Annual modulation from COSINE-100 data using DAMA/LIBRA's analysis technique

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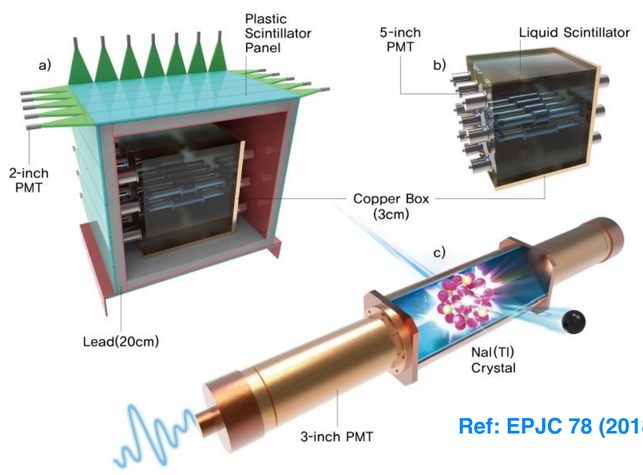
Poster #468

DAMA/LIBRA has consistently reported an observation of annual modulation in residual event rate over 20 years but no definite evidence from other experiments. Apart from the dark matter hypothesis, recent studies reported the possibility of the annual modulation of DAMA/LIBRA due to the slowly varying time-dependent background after subtracting the average background each year. Here, we present the COSINE-100 annual modulation using a similar method of the DAMA/LIBRA. We also generated a simulated pseudo data for the DAMA/LIBRA at 2-6 keV without dark matter signal by assuming the same background compositions. We observe annual modulation with similar amplitude but opposite phase.

COSINE Experiment



COSINE is a dark matter direct detection experiment which deployed 106 kg of NaI(Tl) at Yangyang Underground Laboratory in South Korea.

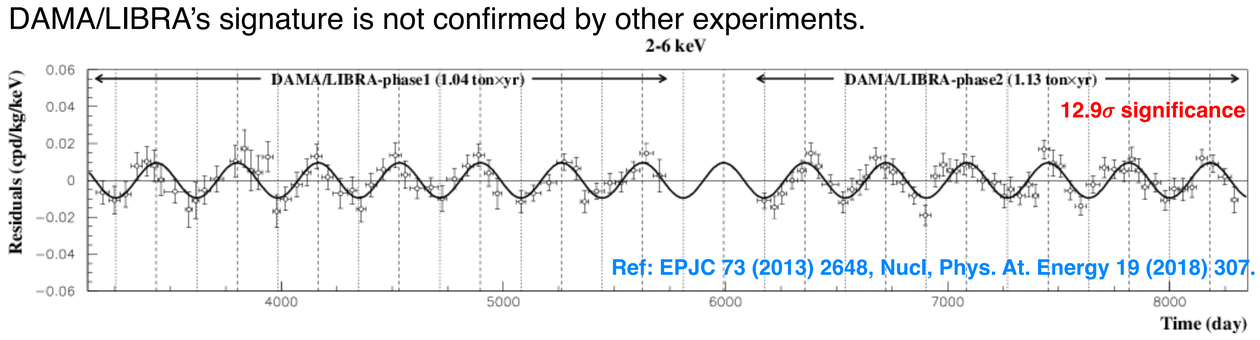
It is a model-independent to test of DAMA/LIBRA's result by searching for the same annual modulation with the same NaI(Tl) target.

See talk in Sat. 9 (Dark Matter Session)

Ref: EPJC 78 (2018) 107, Nature 564 (2018) 83-86, PRL 123 (2019) 131802.

Motivation

DAMA/LIBRA's signature is not confirmed by other experiments.

