10} of input
~2min



Normalized input
~2min

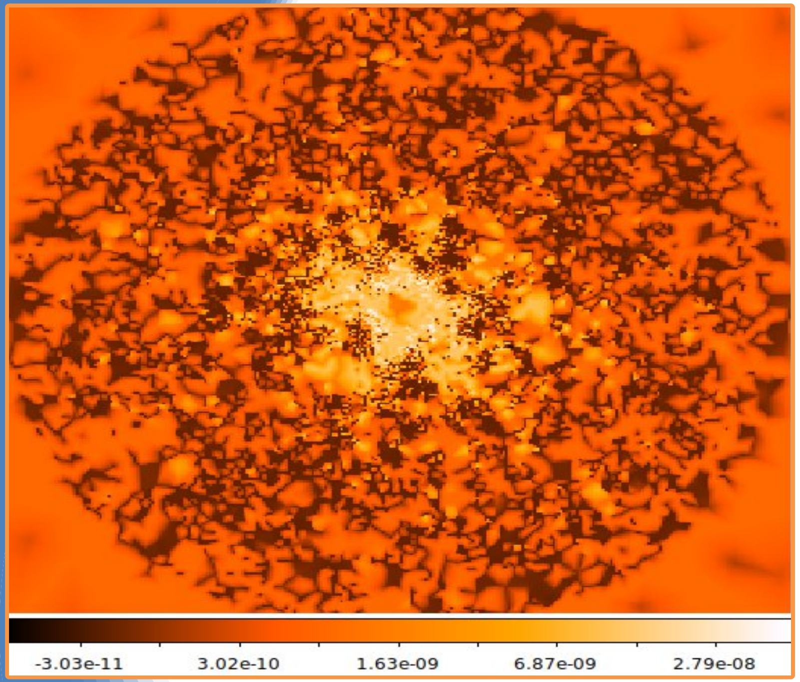
SKIRT + INLA

		Mean	SD	Median	MAD
T=0	INLA_SD	1,833E-05	1,124E-05	1,788E-05	1,517E-05
	Res	1,301E-10	1,126E-10	1,358E-10	1,178E-10
	Res/1e6	1,124E+06	2,663E+07	7,135E+03	1,073E+04
	Diff	-2,877E-05	5,723E-06	-2,814E-05	5,598E-06
	Diff/Res	3,391E+05	1,257E+08	-1,477E+05	1,256E+05
T=1	INLA_SD	2,399E+04	1,004E+05	6,141E+01	8,903E+01
	Res	-3,146E-13	2,625E-12	1,726E-15	3,621E-14
	Res/1e6	-2,296E+02	1,348E+04	8,196E-01	2,674E-01
	Diff	-3,976E+04	1,274E+05	-7,819E+01	1,139E+02
	Diff/Res	-1,442E+20	1,342E+22	-2,432E+14	6,971E+15
T=2	INLA_SD	1,166E-12	9,992E-13	8,140E-13	6,771E-13
	Res	-1,562E-12	2,062E-12	-1,089E-12	8,691E-13
	Res/1e6	-5,944E+03	1,715E+05	-5,746E+01	8,205E+01
	Diff	-3,273E-12	2,385E-12	-2,879E-12	2,178E-12
	Diff/Res	1,128E+01	2,652E+03	2,743E+00	1,303E+00

