# What did we see (or not) in 2014?


Yann Mambrini

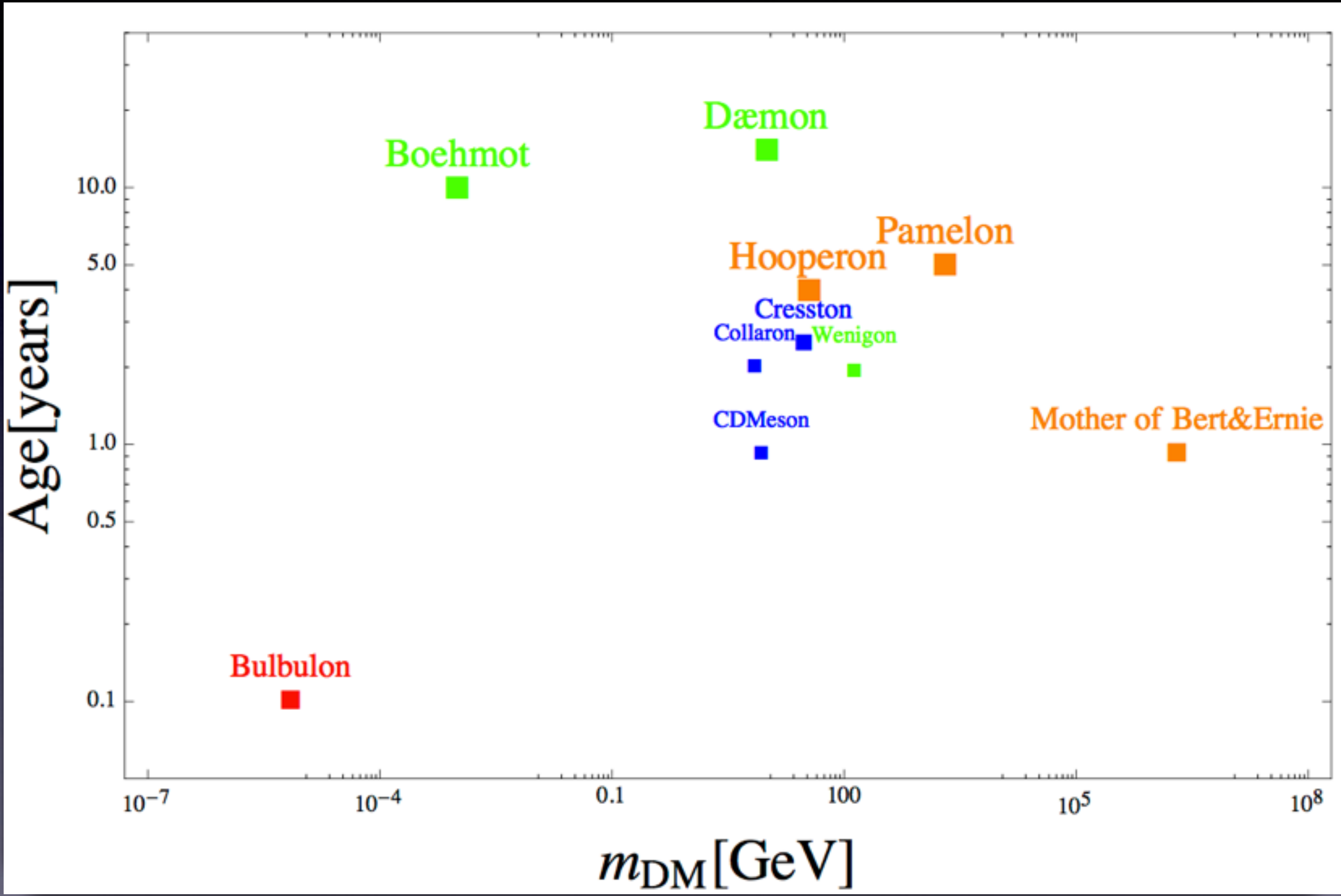
http://www.ymambrini.com/My_World/Physics.html


LPT Orsay

cnrs dépasser les frontières

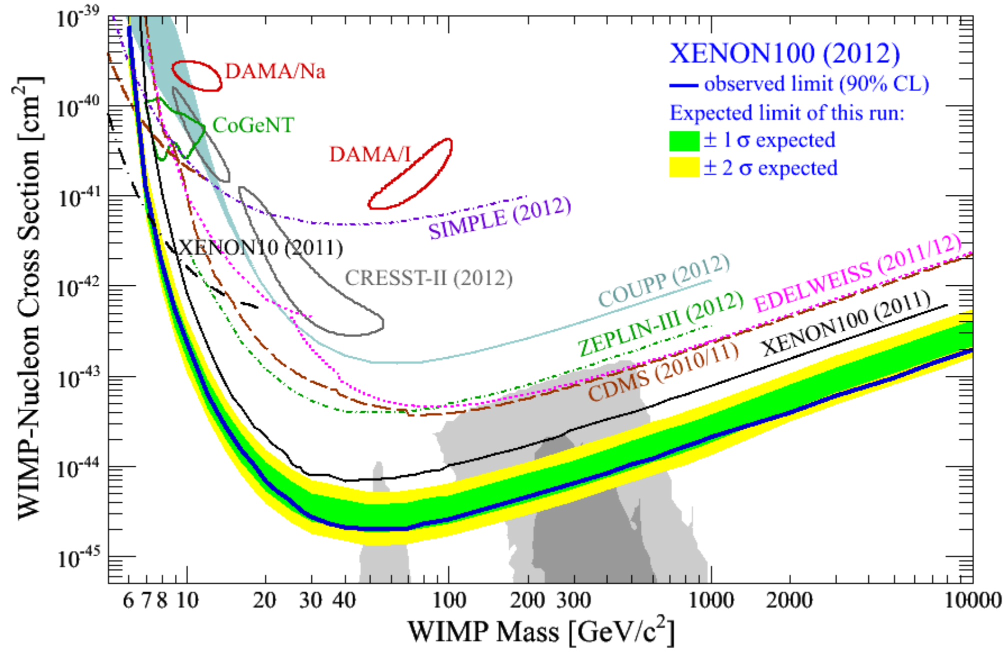

Physics Challenges in the face of LHC-14, IFT Madrid, September 22nd.

# Which candidates for the job?




*Plot extracted from* http://resonaances.blogspot.com/

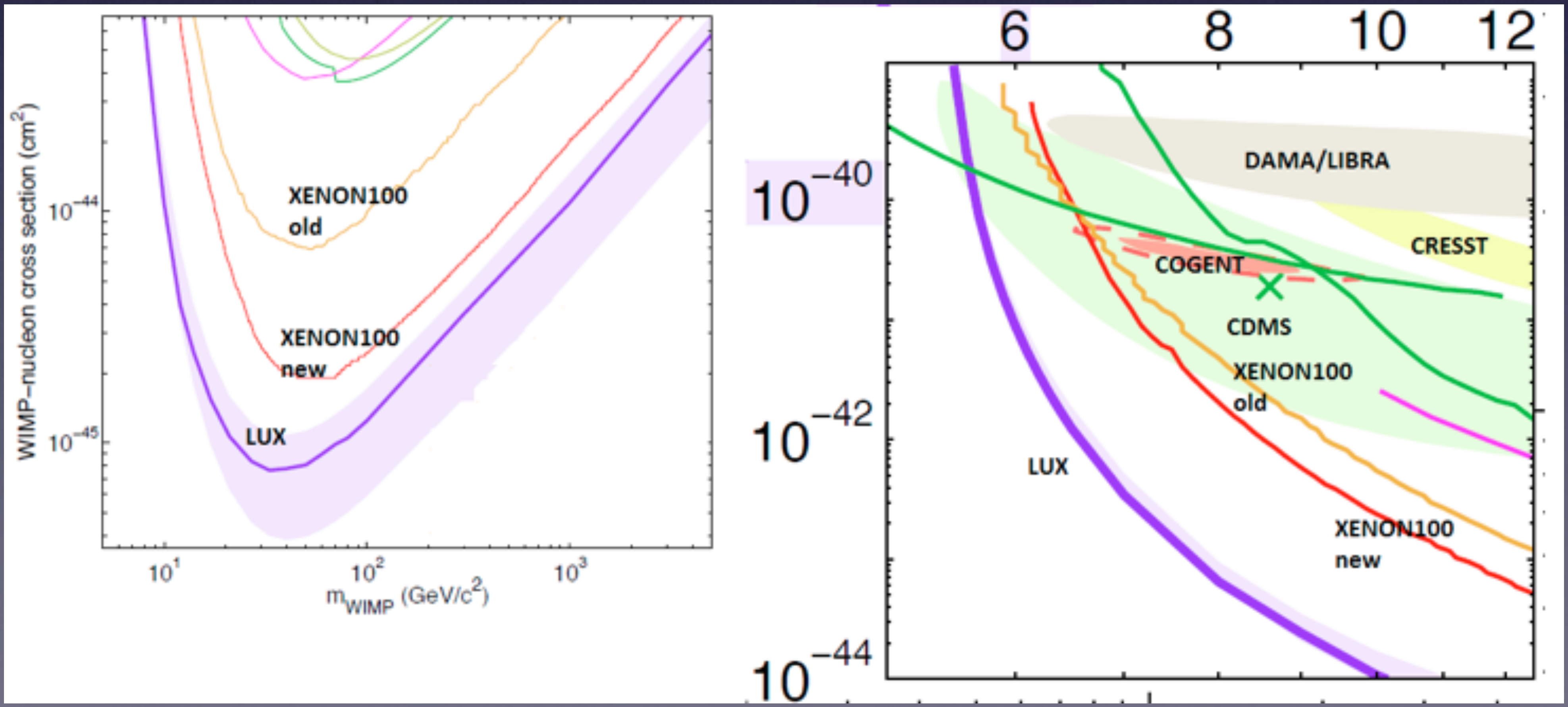
# XENON + LUX results




XENON100 (07/12)

