

The Methods for Direct Detection of WIMP with Mass $\leq 0.5 \text{ GeV}/c^2$

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Abstract The chamber for direct detection of WIMP with mass $\leq 0.5 \text{ GeV}/c^2$ was developed. The chamber is filled with gas mixture Ne+10%H₂ (0-1bar)+0,15ppm Ge(CH₃)₄. For events detections used GEM+pin-anode, which provides the energy threshold about eV. The electron background is suppressed owing to photosensitive addition Ge(CH₃)₄. It is proposed also for direct detection of WIMP the liquid argon chamber with H₂ dissolved in liquid argon at a concentration 100ppm+0,015ppm Ge(CH₃)₄.

Keywords Search the Low Mass WIMP, Metallic GEM+pin-anode, The Energy Threshold about eV

1. Introduction

The detectors with pure NaI, Xe, or Ar allow to search the WIMP with large mass (of dozens or hundreds GeV), because the energy of nuclear recoils in these detectors from low mass WIMP are low. To account for yearly modulation effect in DAMA-LIBRA experiment [1] J.Va'vra [2] have supposed that this effect is explained by low mass WIMP scattering on protons in H₂O molecules which contamination about 1ppm in NaI crystals.

2. Spherical Proportional Detector

The spherical proportional detector was developed for search the low mass WIMP [3].

This detector was filled with H₂ or Ne and has the energy threshold about 100 eV.

3. Double-phase Argon Chamber

The double-phase argon chamber with mass up to 10⁴ tons was proposed for WIMP detection in our work [4]. For electron background suppression was proposed the photosensitive addition Ge(CH₃)₄.

For detecting events in gas-phase was developed the

system GEM+ pin-anode with 10%H₂ addition and $K_{\text{ampl}}=5 \cdot 10^7$ [5]. The concentration H₂ in liquid Ar is equal about 100 ppm, this allows to detect the low mass WIMP ($\leq 0.5 \text{ GeV}$) also because the concentration H₂ is 100 time more then in [1].

4. The Chamber with Ne+10%H₂(0-1bar) Filling

On Fig. 1 is shown the system GEM+ pin-anode, which is used for events detecting in this chamber and in double-phase argon chamber. The fronts of signal in this system is equal $\leq 3 \mu\text{sec}$. The detecting of front allows to measure the event dimension in z-direction for electron background suppression.

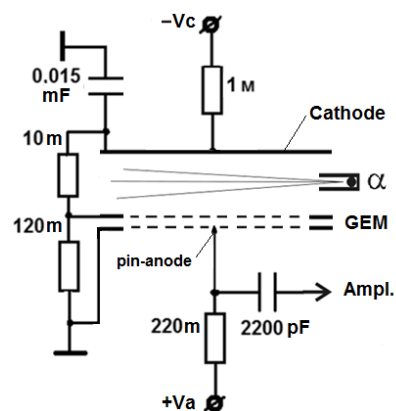


Figure 1. GEM+pin-anode

The addition in chamber of Ge(CH₃)₄ allows to suppress the electron background (gamma-background, Ar³⁹ and tritium decays).

On Fig. 2 the dependence of K_{ampl} on potential difference between the pin-anode and GEM is shown. The use in chamber of spectrometric amplifier allows to obtain the energy threshold about eV. This energy threshold allows to search The WIMP with mass $\leq 0.5 \text{ GeV}/c^2$ [3]. Double-phase Ar chamber or the chamber with Ne+10%H₂ filling are placed in low background laboratory in low background shielding for search the yearly or daily modulation effects.