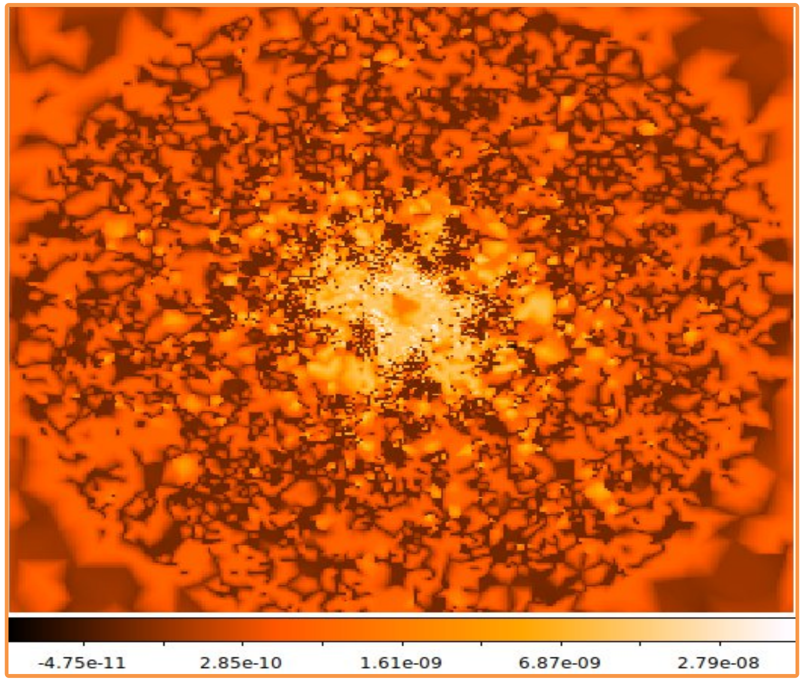
Possible statistical metrics to evaluate INLA's performance on SKIRT data

SKIRT + Imputation + INLA

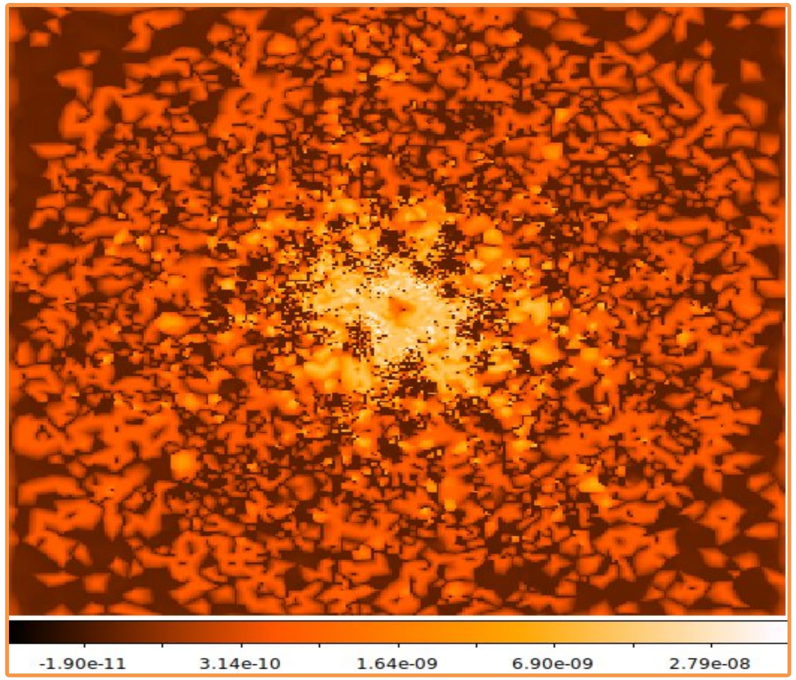
Upscaling face-on AGN, at 9.72 μm, with imputation of 0's on regular input before INLA