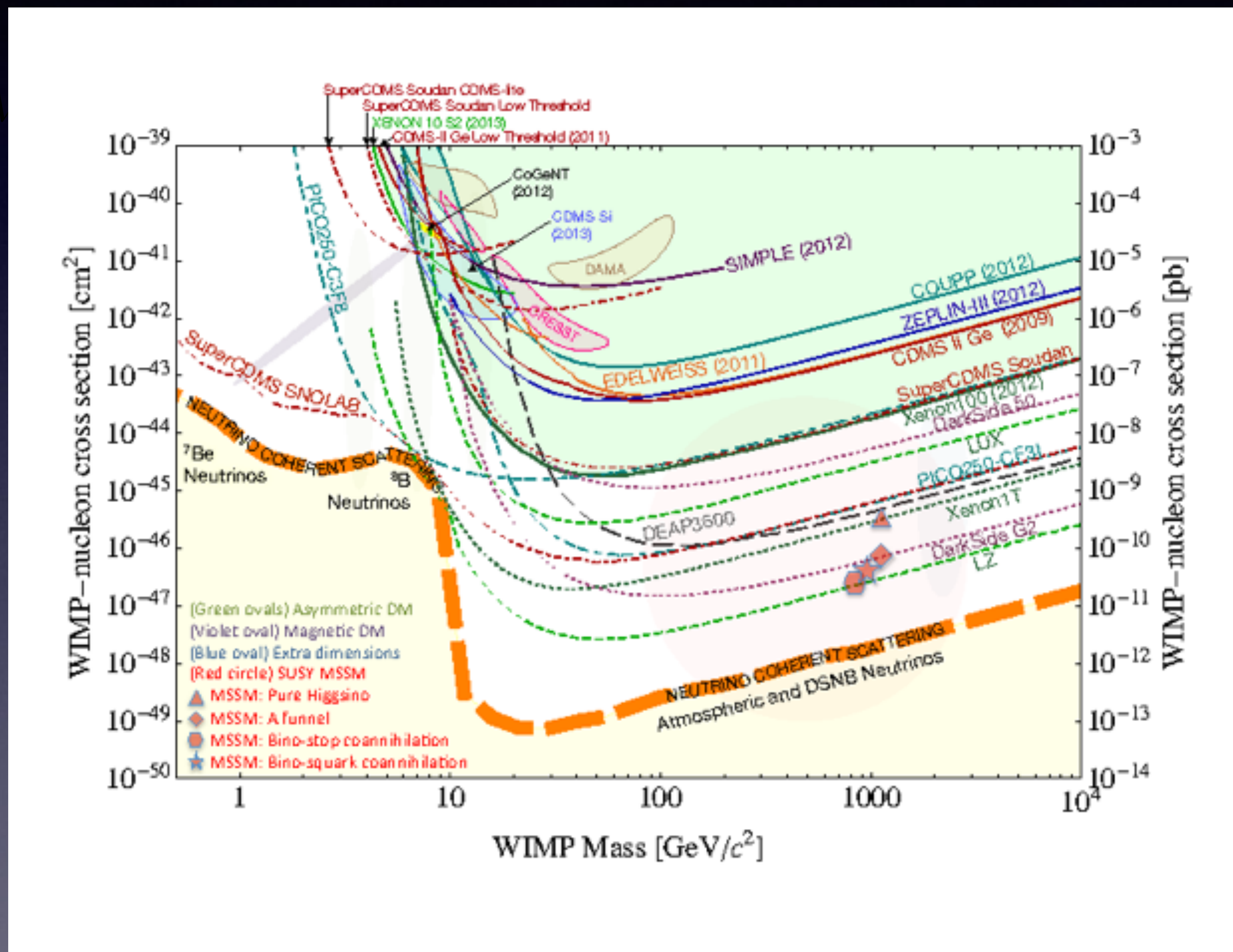
XENON100 -> XENON1T (end 2014)

LUX (09/13, 1310.8214)



# *Direct detection: summary*

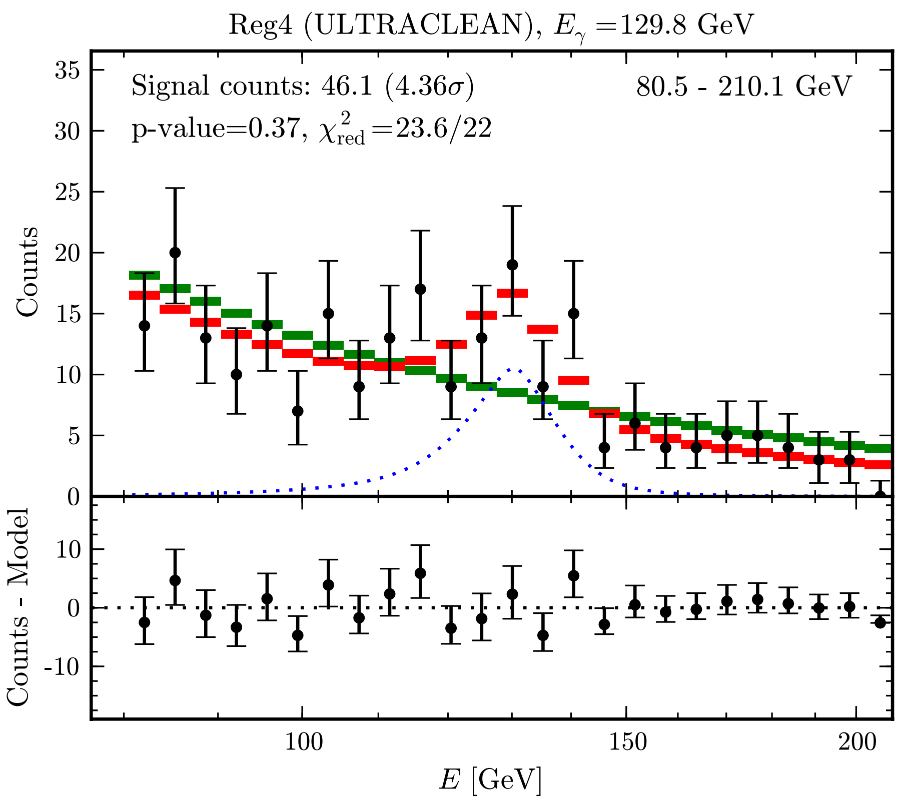
*The neutrino wall is approaching dangerously…*



# Monochromatic signal at 130 GeV (2012/2013)

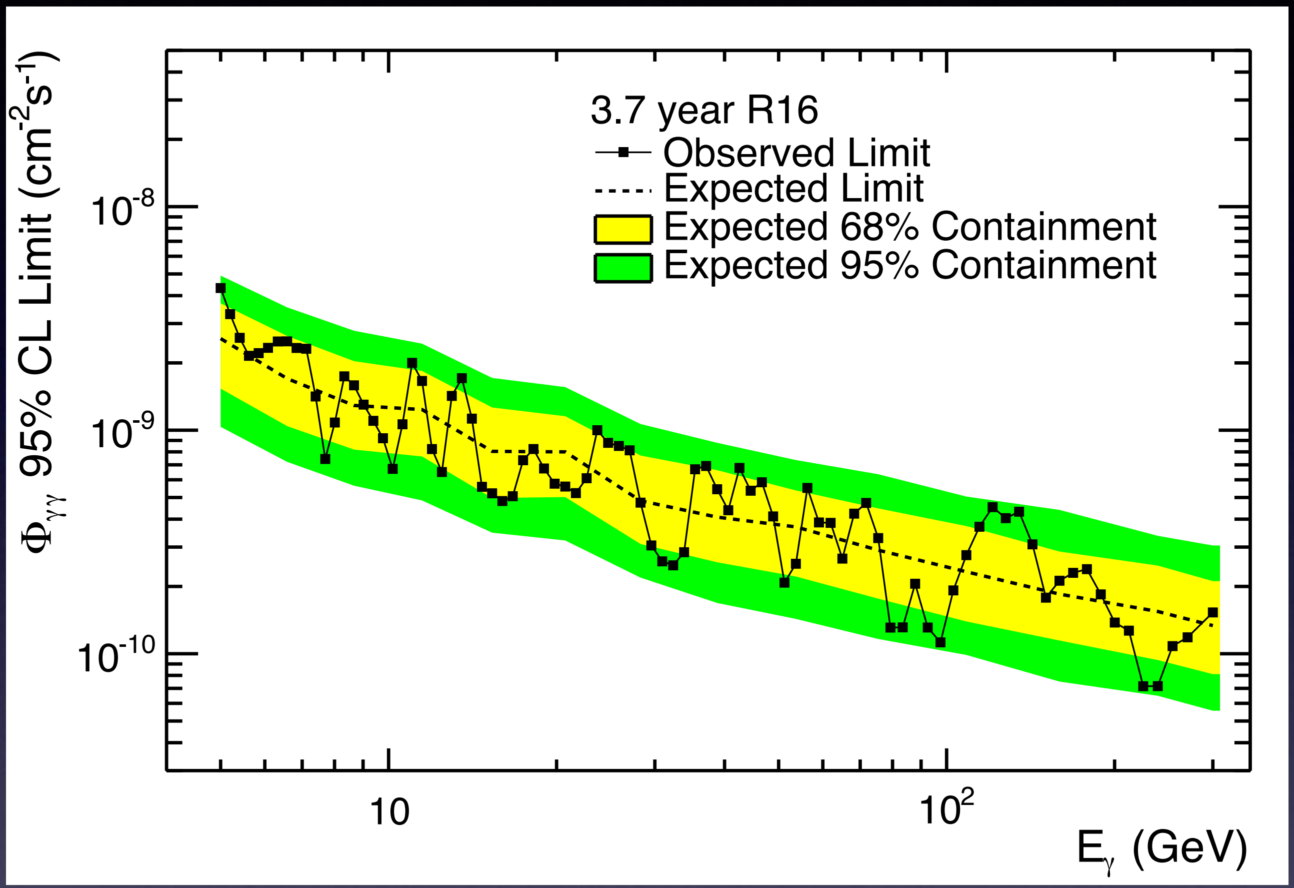
Spectrum from Galactic Center [FERMI data]

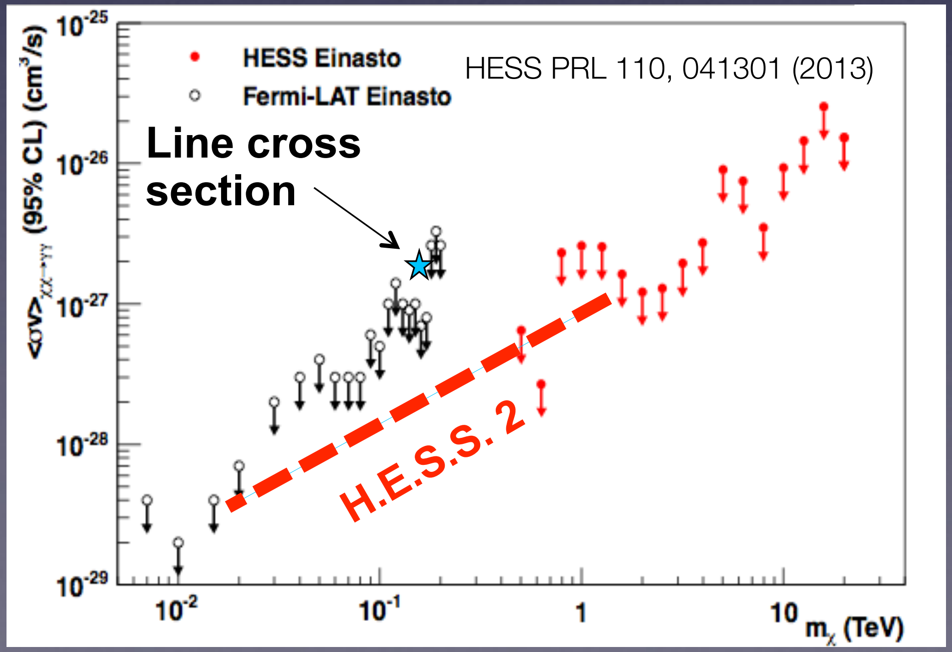
Bringmann, Huang, Ibarra, Vogl, Weniger, 1203.1312; Weniger, 1204.2797




