Analysis of Data from direct Dark Matter searches or Going to the Limit!

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Motivation of the upper limit-plots

- Compare diffent Dark Matter and accalerator experiments
- Compare with theory
- For playing:
  http://pisrv0.pit.physik.uni-tuebingen.de/darkmatter

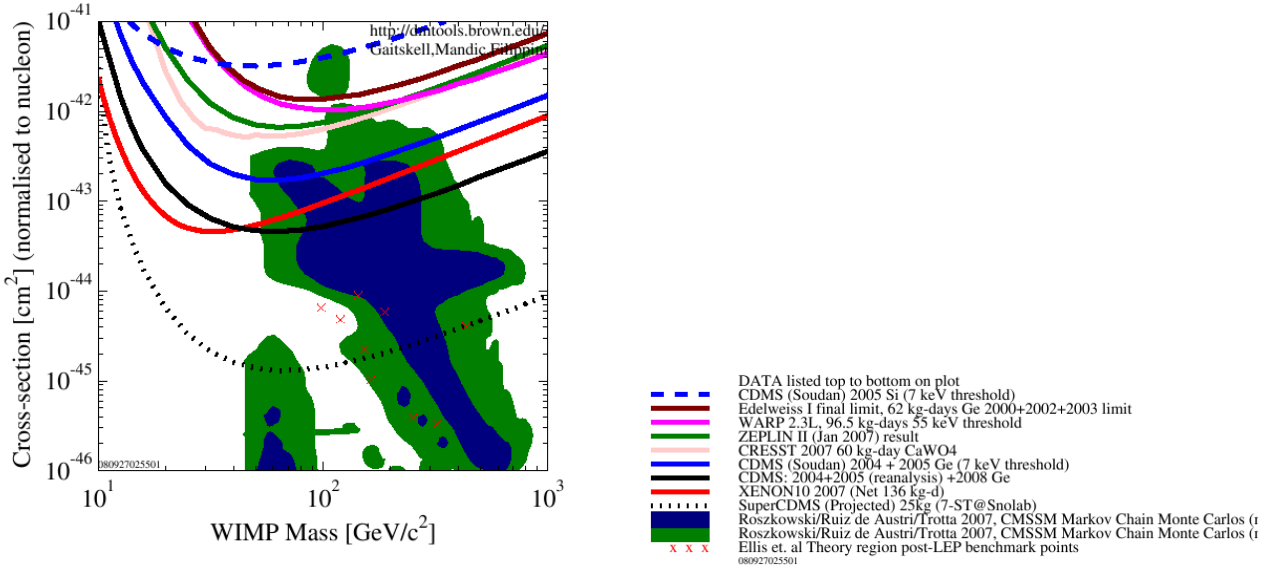


Figure: Example for exclution plot from Gaitskell et al.

General Problem with exclution plot

- data quality is hidden
- discovery potential is not obvious

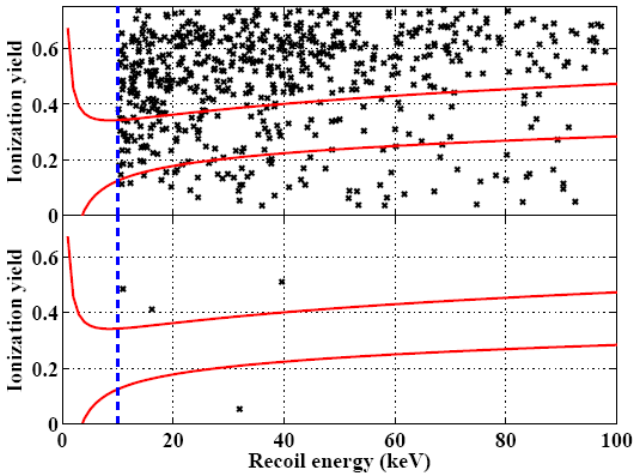


Figure: Example for solid state detector from CDMS (2007)

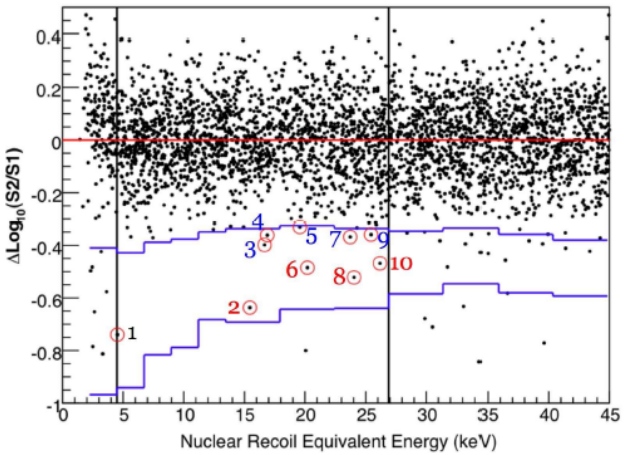


Figure: Example for liquid nobel gas detector from Xenon (2008)

Analysis Concept

- Calculate expected Spektrum (dR/dE)
- Measured data
- Finding the best upper limit in presence of unknown background
  $\longrightarrow$ Yellin method required (Yellin)

The Yellin-Method

- looks for the optimal gap in the datapoints
- Rescale x-Axis in the "integral of expected events" - variable
- look in that new variable for the largest/optimal gap

