3-Dimensional Nuclear-Recoil-Flux/Energy Distributions Observed in Directional Dark Matter Detection Experiments

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Abstract: In the last (more than) three decades, more than 40 experiments have been built or are being planned to search for different WIMP (Weakly Interacting Massive Particle) candidates by direct detection of their (elastic) scattering signals off target nuclei in low–background underground laboratory detectors. While most direct Dark Matter detection experiments measure only the recoil energies of WIMP events, "directional" DM detection experiments proposed more than one decade aim to provide 3-dimensional information (recoil tracks and/or head–tail senses) of WIMP–scattered target nuclei, as a promising experimental strategy for discriminating WIMP signals from backgrounds.

In this talk, I will first introduce briefly the basic concepts of directional DM detection experiments and phenomenology. Then I will describe our double–Monte Carlo scattering–by–scattering simulation package for 3-dimensional elastic WIMP–nucleus scattering in detail. In the main part of my talk, (the "annual modulations" of) the angular distributions and the recoil–angle dependences of the recoil direction (flux)/energy of target nuclei observed in different (celestial) coordinate systems will be demonstrated. The impact of the cross section (nuclear form factor) suppression as well as some common misunderstandings in literature will particularly be discussed in detail.