

STSM: Including polarization into radiative transfer code SKIRT

REPORT

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STSM Topic: Including polarization into radiative transfer code SKIRT

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SKIRT is a 3D continuum radiative transfer code based on the Monte Carlo algorithm (Baes et al. 2003, 2011). It is a flexible tool that can model the dust extinction, including both absorption and scattering, the thermal re-emission of dust, and the emission from very small grains and polycyclic aromatic hydrocarbon (PAH) molecules. The code is being very actively developed, led by Prof. Maarten Baes and his group at the Ghent University in Belgium. In a collaboration with this group, we have used the code SKIRT for modelling active galactic nuclei (AGN) dusty torus (Stalevski et al. 2012). We modeled the dusty torus as a clumpy two-phase medium, with high-density clumps and low-density medium filling the space between the clumps and calculated a grid of model spectral energy distributions (SEDs) and images of tori at different wavelengths (<https://sites.google.com/site/skirtorus/>).

As the radiation of AGN is polarized over a broad wavelength range, the observed polarization properties hold important information about geometry of the inner regions of AGN. When light is scattered, the angle of polarization depends on the direction of the last scattering, so the angle of polarization is expected to be related to the structure of the AGN. Thus, spectropolarimetric information can be used to constrain the geometry of different scattering regions, such as, the dusty torus, equatorial scattering regions and polar outflows.

Our aim is to expand the SKIRT code to include the calculation of polarization as well. During the first part of the visit, we discussed the polarization as a tool to study the structure of AGNs and identified the main scientific objectives. Although polarization studies of AGN with Monte Carlo radiative transfer studies have been done before, none of them were based on physically

motivated clumpy 3D geometries, such as is our model of the dusty torus.

In the second part of the visit, we discussed the details of implementation of calculating polarization in the SKIRT code and we identified the course of action and particular steps to be taken to successfully carry out this project. The most important steps include: (a) adopting photon class used in SKIRT to take into account all Stokes parameters instead of just intensity; (b) adopting the treatment of scattering of photons in SKIRT to use the full Mueller matrix instead of scattering phase function; (c) calculate properties of the dust (elements of Mueller matrix) for the dust mixtures already present in the SKIRT.