STSM: Including polarization into the radiative transfer code SKIRT

REPORT

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STSM Topic: Including polarization into the 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; Saftly et al. 2013; Camps et al. 2013). 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. 2012a, 2012b, 2012c). We modeled and analyzed infrared emission 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 was to extend the SKIRT code to include the treatment of polarization as well. In the previous STSM we discussed the polarization as a tool to study the structure of AGNs and

identified the main scientific objectives. We also discussed the details of implementation of calculating polarization due to scattering on dust grains and electrons in SKIRT. In between the two STSMs, SKIRT code has been substantially upgraded by Peter Camps and Maarten Baes to become more flexible and efficient. The applicant has been working on the routines related to polarization due to scattering. The most important changes relevant for polarization include updating the photon class to include all Stokes parameters, sampling of scattering angles from the appropriate phase functions depending on polarization state of the incident photon, changing the polarization state by applying Mueller matrix. During this STSM, we have been working together on implementing these routines and adapting them to the new structure of the code. These efforts have been successful and we will be able to produce the first results soon.

During the second week, Rene Goosmann from Observatoire Astronomique de Strasbourg joined us at the Ghent University. Rene Goosmann is the author of STOKES, a Monte Carlo radiative transfer code for modeling polarization. We were discussing the joint use of our codes for modeling polarization properties of AGNs in a broad wavelength range. For this purpose, we looked into the details of radiative transfer implementation in both codes and we conducted benchmark tests to ascertain that we can obtain consistent results.