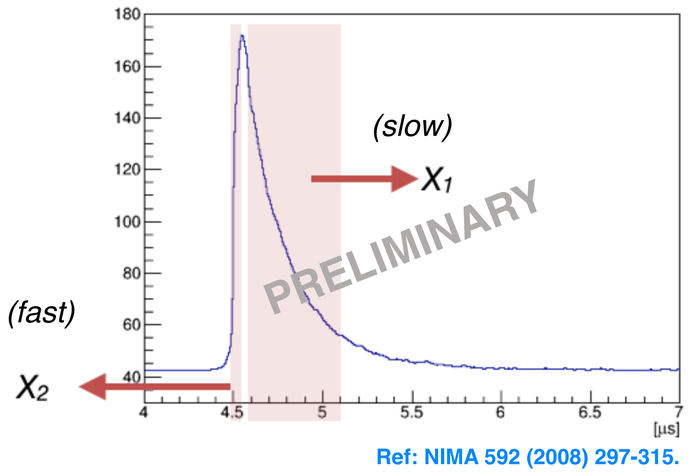


Several studies reported the possibility that the modulation is induced by variations in their detector's environment or specific analysis methods.

Here, we study the COSINE-100 data using an analysis method similar to the one adopted by the DAMA/LIBRA.

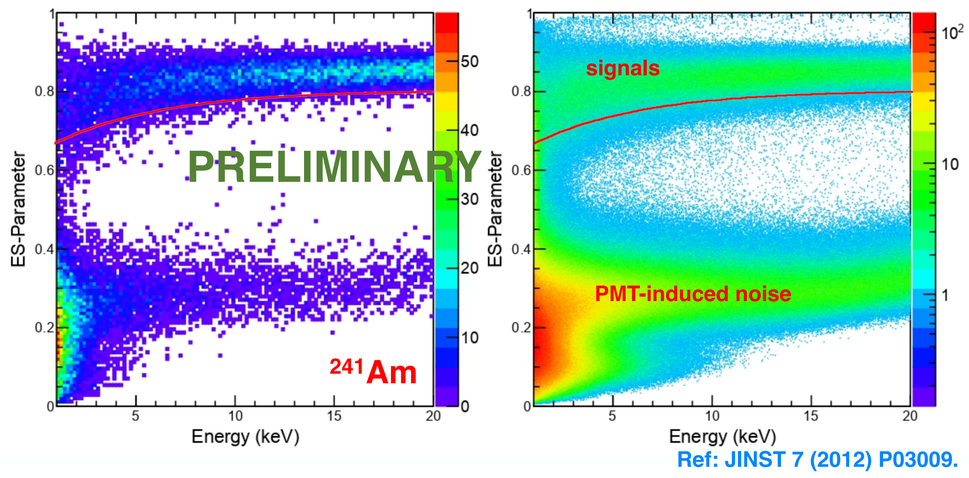
An analysis method adopted by DAMA/LIBRA

Event reconstruction



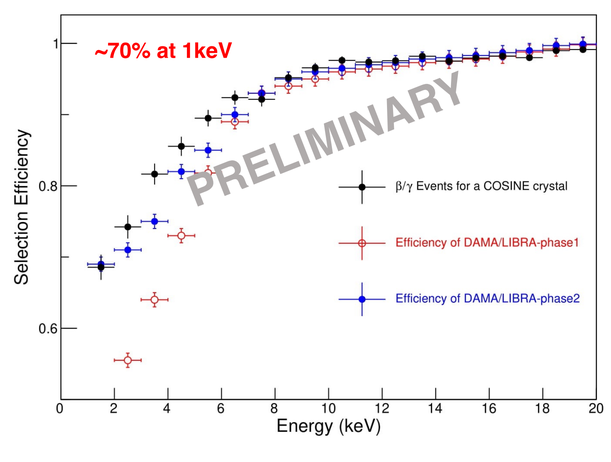
Ref: NIMA 592 (2008) 297-315.

