DM Direct Searches

Conveners: P. Belli, S. Davini, D. Snowden-Ifft

Introduction:

- The challenges for direct detection of light dark matter (Z. Berezhiani)

(mirror DM; “paradigma’s” and “standard model of DM” meaningless)

Underground expts:

- The DAMA results in the light of LDM (R. Bernabei)
- Direct Search for Light Dark Matter in CRESST-III (N. Ferreiro)
- Dark Matter direct detection with Xenon and Argon Targets (A. Pocar)
- DAMIC status and prospects for a kg-size experiment (P. Privitera)
- NEWS-G, Ultra-Light Dark Matter searches with a Spherical Gaseous Detector (I. Katsioulas)

(very low bckg techniques; model-independent signature as annual modulation; DAMA positive result; low energy threshold; bckg identifications; how reliable is the sensitivity claimed at low mass?,…)

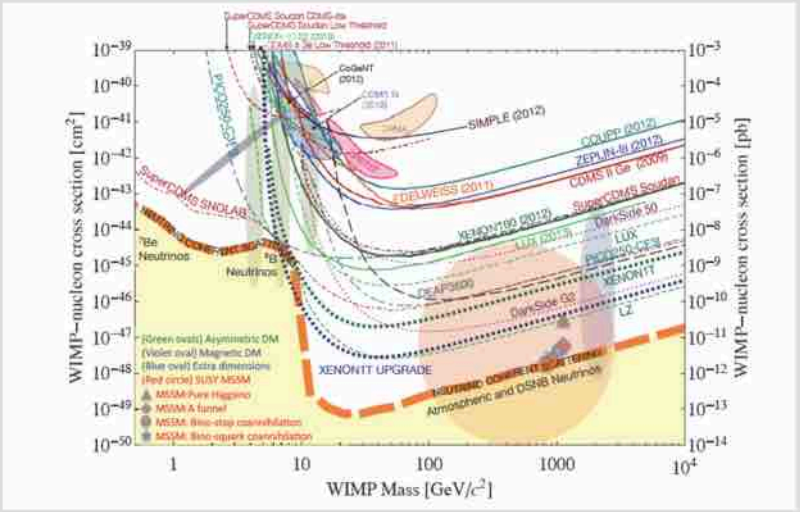
Axions in the galactic halo:

- Dark Matter axion detection (K. van Bibber)

Production of Axions in lab:

- The STAX project (P. Spagnolo)

Is it an "universal" and "correct" way to approach the problem of DM and comparisons?



No, it isn't. This is just a largely arbitrary/partial/incorrect exercise

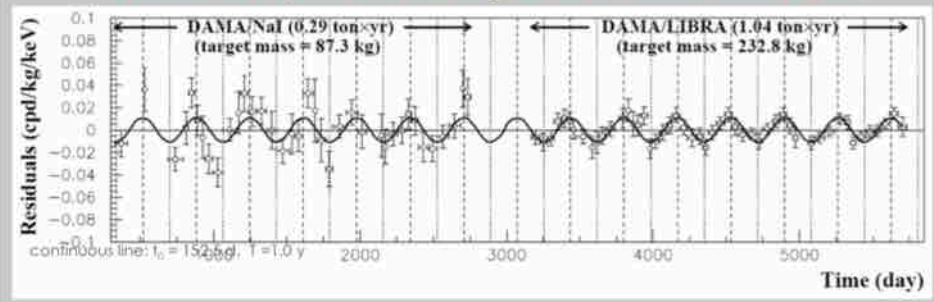
Bernabei's talk

Model Independent Annual Modulation Result

DAMA/NaI + DAMA/LIBRA-phase1 Total exposure: 1.33 ton×yr

EPJC 56(2008)333,
EPJC 67(2010)39,
EPJC 73(2013)2648

residual rate of the 2-6 keV single-hit scintillation events *vs* time



About interpretation and comparisons

See e.g.: Riv.N.Cim.26 ono.1(2003)1, IJMPD13(2004)2127, EPJC47(2006)263, IJMPA21(2006)1445, EPJC56(2008)333, PRD84(2011)055014, JMPA28(2013)1330022

...models...

- Which particle?
- Which interaction coupling?
- Which EFT operators contribute?
- Which Form Factors for each target-material?
- Which Spin Factor?
- Which nuclear model framework?
- Which scaling law?
- Which halo model, profile and related parameters?
- Streams?
- ...

...and experimental aspects...