An excess at 3.7 σ was observed, peaked at an energy of 130 GeV

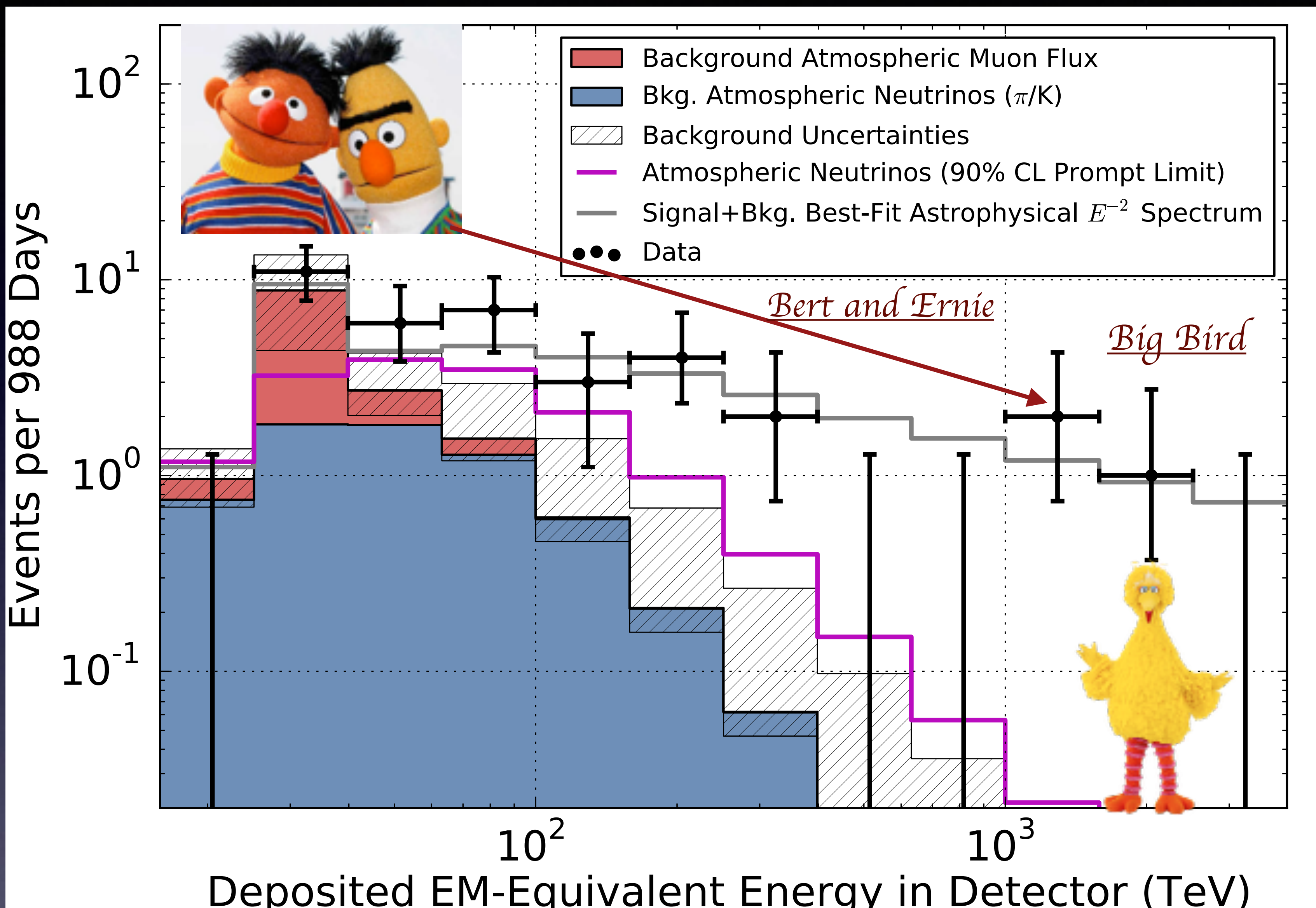
Last FERMI result : no confirmation of the presence of the line