Event selection

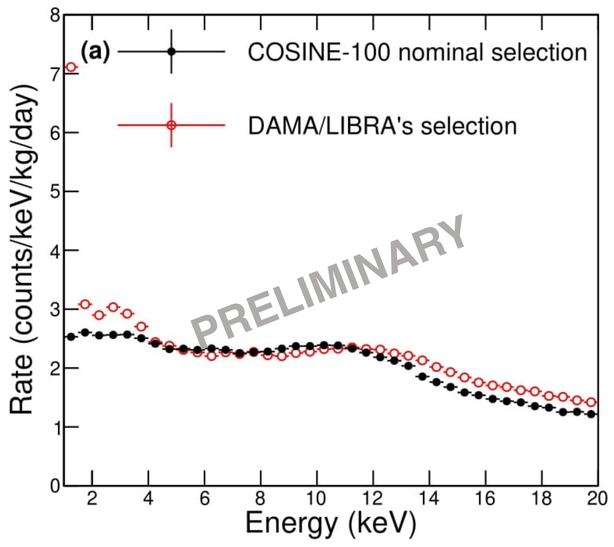


Ref: JINST 7 (2012) P03009.

Efficiency



Energy spectrum at single-hit



Background subtraction

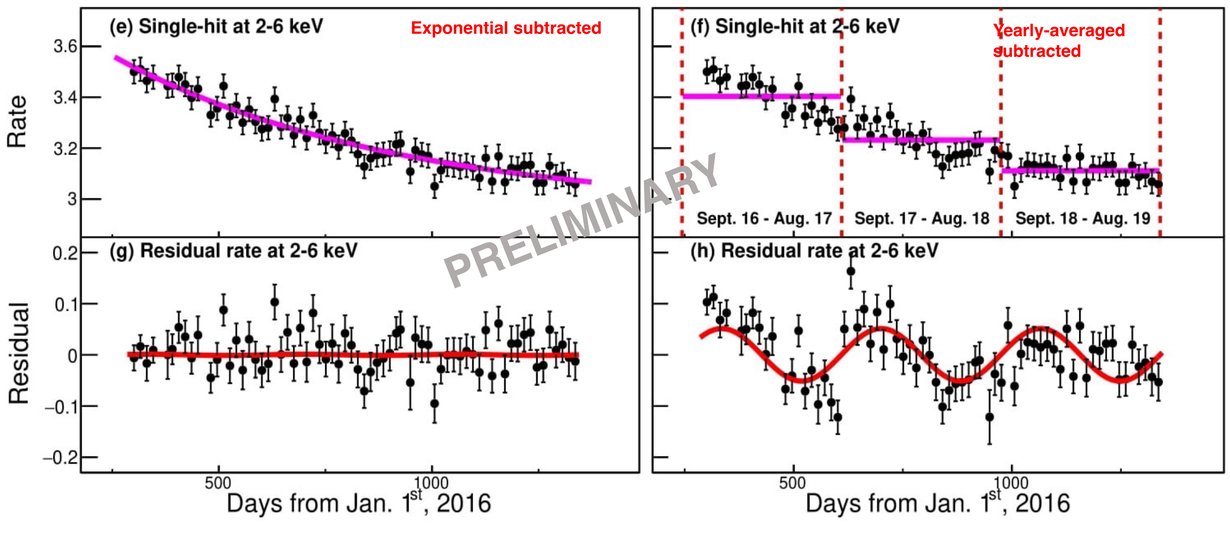
1. By a single-exponential)

