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RadioPropa: A Modular Raytracer for In-Matter Radio Propagation

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Experiments for radio detection of UHE particles such as e.g. ARA/ARIANNA or NuMoon require detailed understanding of the propagation of radio waves in the surrounding matter. The index of refraction in e.g. polar ice or lunar rock may have a complex spatial structure that makes detailed simulations of the radio propagation necessary to design the respective experiments and analyse their data. Here, we present RadioPropa as a new modular ray tracing code that solves the eikonal equation with a Runge-Kutta method in arbitrary refractivity fields. RadioPropa is based on the cosmic ray propagation code CRPropa, which has been forked to allow efficient incorporation of the required data structures for ray tracing while retaining its modular design. This allows for the setup of versatile simulation geometries as well as the easy inclusion of additional physical effects such as e.g. partial reflection on boundary layers in the simulations. We discuss the principal design of the code as well as its performance in example applications.

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