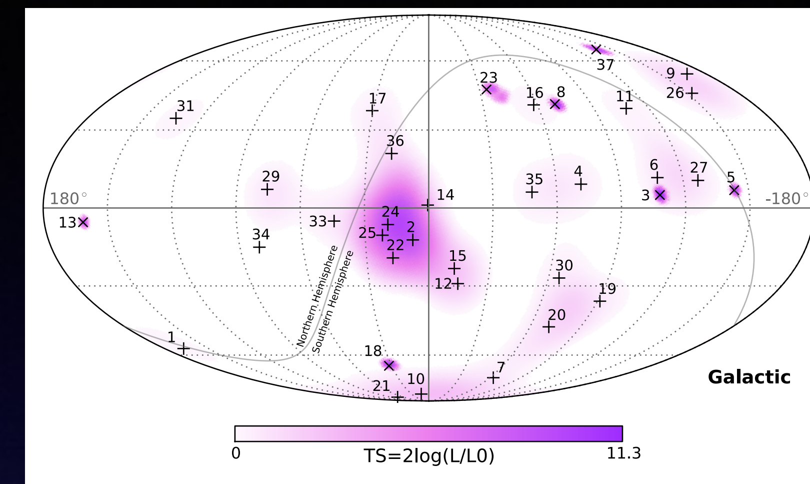


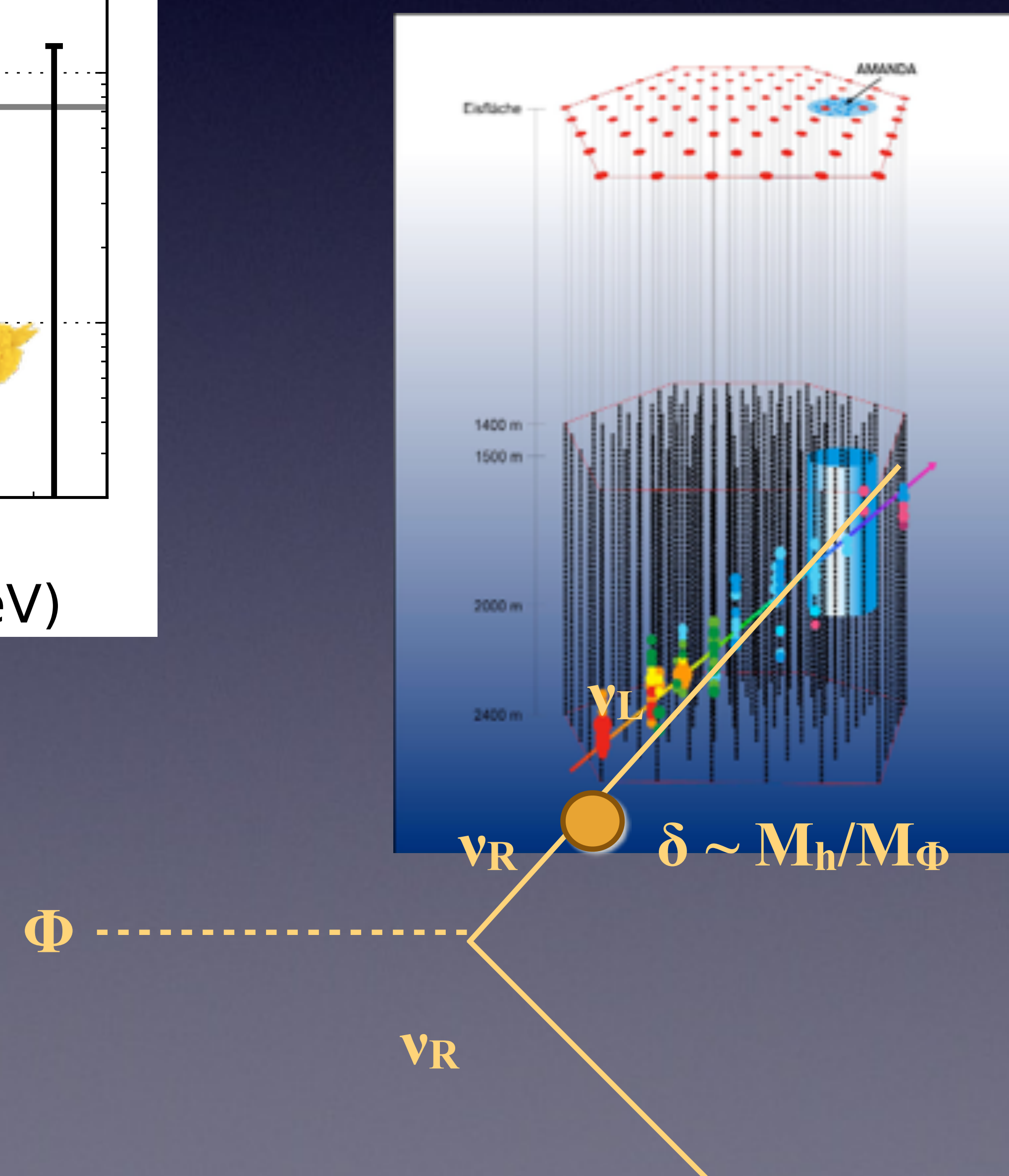




HESS2 perspective

# Ultra High Energy neutrinos with Icecube



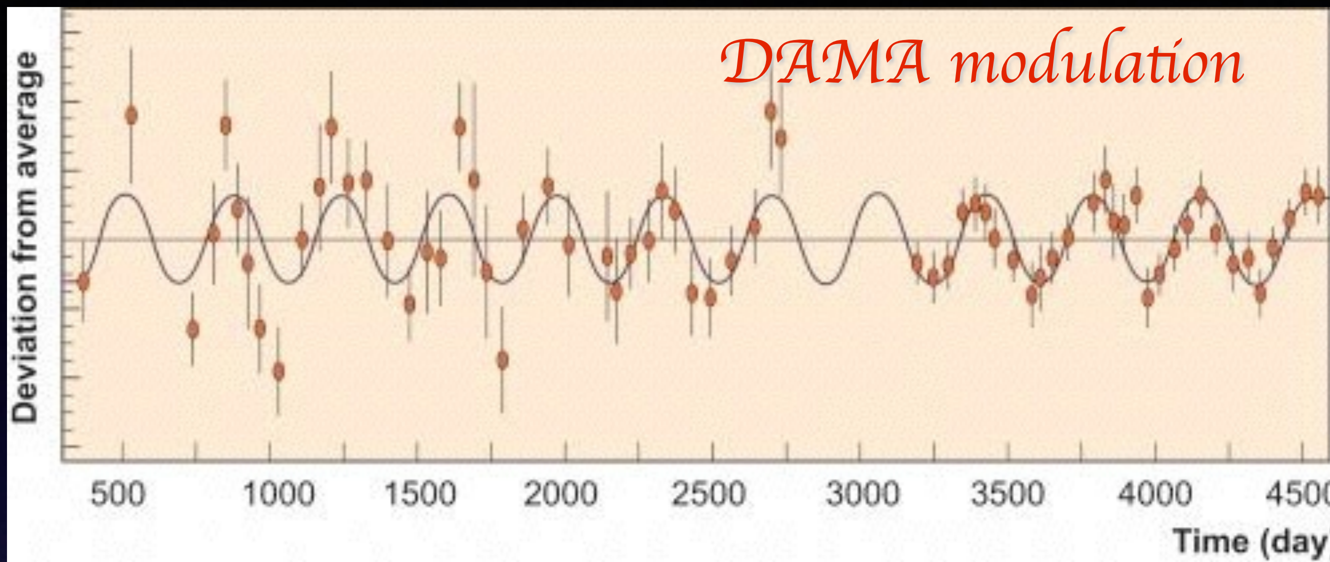



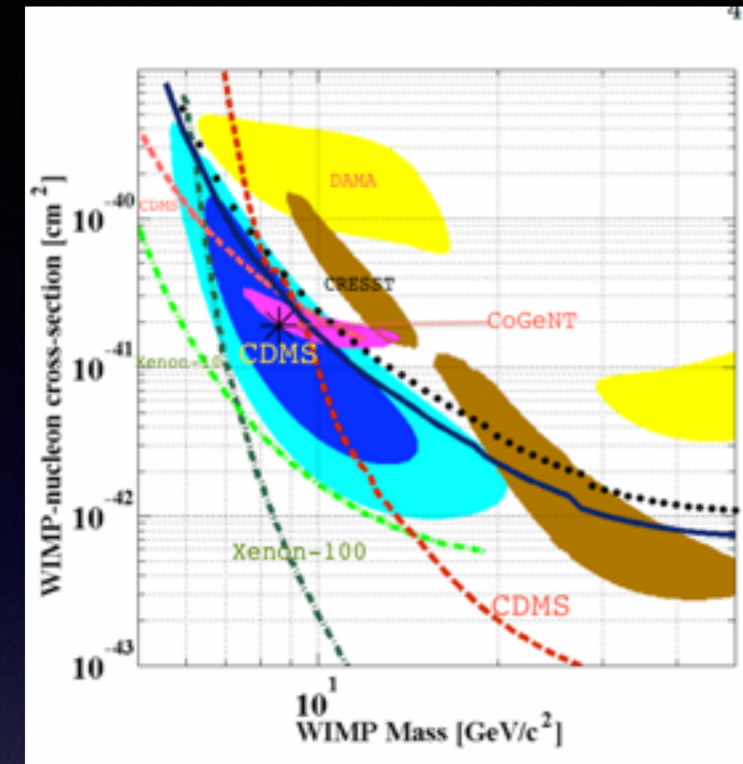




3 PeVs events and no clear anisotropies. However similar to an $E^{-2}$ spectrum (AGN?)

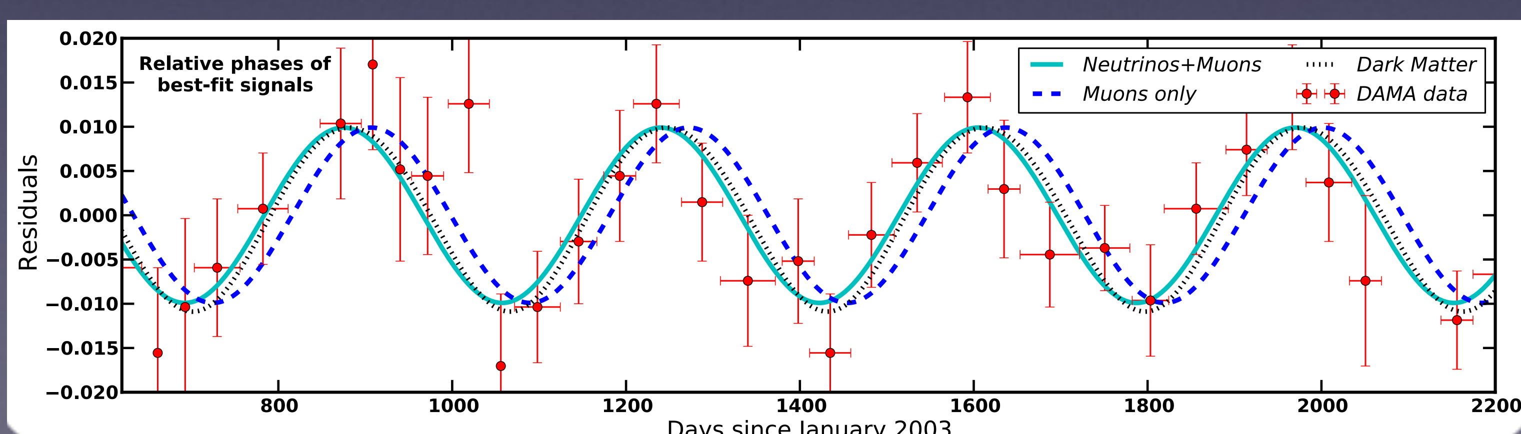
# DAMA signal?

Oscillation with a period of 1 year, maximum at 2nd of June




Signal > 9σ corresponding to a dark matter mass of 10 GeV and $\sigma_{\chi p}$ ~$10^{-40}$ $cm^2$. This should correspond to more than 5000 events for LUX which saw.. nothing




(J. Davis, PhysRevLett.113.081302; 1407.1052)

Moreover, it exist an alternative: a mixed between cosmic muon (peaked at end of June due to the temperature of the atmosphere in north hemisphere) and solar neutrino (peaked on 4th of January due to the shortest distance earth-sun) can fit the data

# DAMA act III

(Barbeau, Collar, Efremenko, Scholberg; 1409.3185)

**Comment on "Fitting the annual modulation in DAMA with neutrons from muons and neutrinos"**

P.S. Barbeau[a], J.I. Collar[b], Yu. Efremenko[c], and K. Scholberg[a,*].
[a] *Department of Physics, Duke University, Durham, NC 27708 USA*
[b] *Department of Physics, University of Chicago, Chicago, IL 60637 USA*
[c] *University of Tennessee, Knoxville, TN 37996 USA*
[*] *Corresponding author. E-mail: schol@phy.duke.edu*

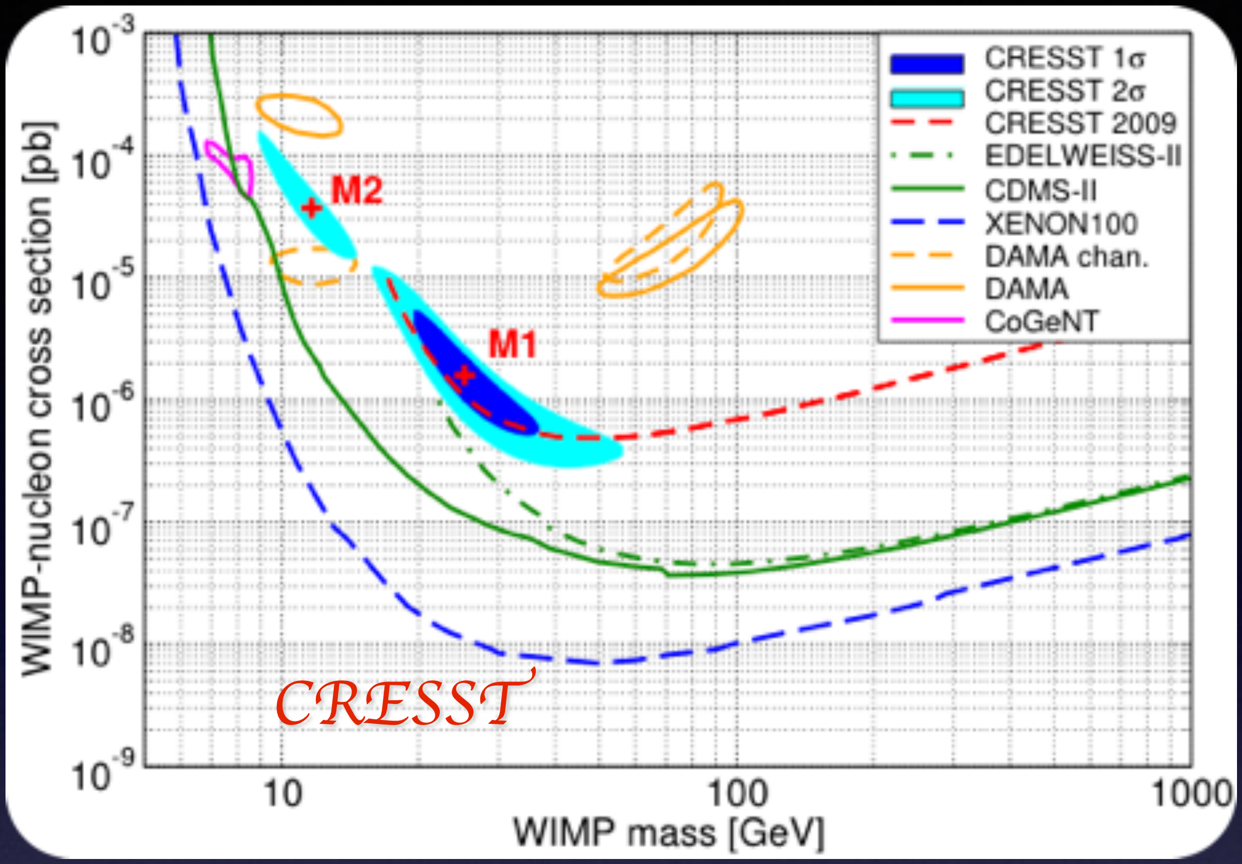
We estimate rates of solar neutrino-induced neutrons in a DAMA/LIBRA-like detector setup, and find that the needed contribution to explain the annual modulation would require neutrino-induced neutron cross sections several orders of magnitude larger than current calculations indicate. Although these cross sections have never been measured, it is likely that the solar-neutrino effect on DAMA/LIBRA is negligible.

with next-neighbor crystals. This results in $4.3 \times 10^{-6}$ NINs per day creating relevant signals, which in turn implies that the NIN cross section in lead that would be required to produce the necessary $R_\nu$ is more than six orders of magnitude greater than calculated in [8]. We would require a cross section nearly as large for NINs

