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Development of a super-resolution optical microscope for directional Dark Matter search experiment

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The Dark Matter (DM) existence is one of the most open and discussed questions nowadays. The best candidates are so-called Weakly Interactive Massive Particles (WIMPs) with mass ranging from few GeV to a few TeV that interact with ordinary matter with cross sections typical or smaller than that of the weak processes. The motion of the Sun inside the galaxy causes an anisotropy in direction of WIMP-induced nuclear recoils, and, as it has never been observed, its evidence would unambiguously prove the existence of WIMP particles as DM constituents, which makes the directional DM search an extremely interesting and important issue from the point of view of fundamental science. Nuclear emulsion is a perfect choice for a detector for directional DM search because of its high density and the best position accuracy. The track length of recoil nuclei in emulsion is of the order of 100 nm, making the resolution of conventional optical microscopes insufficient to resolve them. Here we report about the R&D on a super-resolution optical microscope to be used in a future directional DM search experiment with nuclear emulsion as a detector media. The microscope will be fully automatic, will use novel image acquisition and analysis techniques, will achieve the spatial resolution of the order of few tens of nm and will be capable of reconstructing recoil tracks with the length of at least 100 nm with high angular resolution.

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