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The Sensitivity of C2H2F4 superheated liquid detector for WIMP dark matter search

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Observation of the rotational velocity of stars in our galaxy and other gravitational effects point to the existence of huge non-luminous matter which is known as Dark Matter. The most promising candidate of dark matter is the weakly interacting massive particles (WIMPs). They naturally give the appropriate relic abundance and also appear in the theories of weak scale physics beyond the standard model. The predicted mass of WIMPs varies from few MeV to few hundreds of TeV. It can be detected by the recoil nuclei from the WIMPs-nuclear elastic scattering in the detector material by the direct detection process. Superheated liquid detector (SLD) with C2H2F4 (b.p. = -26.3 oC) liquid has the potential to detect the low mass WIMPs. The major advantage of SLD is that the certain backgrounds can be rejected by adjusting the operating temperature and pressure of the detector. The calculation shows that SLD with C2H2F4 liquid at the operating temperature of 60 oC is found to be able to detect 140 MeV, 430 MeV, and 540 MeV WIMP masses by the elastic collision with 1H, 12C, and 19F nucleus respectively. At this high temperature, SED becomes sensitive to background gamma rays also. The reduced background environment is essential for such an experiment searching for the WIMPs. The initiative of the experiment has been started at the Jaduguda Underground Science Laboratory (JUSL), UCIL, Jharkhand, India, at 555 m deep underground from the surface. The preliminary measurement was performed at JUSL with an exposure of 101.2 gm.hr at a temperature of 24 oC. The background count rate was observed to be as 7.96 x10ˆ-2 (kg)ˆ-1 and the maximum sensitivity that can be achieved at this temperature and exposure is 3.80 x 10ˆ-33 cmˆ2 at a WIMP mass of 7 GeV. It is already established that the C2H2F4 SLD has the potential to probe WIMPs-nucleon spin-independent cross section with a projected sensitivity levels (at 90% C.L.) better than 4.6 × 10ˆ-41 cmˆ2 at WIMP masses down to ~4 GeV with a total exposure of ~1000 kg.day for a zero background consideration. The R & D has been started to increase the mass of the detector and the aim is to reach this highly sensitive region in several steps by increasing the exposure of the detector and lowering the backgrounds in near future.

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