Imputation freq: 1/900



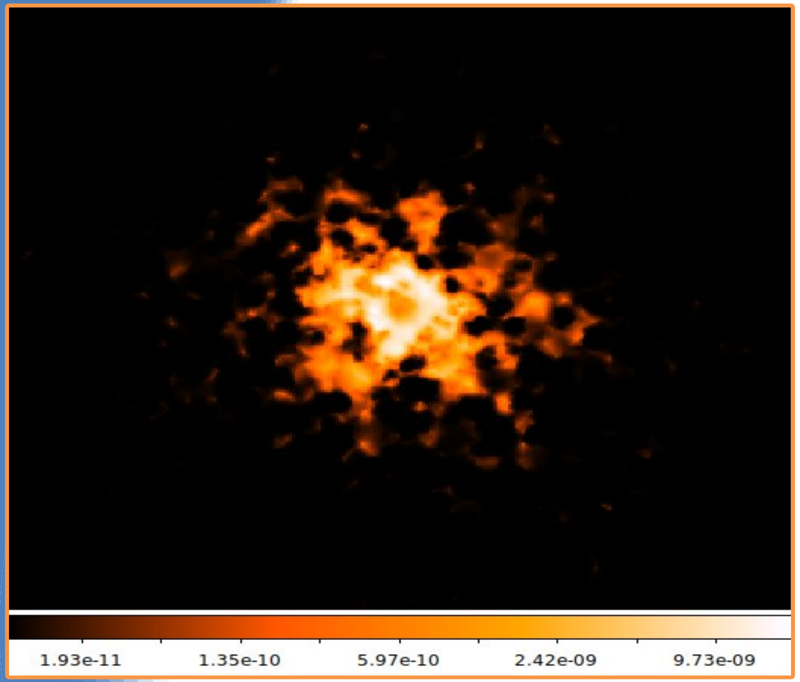
Imputation freq: 1/144



Imputation freq: 1/36

SKIRT + Imputation + INLA

Upscaling face-on AGN, at 9.72 μm, with imputation of -15's on $\log_{10}$ input before INLA



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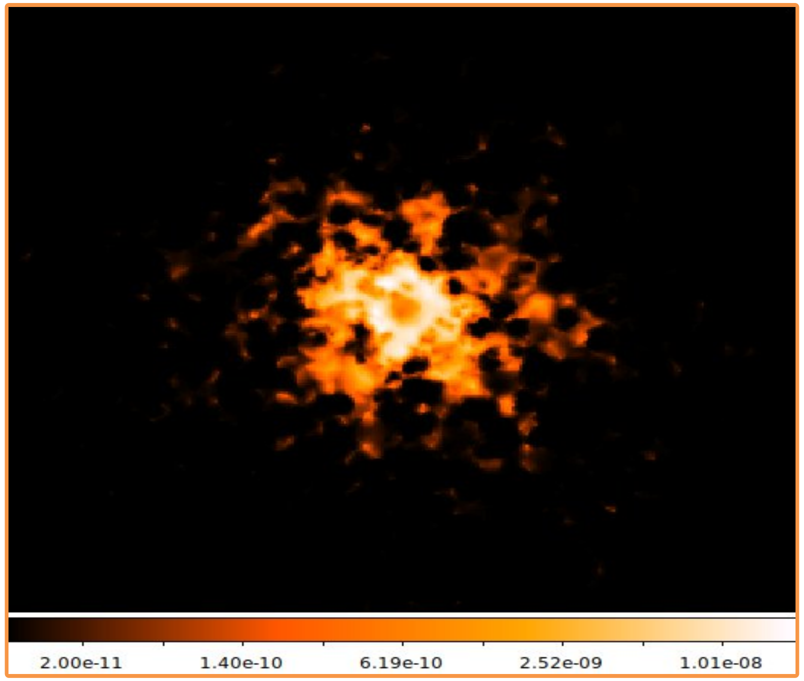
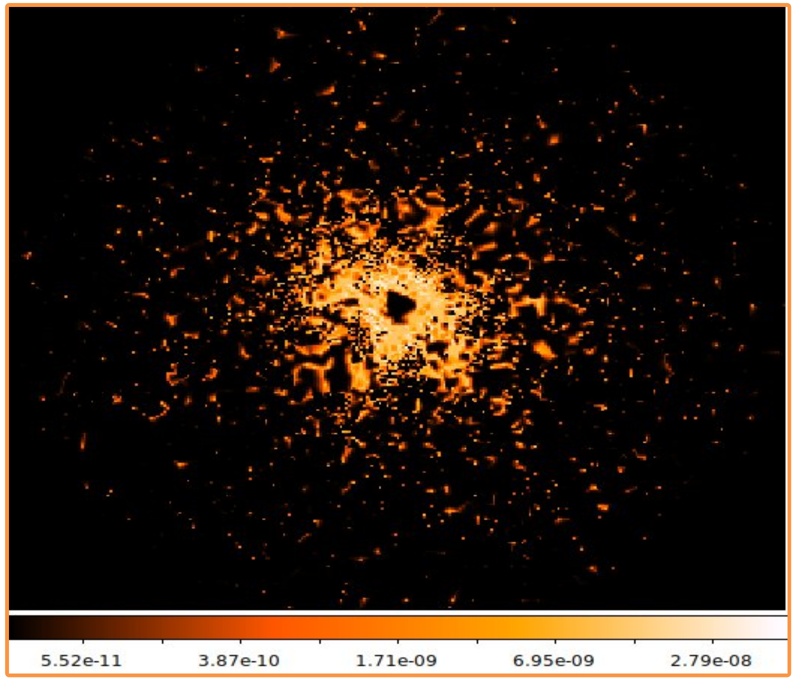