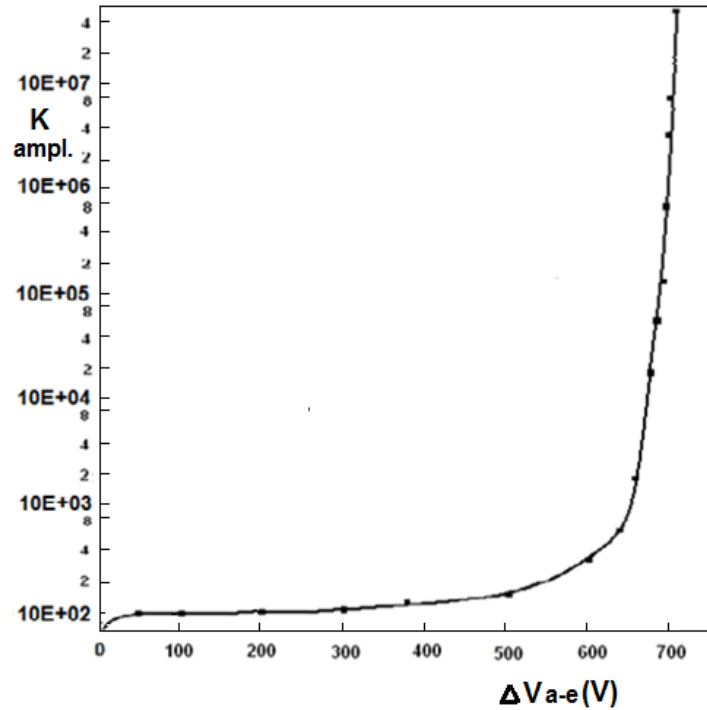


Figure 2. The dependence of $K_{\text{ampl.}}$ on potential difference between the pin-anode and GEM

The chamber with $\text{Ne}+10\%\text{H}_2$ filling is shown on Fig.3.

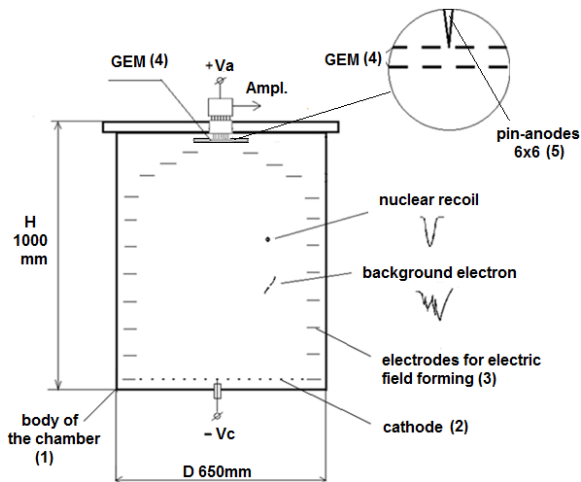


Figure 3. The chamber with $\text{Ne}+10\%\text{H}_2$ filling.

5. Conclusions

The method of H_2 addition in liquid Ar and method of event detecting, proposed in this paper allow to search the

low mass WIMP in all experiments with Ar chamber.

REFERENCES

- [1] R.Bernabei, P.Belli, F.Cappella, V.Caracciolo, S.Castellano, R.Cerulli, C.J.Dai and A.d'Angelo," Final model independent result of DAMA/LIBRA-phase1", Eur.Phys.J. C73 (2013) 12, 2648R.
- [2] J. Va'vra,"A New Possible Way to Explain the DAMA Results" arXiv:1401.0698v5, (2014), Physics Letters B 735 (2014)181.
- [3] Y. Giomataris, I. Irastorza, I. Savvidis et al., "A Novel Large-volume Spherical Detector with Proportional Amplification read-out", JINST 3:P09007, (2008).
- [4] B.M. Ovchinnikov, Yu .B .Ovchinnikov, V.V. Parusov, "Massive liquid Ar and Xe detectors for direct DM searches", JETP Lett. , 96, (2012) 149-152 , Universal Journal of Physics and Application 1(2): 66-70,2013.
- [5] B.M. Ovchinnikov,V.V. Parusov, "Methods for Detecting Events in Double-Phase Argon Chambers", Instruments and Experimental Techniques, 2013 , Vol.56 , No.5 , pp. 516-520.