Report of the Short Term Scientific Missions (STSM)

Polarization studies of AGN and their BLR with the radiative transfer code SKIRT

Dr Dragana Ilic
Faculty of Mathematics, University of Belgrade, Belgrade, Serbia

From November 9 to 16, 2013 I was visiting the Sterrenkundig Observatorium, Universiteit Gent (Gent, Belgium), where my host was Professor Maarten Baes. During my visit I daily discussed with Prof. Baes and Dr Marko Stalevski possible collaboration in investigation of the inner structure of active galactic nuclei (AGNs) using the polarization studies and SKIRT radiative transfer code.

There are still many open questions related to the inner structure of AGNs, e.g. the physical properties of the broad line region (BLR), its structure and location, as well as its connection with the surrounding dusty torus.

SKIRT is a 3D continuum radiative transfer code based on the Monte Carlo algorithm (Baes et al. 2003, 2011). It has been used to model variety od dusty environments, e.g. different types of galaxies (Baes et al. 2010; de Looze et al. 2010), but our group, in a collaboration with the group of Prof Baes, have used the code SKIRT for modelling the 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/). At the moment, the code includes calculation of dust emission, self-absorption and scattering. The radiation of AGN is polarized over a broad wavelength range, thus the polarization properties can be exploited to constrain the geometry of the emitting and scattering regions. 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, accretion disk and polar outflows.

During this STSM, we discussed the following: a) 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. Therefore, we considered the possibilities to expand the SKIRT code to include the calculation of polarization as well. b) the details of implementation of calculating polarization in the SKIRT code. We identified the course of action and particular steps to be taken to successfully carry out this project, e.g. setting photon class used in SKIRT to take into account all Stokes parameters instead of just intensity, etc. c) the possibility to model the polarized light in broad emission lines, since in 2012 we started the spectropolarimetric monitoring program of 12 broad emission line AGNs with the 6m telescope of Special Astrophysical Observatory of the Russian Academy of Science.

We would like to thank the COST action 1104 for help in realization of this mission and we hope that we will be able to present some results very soon. Also, the plan is to present the results from this research during the special session "Spectral Lines and Polarization" of the COST Action MP1104, that will be organized in the frame of the "9th Serbian Conference on Spectral Line Shapes in Astrophysics", in Serbia, May 2013.