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EXPANDING SKIRT'S CAPABILITIES: X-RAY RADIATIVE TRANSFER IN PARTIALLY IONIZED MEDIA

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The SKIRT[1] radiative transfer (RT) code (Camps & Baes 2015, 2020), originally developed as a Monte Carlo code for dust RT (Baes et al. 2003, 2011), has recently been expanded to include a broader range of physical processes and applications, including X-ray RT. These extensions focused on absorption and scattering by dust, pure electrons, and neutral gas, with AGN circumnuclear media as the primary application (Van der Meulen 2023), and also incorporated polarized Compton scattering (Van der Meulen2024). However, many X-ray sources involve a medium that is neither fully neutral nor fully ionized, resulting in a partially ionized state where different ions of the same element coexist. We aim to extend SKIRT's capabilities to handle this complexity.

This new implementation will enable SKIRT to treat partially ionized media, incorporating not only the existing treatment of photoabsorption and fluorescence but also additional physical processes such as radiative (de)excitation and continuum recombination. These are essential for accurately modeling the soft X-ray spectra of both Compton-thin and obscured sources (e.g. Guainazzi et al. 2007, Kallman et al. 2014). Our long-term goal is to develop a self-consistent model that internally uses precomputed Cloudy (Gunaskera et al. 2023) tables to determine the ionization structure. As a first step, however, we adopt a simpler approach by importing a fixed ionization structure from Cloudy.

[1]https://skirt.ugent.be/

This development will substantially improve our ability to model X-ray radiation in extreme environments. With its modular design and broad applicability, SKIRT offers an ideal platform for integrating the necessary physics. Its Monte Carlo framework supports detailed, self-consistent simulations across a wide range of source geometries and physical conditions. As a key application, we highlight the potential of this extension for spectropolarimetric analysis of MHD-driven accretion disk winds in AGN and X-ray binaries.