Imputation freq: 1/144



Imputation freq: 1/36

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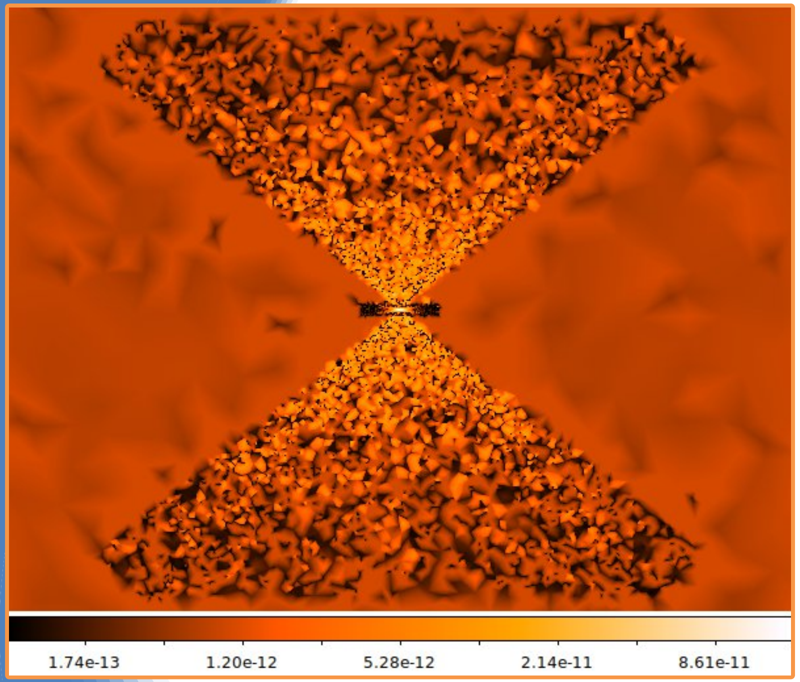