$$R(t) = p_0 \exp - \frac{\ln 2t}{p_1} + S_m \cos \frac{2\pi(t - t_0)}{T},$$

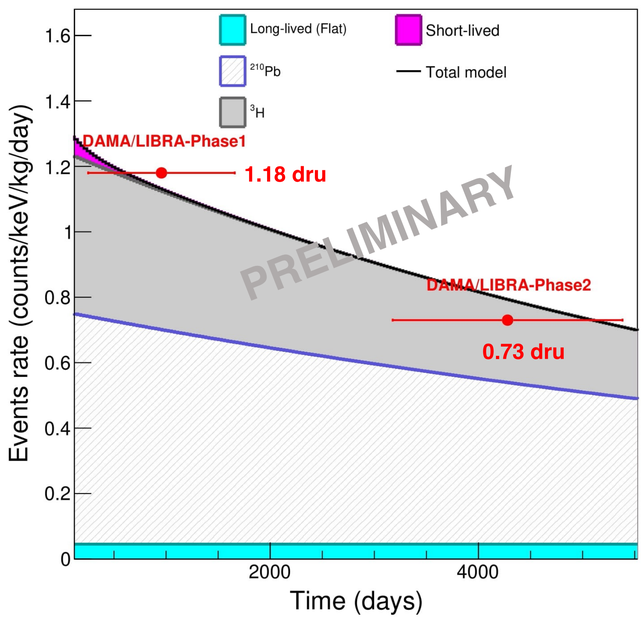
2. Based on DAMA method's

$$R(t) = S_m \cos \frac{2\pi(t - t_0)}{T},$$

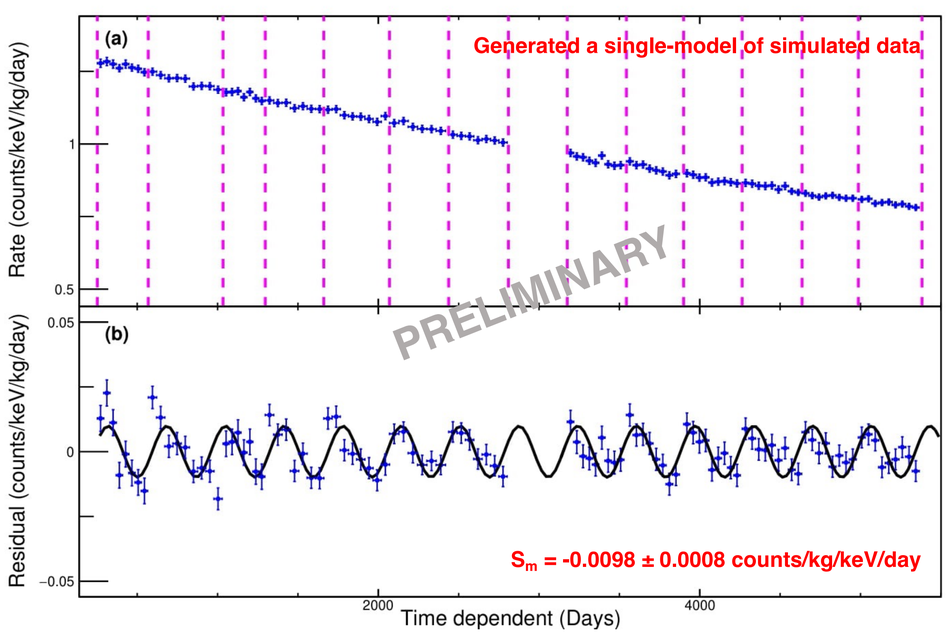
Results for 2-6 keV at single hit



Simulated data for time-dependent background



- COSINE-100 background components are scaled to simulate DAMA/LIBRA at 1.3 counts/keV/kg/day.
- Main background contributions is ^{210}Pb and ^{3}H.



Conclusions

Results of modulation amplitude

counts/kg/keV/day	1–6 keV	2–6 keV
This work ✓	-0.0441±0.0057	-0.0456±0.0056
DAMA/LIBRA	0.0105±0.0011	0.0095±0.0008
COSINE-100	0.0067±0.0042	0.0050±0.0047
ANAIS-112	-0.0034±0.0042	0.0003±0.0037

- We observe a significant annual modulation with negative amplitude .
- But the modulation phase is almost opposite to that of the DAMA/LIBRA data.
- The pseudo data also showed strong negative amplitude of **-0.0098 ± 0.0008 counts/kg/keV/day.**
- A similar modulation amplitude with the opposite phase was observed.

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