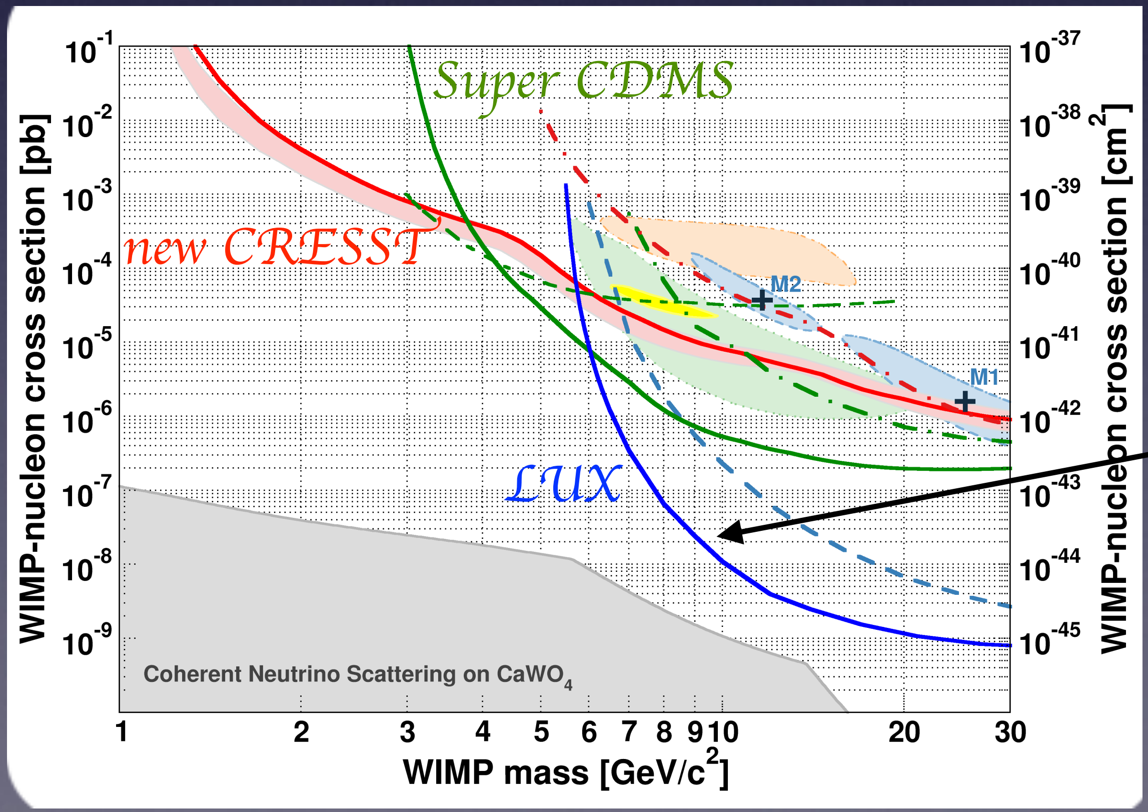
*« This « mathematical » exercice produces two « big » modulation amplitudes since a sort of cancellation occurs between the two effects, having quasi—opposite phases. But this « mathematical » exercice does not represent a physical possibility.. »*

(DAMA collaboration; 1409.3516)

# CRESST excess (2012)?



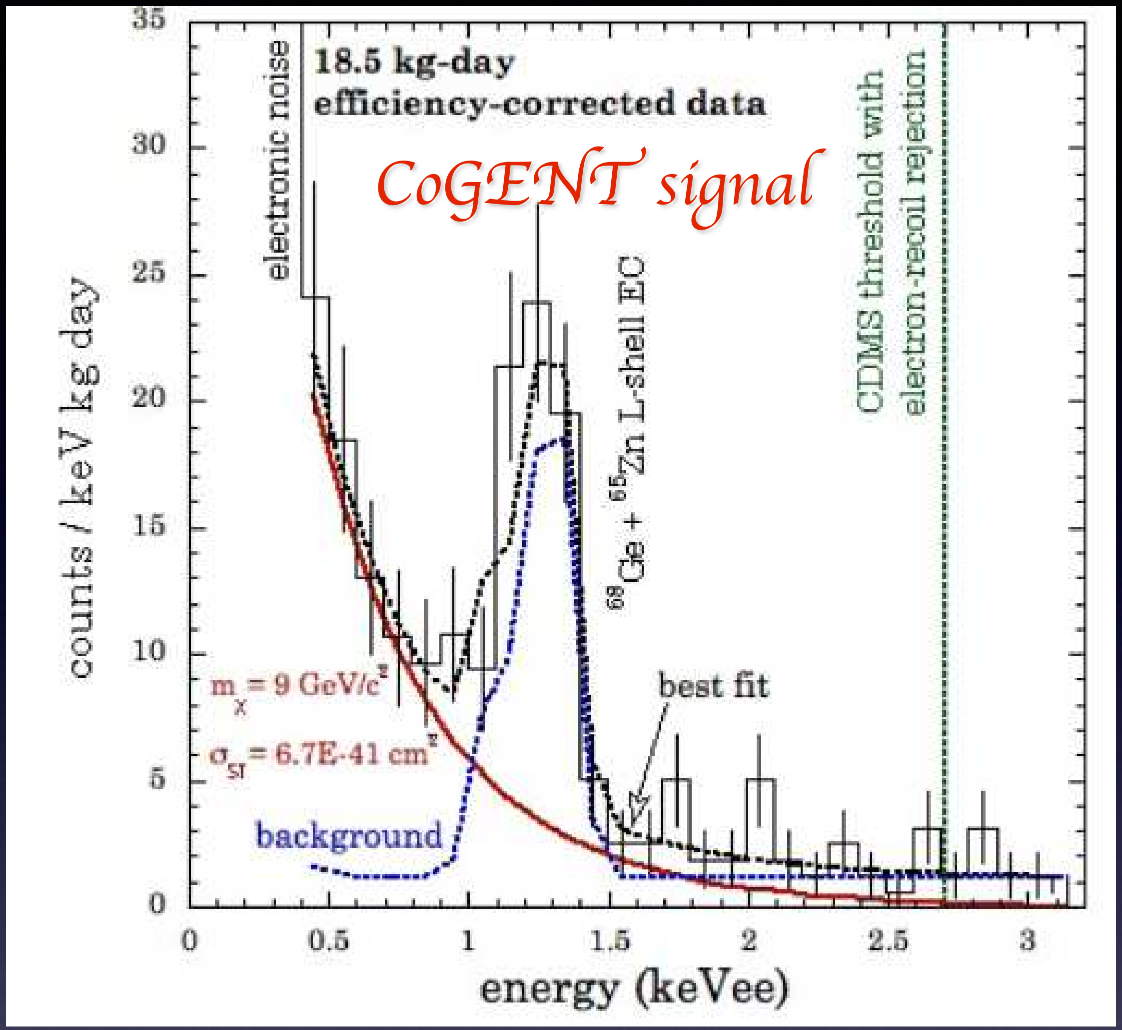

Signal > 3 σ corresponding to a dark matter mass of 15 GeV and $\sigma_{\chi p} \sim 10^{-41}\ cm^2$



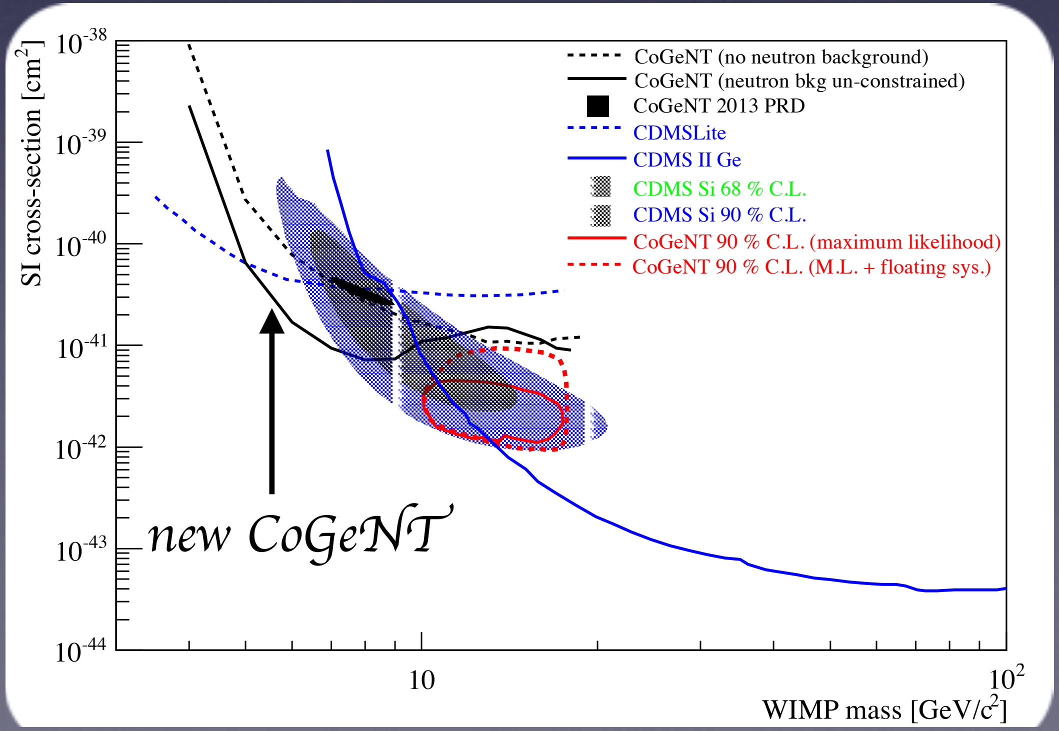

Recent analysis of CRESST itself in July exclude its own region of « signal » parameter space

(CRESST collaboration; 1407.3146)

# CoGeNT signal (2012)?



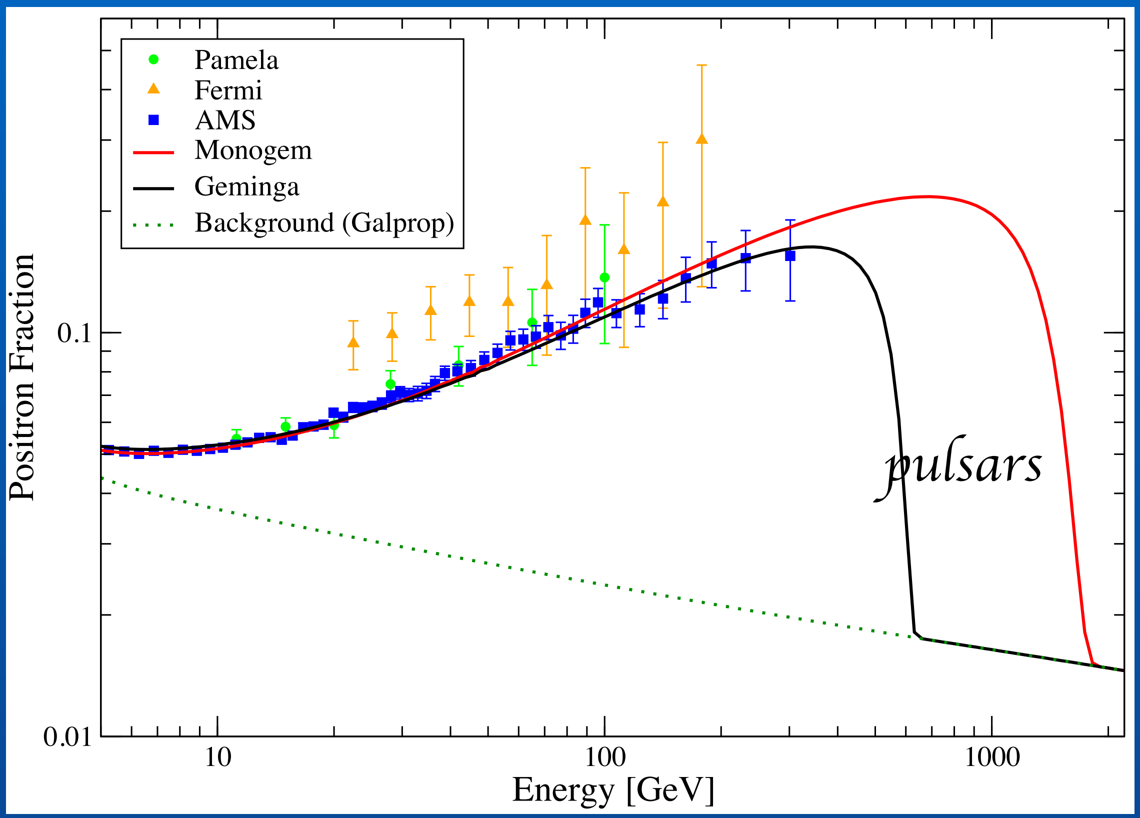

Signal at 4.7 σ corresponding to a dark matter mass of 8 GeV and $\sigma_{\chi p} \sim 10^{-41}$ cm$^2$