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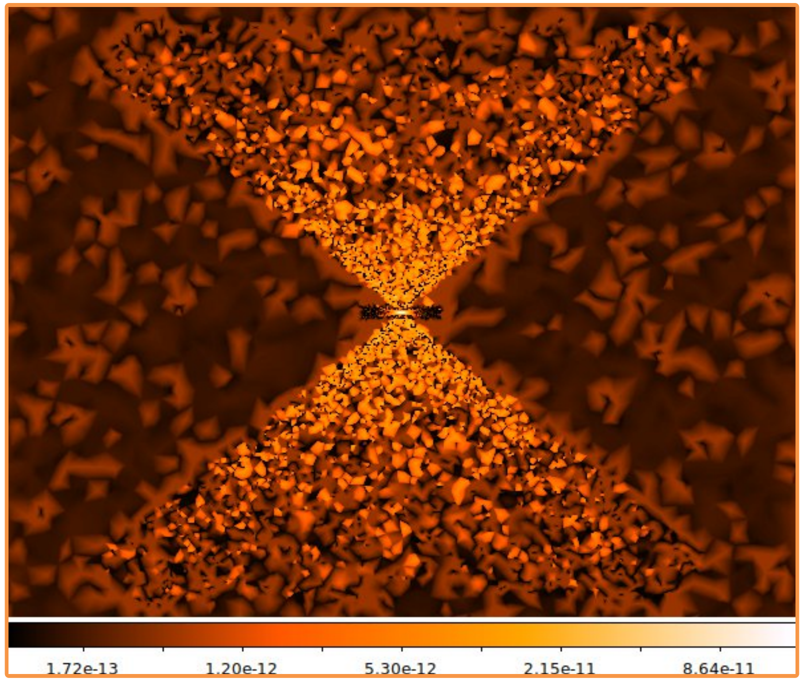
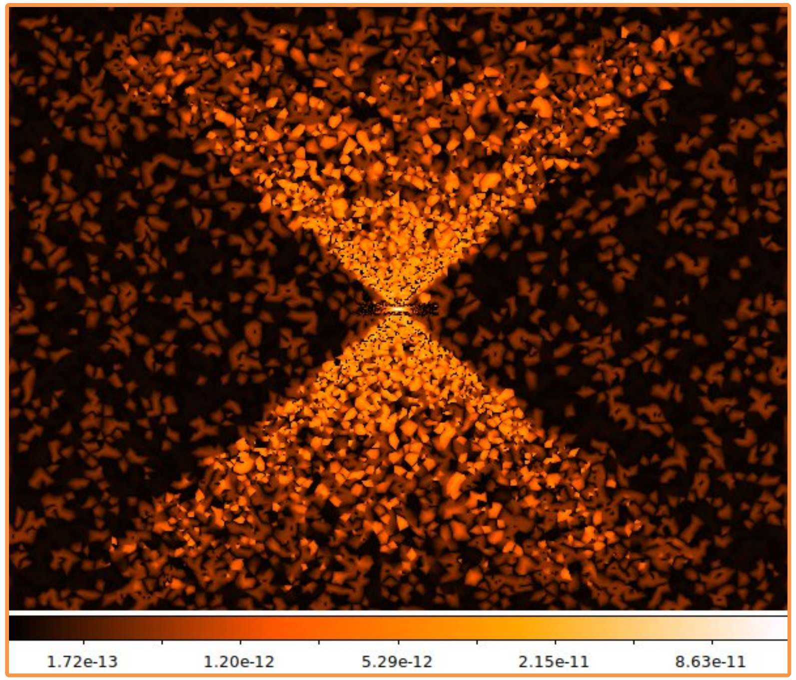


Imputation freq: 1/144



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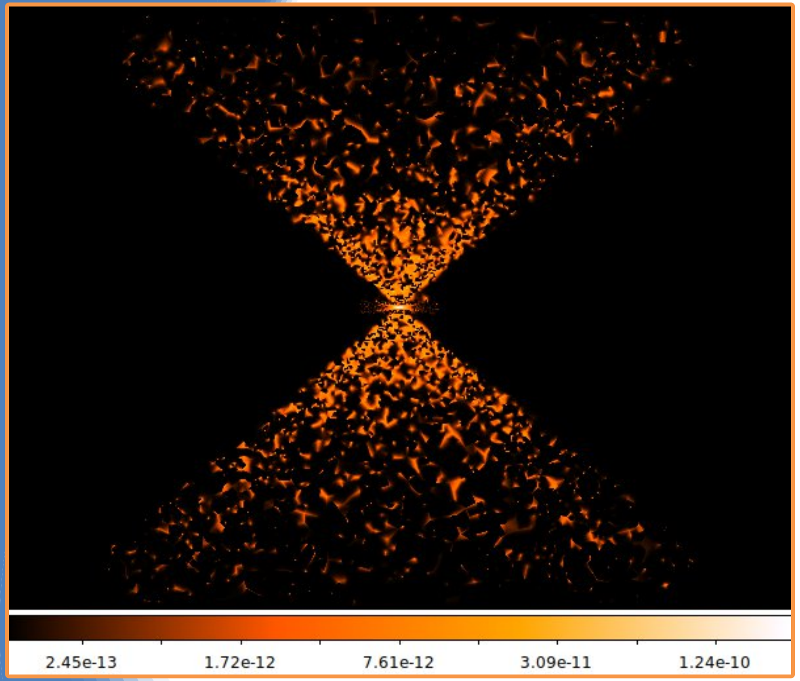