- Exposures
- Energy threshold
- Detector response (phe/keV)
- Energy scale and energy resolution
- Calibrations
- Stability of all the operating conditions.
- Selections of detectors and of data.
- Subtraction/rejection procedures and stability in time of all the selected windows and related quantities
- Efficiencies
- Definition of fiducial volume and non-uniformity
- Quenching factors, channeling
- ...

Uncertainty in experimental parameters, as well as necessary assumptions on various related astrophysical, nuclear and particle-physics aspects, affect all the results at various extent, both in terms of exclusion plots and in terms of allowed regions/volumes. Thus comparisons with a fixed set of assumptions and parameters' values are intrinsically strongly uncertain.

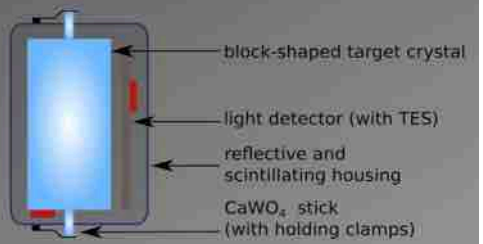
No experiment can – at least in principle - be directly compared in a model independent way with DAMA

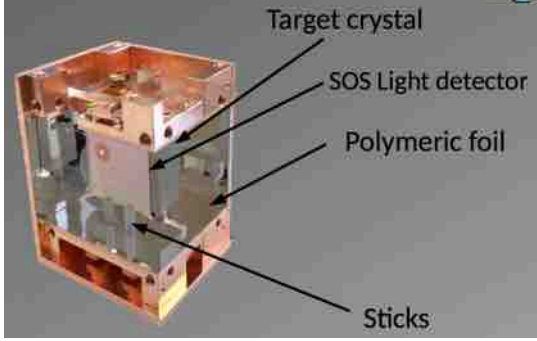
Ferreiro's talk

CRESST-III

Our goals:

- Exposure of 50 kg days
- Self-grown crystals of high radiopurity
- Energy threshold ~100eV



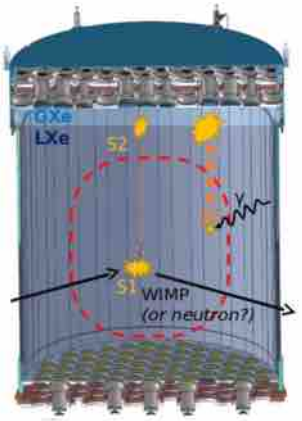


Prototype

- Main absorber of 24g
- Fully scintillating housing
- Energy threshold: 60 eV!

Pocar's talk

Dual-phase LXe TPC

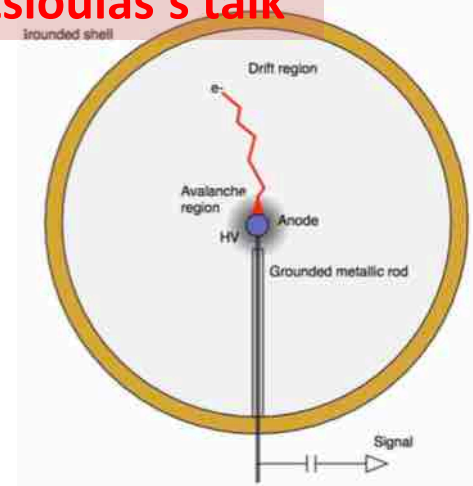


- S2/S1 ratio provides particle ID
- Top-array hit pattern provides the vertex position in the X-Y plane
- The time difference provides the depth

Katsioulas's talk

Spherical Proportional Counter

Principal of operation



I.Giomataris et al ,JINST,2008, P09007

Greatly varying field along the radius

$$E = \frac{V_0}{r^2}\frac{r_1 r_2}{r_2 - r_1} \approx \frac{V_0}{r^2} r_1$$

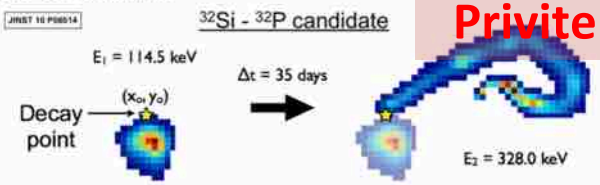
r_1 = anode radius
r_2 = cathode radius

Natural division of the volume in two
- Drift volume
- Multiplication volume

Privitera's talk

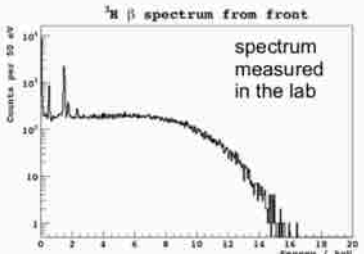
DAMIC-1K background

- Cosmogenic ^{32}Si rate will be accurately measured by the current detector at SNOLAB