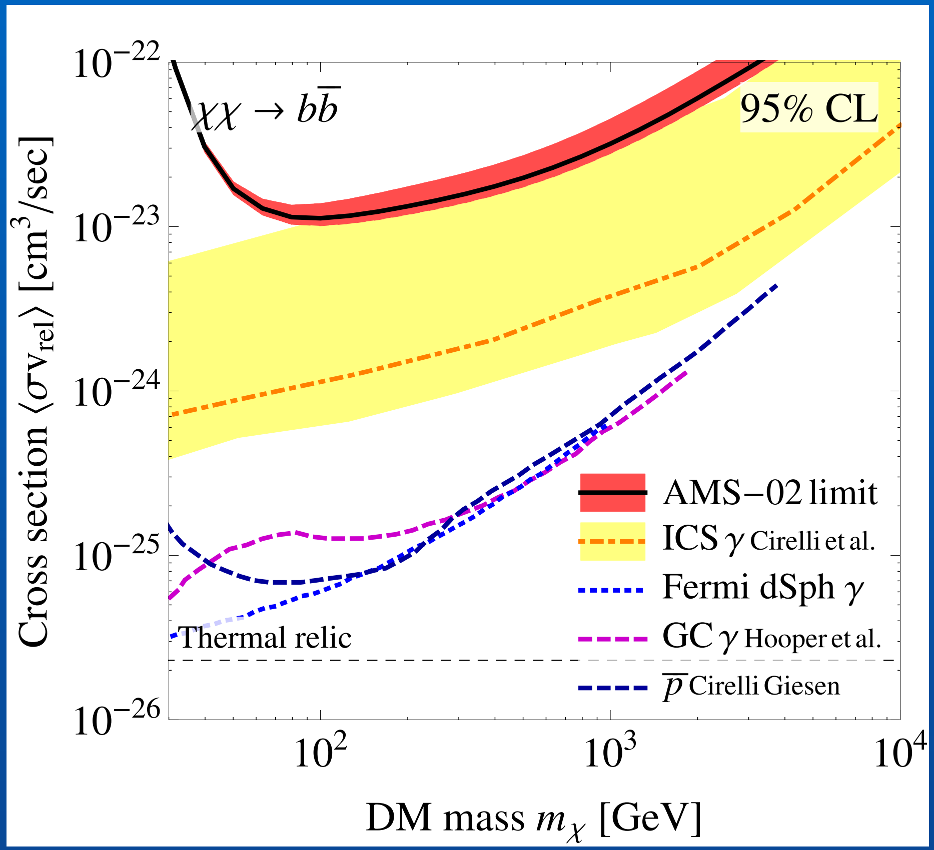

Recent new analysis of CoGeNT (new likelihood analysis) show that the region is below 3 σ

# Antimatter (2013)

## positron spectrum measured by AMS (in ISS)




M. Aguilar et al. [AMS Collaboration], Phys. Rev. Lett. 110 , no. 14, 141102 (2013).




Can be fitted by 2 pulsars, Monogem and Geminga (Profumo, 1304.1791)

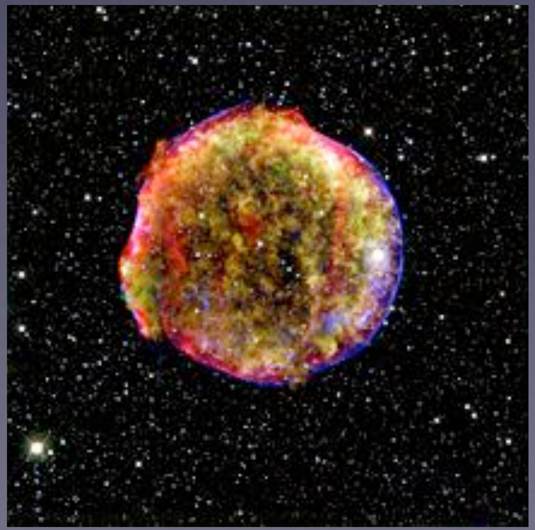
Such spectrum if from DM origin, should exhibit a clear photon signal at FERMI which is not the case

Energetic wind of photons from PWN (Pulsar Wind Nebulae) hit the CMB to produce electron/positron pairs

$\gamma + \gamma_{CMB} \to e^+ e^-$

Can also be explained by supernovae remnants: $p+p \to e^+$

(Mertsch, Sarkar; 1402.0855)



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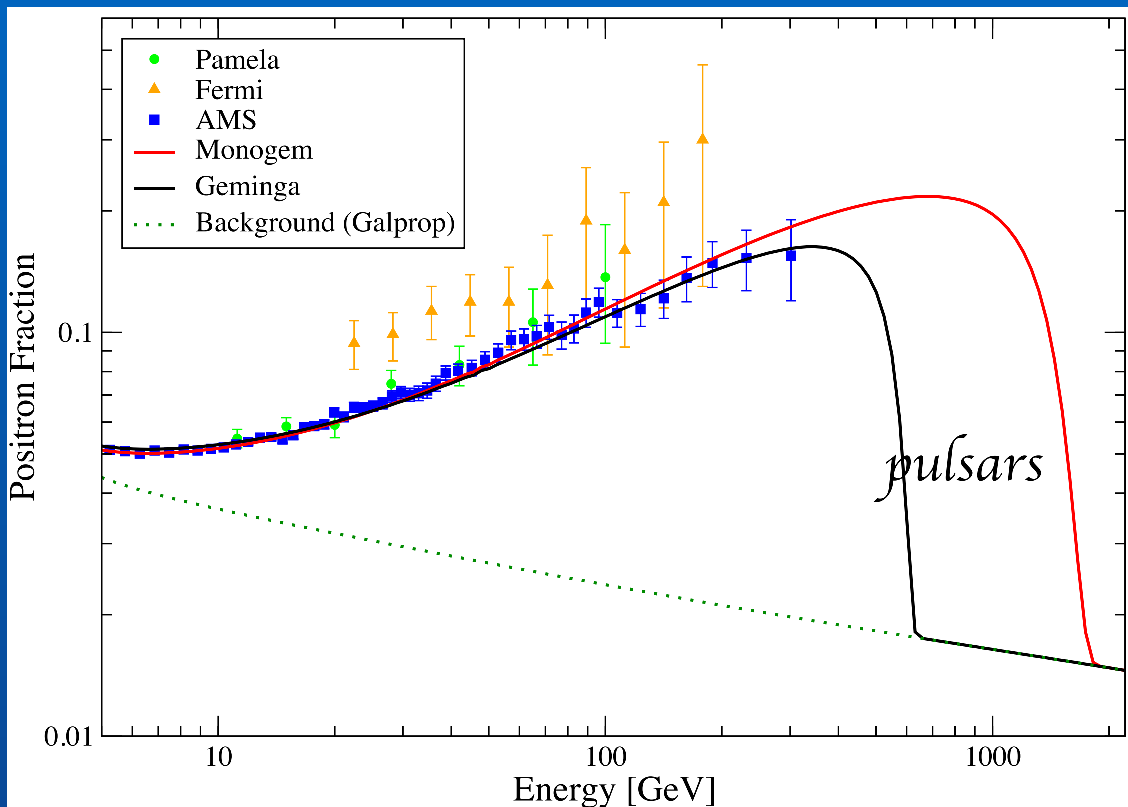
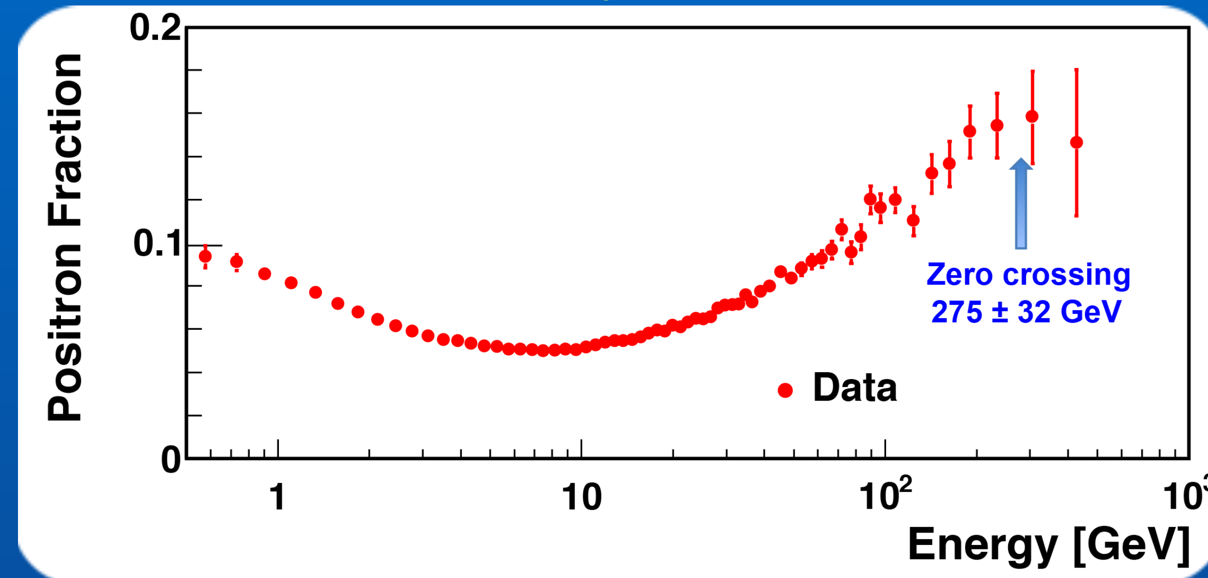



M. Aguilar et al. [AMS Collaboration], Phys. Rev. Lett. 110 , no. 14, 141102 (2013).

AMS collaboration, Phys.Rev.Lett. 113 (2014) 121102




Not clear yet if it is a pulsar or a dark matter interpretation.