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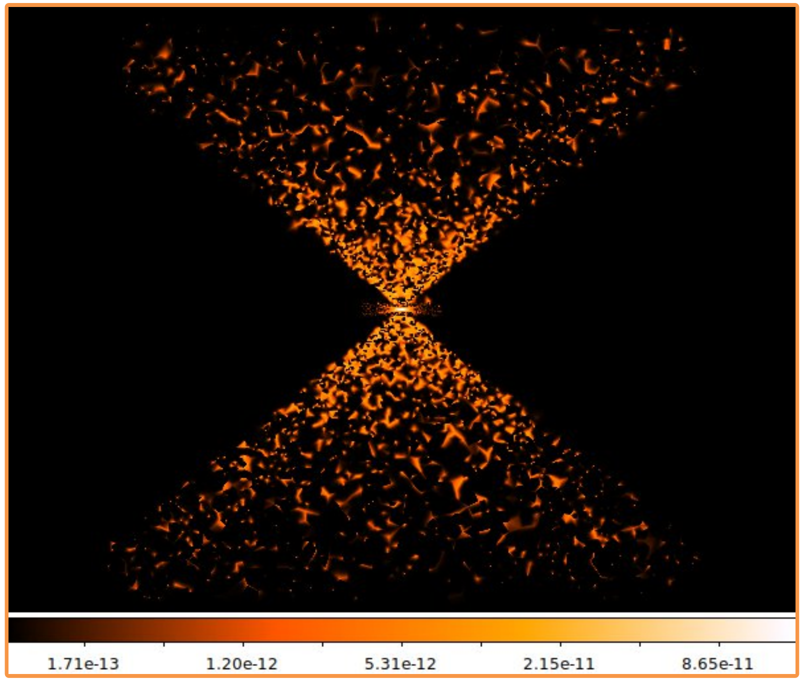

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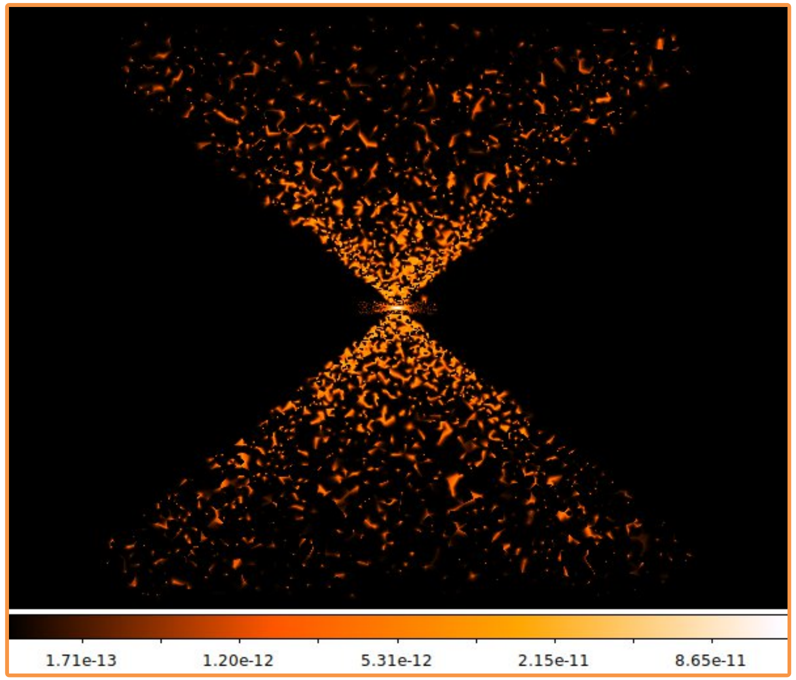

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