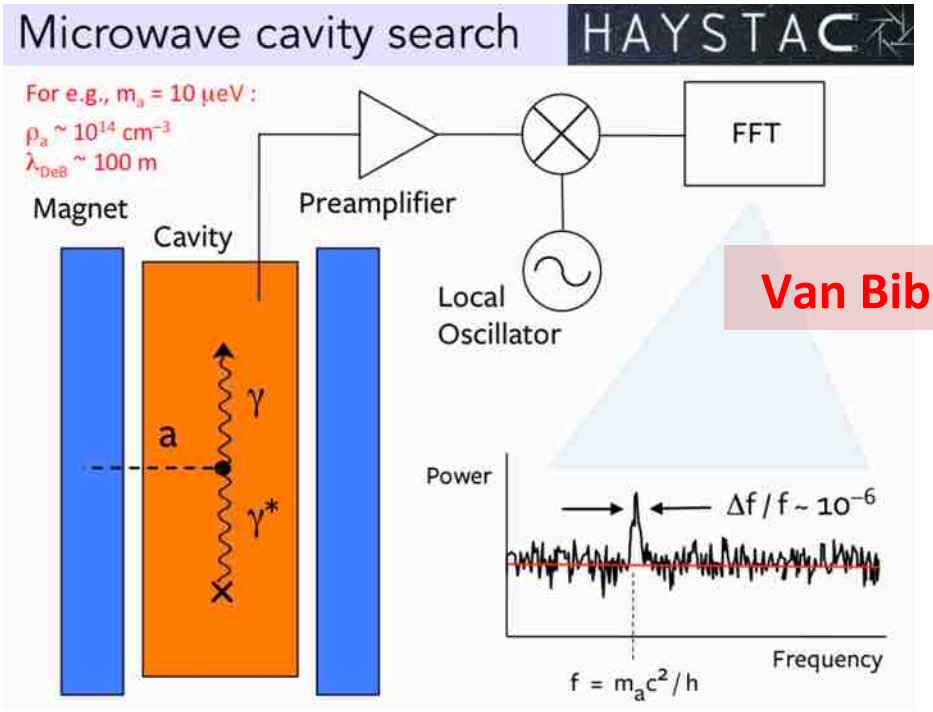
≈ 1 dru (dominant bkg. in SuperCDMS); rejected in DAMIC-1K by spatial correlations

- Tritium expected to be the dominant bkg. for DAMIC-1K.

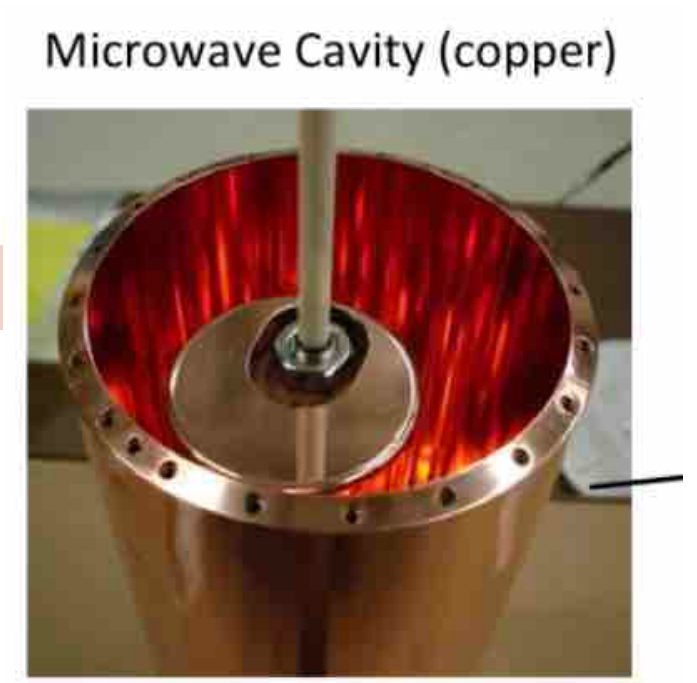


A measurement of its rate may be within reach of the current DAMIC detector at SNOLAB (so far only estimates are used for forecasts)

Axion searches



Van Bibber's talk



STAX Experiment

Spagnolo's talk