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PARTICLE DARK MATTER SEARCH WITH LIQUID XENON DETECTOR AT GRAN SASSO: STATUS REPORT

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for the DAMA group

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Abstract

An update of the direct dark matter search with liquid xenon target-detector at Gran sasso is presented.

We pointed out since ref. (Belli et al., 1990) the interest in using a liquid xenon scintillator as target-detector for particle dark matter search. For this purpose we realized firstly a $\simeq$ 3.5 Kg prototype not optimized for low activity. The performances of that prototype was studied in detail (Belli et al., 1993); it allowed us to confirm a quenching factor for αs equal to 1.2 and a different decay time between electrons and αs: (41 $\pm$ 6) ns and (30 $\pm$ 1) ns respectively. This information supports an higher quenching factor for recoil nuclei than expected from Lindhard theory (Lindhard, 1963) due to the recombination effect (estimate $\simeq$ 0.8) and the possibility of a statistical discrimination at low energy between electrons and recoils. Both these estimates will be soon verified at neutron beam with a dedicated set-up. Because the prototype was not a low activity detector, we measured independently and subtracted - by a procedure described elsewhere (Bacci et al., 1994) - the environmental background contribution to the low energy spectrum (15-50 keV) filling the detector with Xenon gas at 2.5 bar. The residual spectrum can be ascribed only to eventual WIMP-nucleus elastic scatterings or contaminants present in the xenon, whose rate depends on the mass, like e.g. ^{85}Kr and radon. A preliminary exclusion plot for spin dependent interaction on ^{129}Xe and ^{131}Xe has been reported in ref. (Bacci et al., 1994). Spin factors (Ellis and

Flores, 1991), nuclear form factors (Engel, 1991; Engel et al., 1992), energy resolution and detector efficiency have been considered.

We have now installed in Gran Sasso the low activity detector (volume is now $\simeq 2$ liters, i.e. $\simeq 6$ Kg of xenon target) and we calibrated it with ^{109}Cd source. The light collection is assured by three EMI photomultipliers with MgF_2 windows working in coincidence: the energy threshold is now $\simeq 8$ keV electron equivalent (see fig.1).

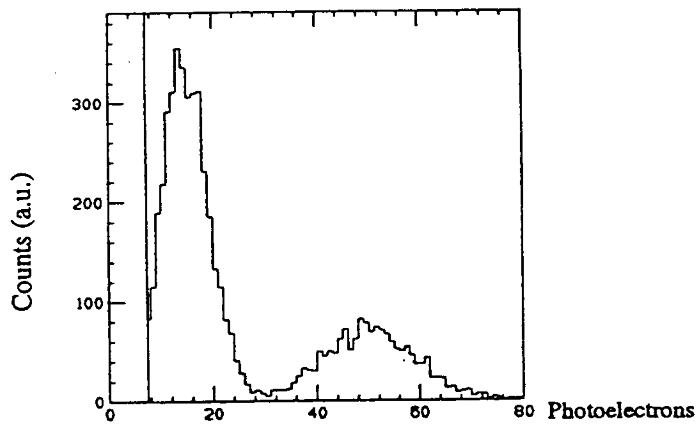

Figure 1: *Response of the low activity LXe scintillator to a bare ^{109}Cd source; 3 photomultipliers in coincidence.*

The vessel is made by OFHC low activity copper with less than 100 μBq/Kg from U/Th and less than 310 μBq from potassium. The shield is made by 5-10 cm low activity copper, 5 cm Boliden lead, $\simeq 1$ mm Cadmium and $\simeq 10$ cm polyethylene.

Preliminary measurements have been performed with natural xenon 4.8 by Messer - Griesheim. The residual integral rate between 8 and 30 keV electron equivalent is less than 657 cpd/Kg at 1 σ C.L. In fig. 2 the exclusion plot evaluated taking into account the old and present data is shown.

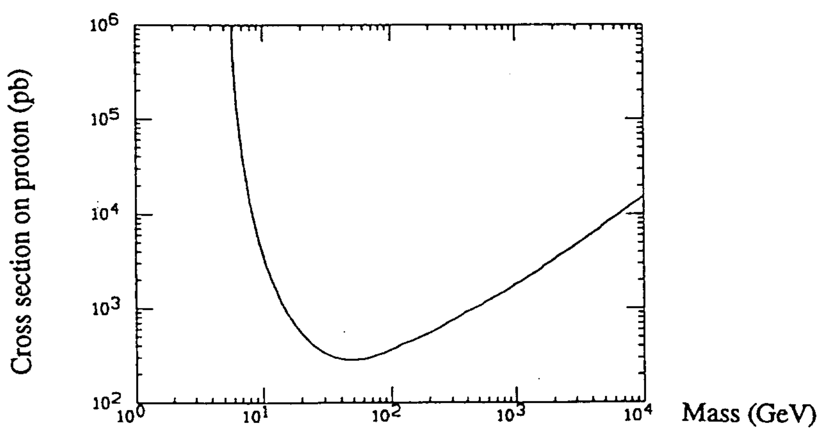

Figure 2: *Exclusion plot for axially coupled WIMPs.*

We have investigated the origin of the still remaining background: part is due to the ^{85}Kr content in the used gas and part is due to the purification system. In particular we measured the activity of the OXISORB cartridge obtaining: (431 ± 9) ppb of ^{232}Th, (298 ± 33) ppb of ^{238}U and (24 ± 5) ppm of ^{nat}K. The limits measured for the getter materials are indeed well reduced. We plan now to modify the purification system and install a second radon trap.

Measurements with Kr-free and xenon enriched once in even and once in odd spin isotopes are in preparation (Belli et al., 1994). The comparison of these results could give us information on the nature of the WIMP-nucleus coupling or an improved sensitivity in the exclusion plot (Belli et al., 1994). Further measurements to look for annual modulation are foreseen.

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