Can be fitted by 2 pulsars, Monogem and Geminga (Profumo, 1304.1791)

Such spectrum if from DM origin, should exhibit a clear photon signal at FERMI which is not the case

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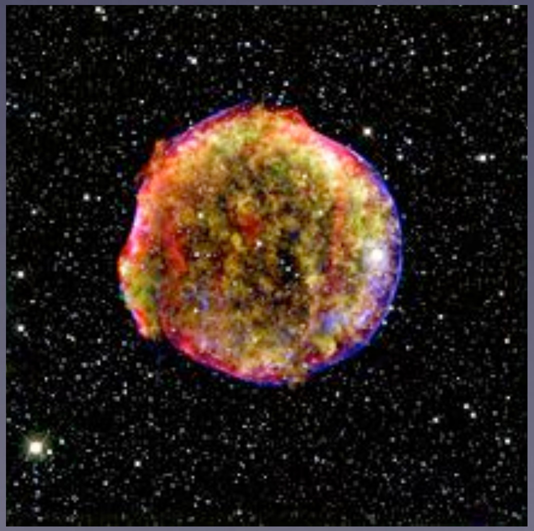
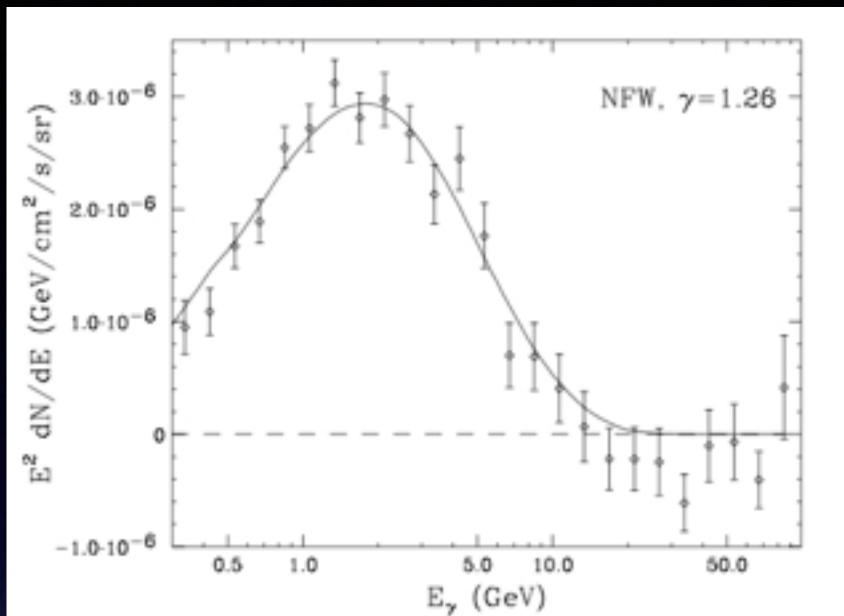
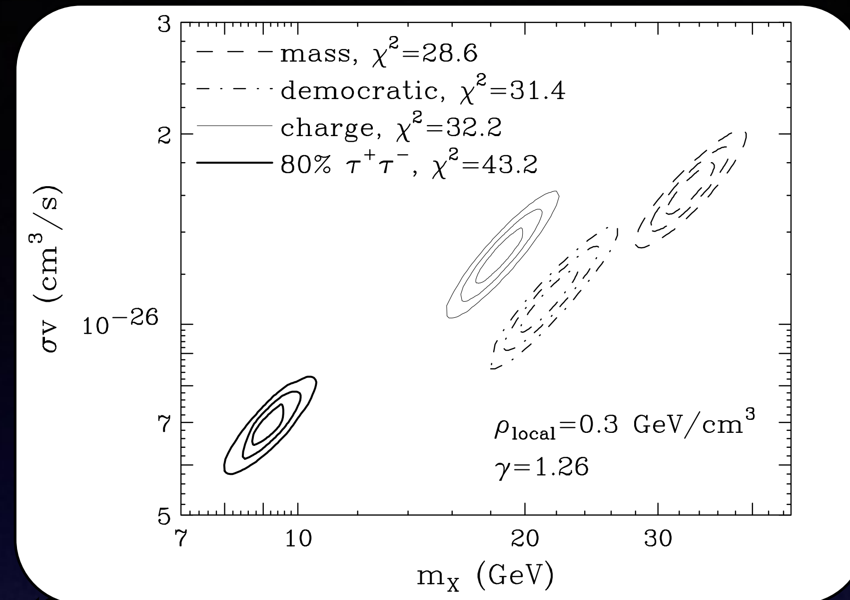
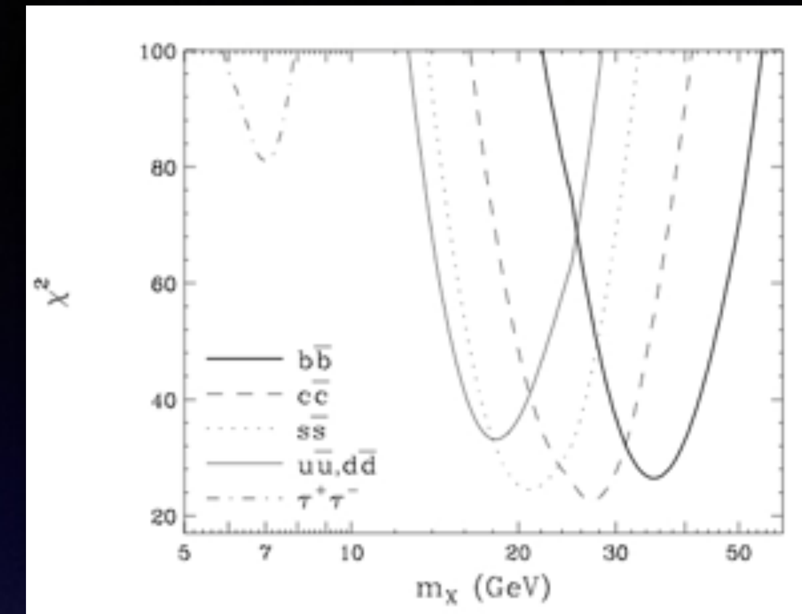


# Galactic center signal [hooperon]?

T. Daylan, D. P. Finkbeiner, D. Hooper, T. Linden, S. K. N. Portillo, N. L. Rodd, and T. R. Slatyer, [1403.6503]



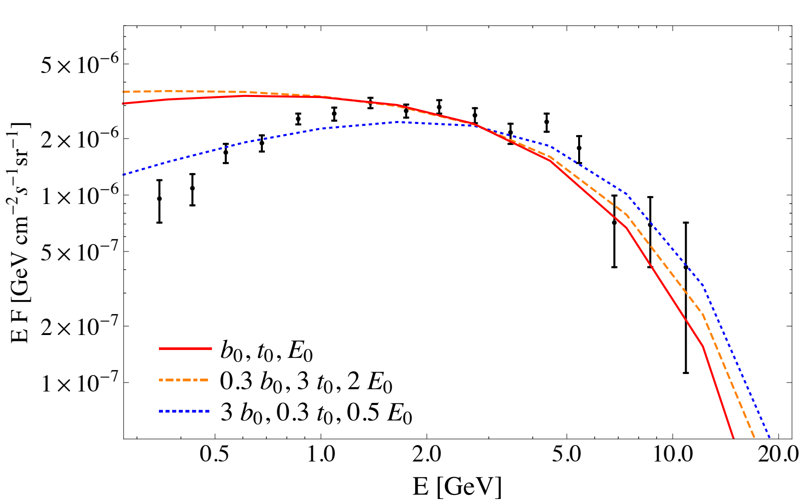




Corresponding to a dark matter mass of ~30 GeV annihilating to bbar (40 σ !!)

**Galactic Center gamma-ray "excess" from an active past of the Galactic Centre?**

Jovana Petrović,[1] Pasquale Dario Serpico,[2] and Gabrijela Zaharijaš[3]

backgrounds at few GeV in Fermi-LAT data in a region around the Galactic Center, consistent with a dark matter annihilation origin. We demonstrate that the main spectral and angular features of this "excess" can be reproduced if they are mostly due to inverse Compton emission from high-energy electrons injected in a burst event of $\sim 10^{52} \div 10^{53}$ erg roughly $\mathcal{O}(10^6)$ years ago. We consider this example as a proof of principle that time-dependent phenomena need to be understood

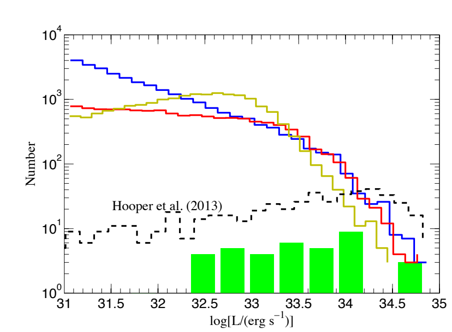


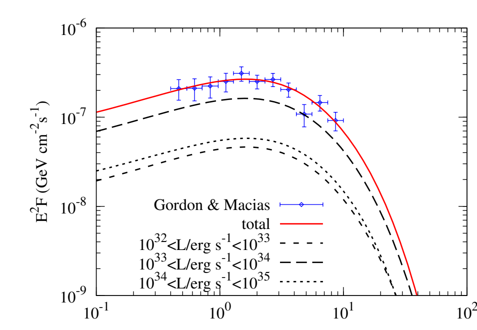

Alternative astrophysical explanations are the possibility of a burst event occurred 1 million years ago or an underestimate of the millisecond pulsar population.