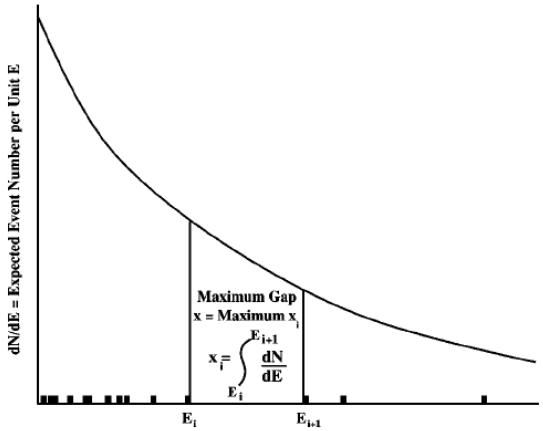


Figure: principle of Yellin-Method

Problems with this method

Yellin's method is the best way in principle to analyse the data, but you strongly depend on theoretical assumtions

$$\frac{dR}{dE_R} = N_T \frac{\rho_\chi}{m_\chi} \frac{m_N \sigma_0}{2m_{red}^2} F^2(q^2) I(v_{min}, v_{sun}, v_{esc}) \tag{1}$$

where

$$I(v_{min}, v_{sun}, v_{esc}) = \int d\vec{v} \frac{f(\vec{v})}{v} \tag{2}$$

- I contains astronomical uncertanties
- $F(q^2)$ contains nuclearphysics uncertanties

F.Donato et al.

Let's focus on the Formfactor

The Helm-Formfactor is used, because

- it is an analytic expretion
- of a simple model
- which is available for all isotops

$$F(q) = 3\frac{j_1(qr_0)}{qr_0}\exp\left(-\frac{1}{2}s^2q^2\right) \quad (3)$$

s is the skinthickness
r_0 are the core-radius

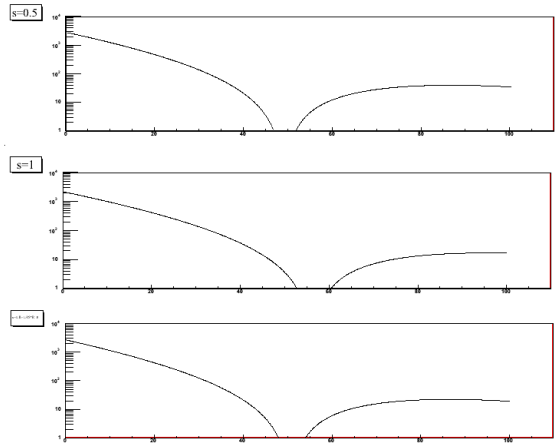


Figure: Variation of Formfactors

Selecting the right parameters

. . . not possible

- parameters taken from electron scattering experiments
- parameters vary much in literature (i.e. Duda et al. (2006))
- in principle one would like to have the mass form factor

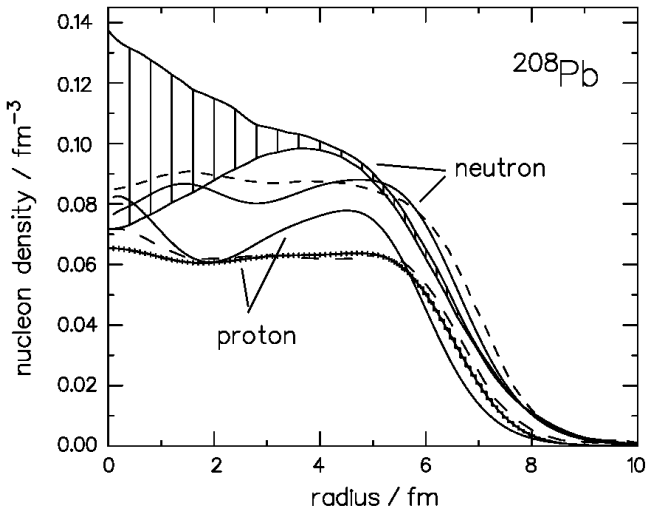
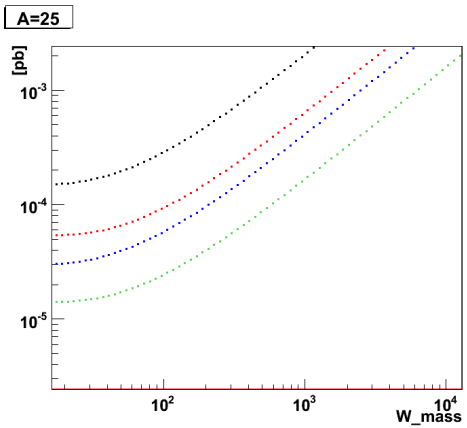


Figure: Measurement of ^{208}Pb from Mairle and P.Grabmayr

Examples

- large spread of results
- if there are events, then the spectral information of the energy distribution makes things even worse



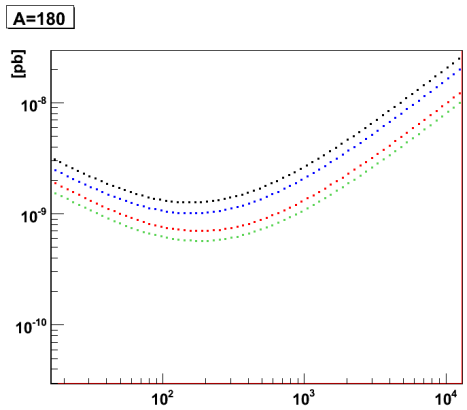


Figure: Example Calculation, blue = standard-parameter, black = half of skinthickness, red = small variation of radius, green = combination of both

Conclusion & Outlook

- Especially if one has events in the region of interest, one is very sensible to the formfactor
- Further work will be performed to give the systematic errors from formfactor uncertanties with higher precition

Literatur

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Geschafft!

Thank You very much for your attention