Millisecond pulsar interpretation of the Galactic center gamma-ray excess

Qiang Yuan[a,b], Bing Zhang[b]

MSPs. The model is then applied to a bulge population of MSPs. We find that the extended $\gamma$-ray excess can be well explained by the bulge MSPs without violating the detectable flux distribution of MSPs by Fermi-LAT. The spatial distribution of the bulge MSPs as implied by the distribution of low mass X-ray binaries follows a $r^{-2.4}$ profile, which is also consistent

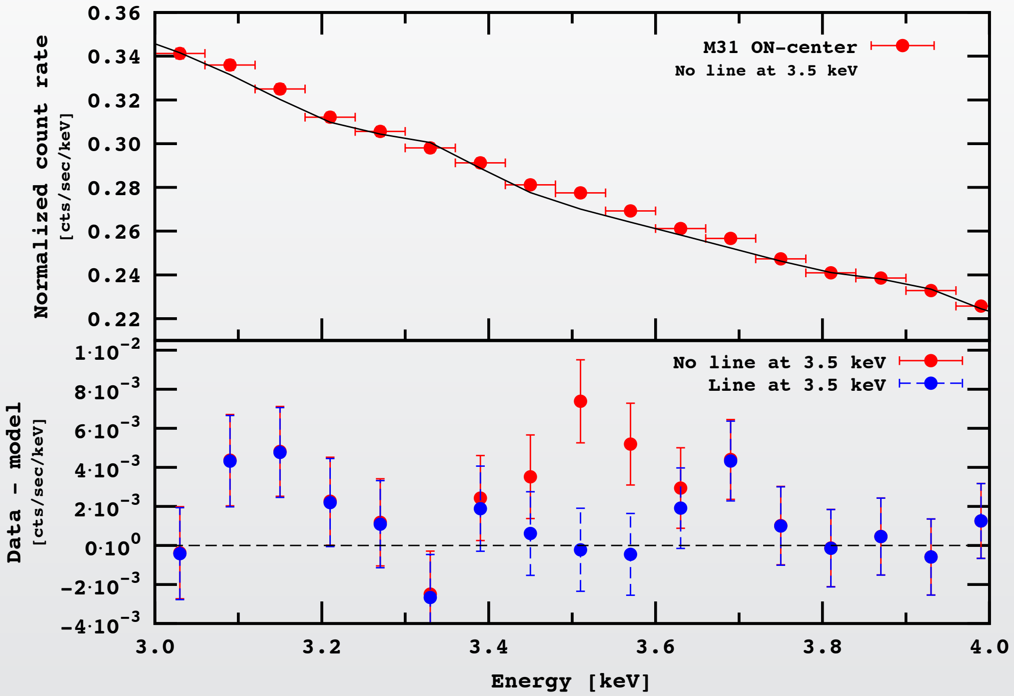


# *Signal: XMM NEWTON and 3.5 keV line?*

XMM Newton

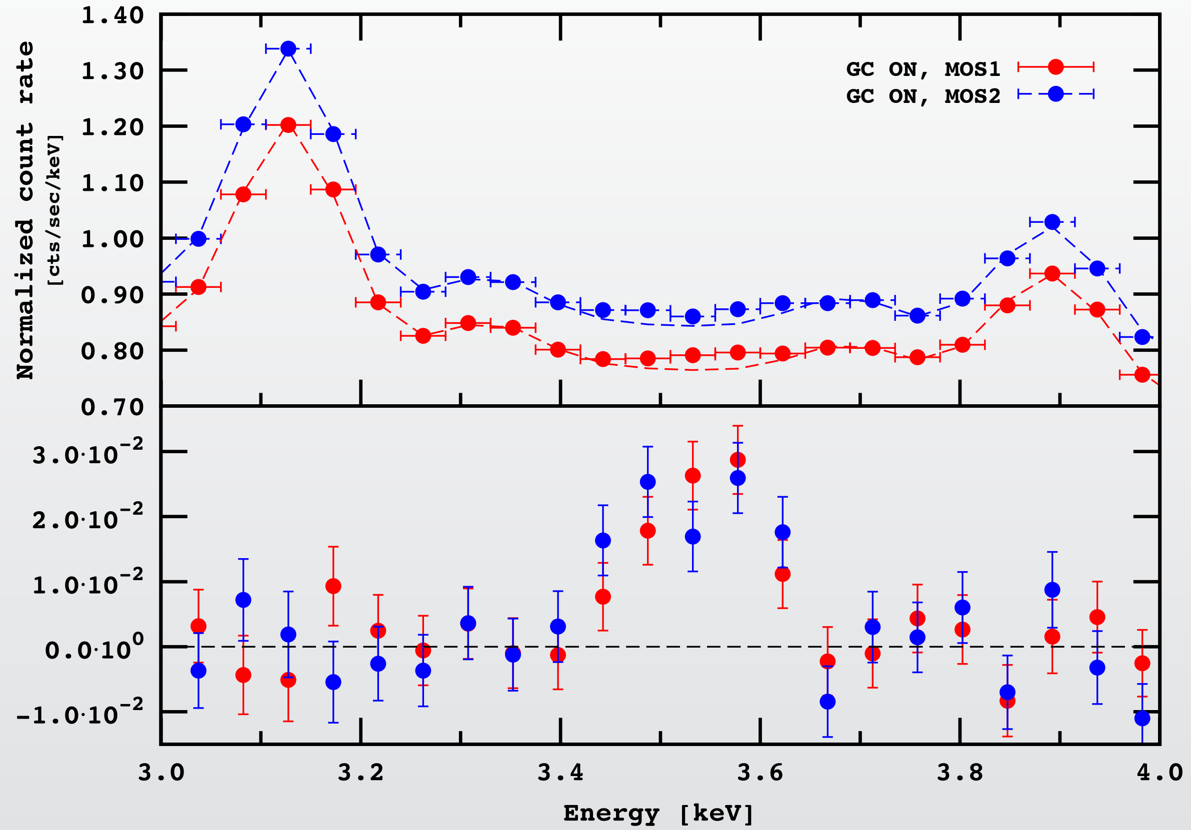
## *Clusters of galaxies (02/14)*




A. Boyarsky, O. Ruchayskiy, D. Iakubovskyi, J. Franse; http://arxiv.org/abs/1402.4119

E. Bulbul, M. Markevitch, A. Foster, R. K. Smith, M. Loewenstein, S. W. Randall; http://arxiv.org/abs/1402.2301

## *Galactic center (08/14)*




A. Boyarsky, O. Ruchayskiy, D. Iakubovskyi, J. Franse arXiv:1408.2503

$\phi^{obs}_{\gamma\gamma} \simeq 5.2 \times 10^{-5}$ photons cm$^{-2}$ s$^{-1}$ at 3.55 keV

*(Perseus, 78 Mpc)*

$$\Phi_{\gamma\gamma} = \frac{L}{4\pi D^2_{pe}} = \frac{\rho_{Pe}}{m_{dm}} \times \Gamma(DM \to \gamma\gamma) \times \frac{(R_{Pe})^3}{3(D_{Pe})^2}$$

$$\Gamma(DM \to \gamma\gamma) \simeq 10^{-23} \left(\frac{m_{dm}}{\text{keV}}\right) \Phi_{\gamma\gamma} \quad \text{cm}^{-2}\text{s}^{-1}$$

# Alternative explanation for the 3.5 keV line

**Dark matter searches going bananas:**
**the contribution of Potassium (and Chlorine) to the 3.5 keV line**

**ABSTRACT**

We examine the claimed excess X-ray line emission near 3.5 keV with a new analysis of *XMM-Newton* observations of the Milky Way center and with a re-analysis of the data on M 31 and clusters. In no case do we find conclusive evidence for an excess. We show that known plasma lines, including in particular K XVIII lines at 3.48 and 3.52 keV, provide a satisfactory fit to the *XMM* data from the Galactic center. We assess the expected flux for the K XVIII lines and find that the measured line flux falls squarely within the predicted range based on the brightness of other well-measured lines in the energy range of interest. We then re-evaluate the evidence for excess emission from clusters of galaxies, including a previously unaccounted for Cl XVII line at 3.51 keV, and allowing for systematic uncertainty in the expected flux from known plasma lines and for additional uncertainty due to potential variation in the abundances of different elements. We find that no conclusive excess line emission is present within the systematic uncertainties in Perseus or in other clusters. Finally, we re-analyze *XMM* data for M 31 and find no statistically significant line emission near 3.5 keV to a level greater than one sigma.

*Two lines of potassium KXVIII are at 3.48 and 3.51 keV. Underestimating their amplitude (the density of such elements in a galactic environment) could mimic a dark matter signal. The authors showed that within the reasonable abundance (comparing with other more known concentrations like Argon) the « signal » can easily be below 1 $\sigma$ and mainly due to atomic rays of Potassium*

(Jeltema, Profumo; 1408.1699)

# Answers to the KVIII argument

**Comment on the paper "Dark matter searches going bananas: the contribution of Potassium (and Chlorine) to the 3.5 keV line" by T. Jeltema and S. Profumo**

A. Boyarsky[1], J. Franse[1,2], D. Iakubovskyi[3], and O. Ruchayskiy[4]
[1]Instituut-Lorentz for Theoretical Physics, Universiteit Leiden, Niels Bohrweg 2, Leiden, The Netherlands
[2]Leiden Observatory, Leiden University, Niels Bohrweg 2, Leiden, The Netherlands
[3]Bogolyubov Institute of Theoretical Physics, Metrologichna Str. 14-b, 03680, Kyiv, Ukraine
[4]Ecole Polytechnique Fédérale de Lausanne, FSB/ITP/LPPC, BSP, CH-1015, Lausanne, Switzerland

(■Dated: August 20, 2014)

We revisit the X-ray spectrum of the central $14'$ of the Andromeda galaxy, discussed in our previous work [1]. Recently in [2] it was claimed that if one limits the analysis of the data to the interval $3-4$ keV, the significance of the detection of the line at 3.53 keV drops below $2\sigma$. In this note we show that such a restriction is not justified, as the continuum is well-modeled as a power law up to 8 keV, and parameters of the background model are well constrained over this larger interval of energies. This allows for a detection of the line at 3.53 keV with a statistical significance greater than $\sim 3\sigma$ and for the identification of several known atomic lines in the energy range $3-4$ keV. Limiting the analysis to the $3-4$ keV interval results in increased uncertainty, thus decreasing the significance of the detection. We also argue that, with the M31 data included, a consistent interpretation of the 3.53 keV line as an atomic line of K XVIII in all studied objects is problematic.

*Boyarski, Franse, Iakubovskyi, Ruchayskiy, arXiv1408.4388*

COMMENT ON "DARK MATTER SEARCHES GOING BANANAS: THE CONTRIBUTION OF POTASSIUM (AND CHLORINE) TO THE 3.5 KEV LINE"

Esra Bulbul (1), Maxim Markevitch (2), Adam R. Foster (1), Randall K. Smith (1), Michael Loewenstein (2), Scott W. Randall (1)
(1) Harvard-Smithsonian Center for Astrophysics, (2) NASA/GSFC

*Draft version September 16, 2014*

ABSTRACT

The recent paper by Jeltema & Profumo (2014) claims that contributions from K XVIII and Cl XVII lines can explain the unidentified emission line found by Bulbul et al. (2014) and also by Boyarsky et al. (2014a,b). We show that their analysis relies upon incorrect atomic data and inconsistent spectroscopic modeling. We address these points and summarize in the appendix the correct values for the relevant atomic data from AtomDB.

*(Bulbul, Markevitch, Foster, Smith, Loewenstein, Randall; 1409.4143)*

We can, however, recreate their Table 3 if we use the approximate values available in the "strong lines" option at http://www.atomdb.org/WebGUIDE/webguide.php. As described on that page, this option uses an approximation

$$\epsilon(T) = \epsilon(T_{peak})N(T)/N(T_{peak}) \quad (1)$$

where $\epsilon$ is the emissivity, $T$ is the requested temperature, $T_{peak}$ is the temperature for which the transition's emissivity is its maximum, and $N$ is the abundance of the ion. This approximation is intended for quick identification of possible strong lines, as it disregards the change in line emissivity with temperature, instead accounting only for the relative change in ion abundance.[1]

# Conclusion

Indirect detection seems has(z)ardous
(just my two cents)

Neutrino wall is approaching direct detection hopes

From keV to multi-PeV DM, lots of fun for
model builders