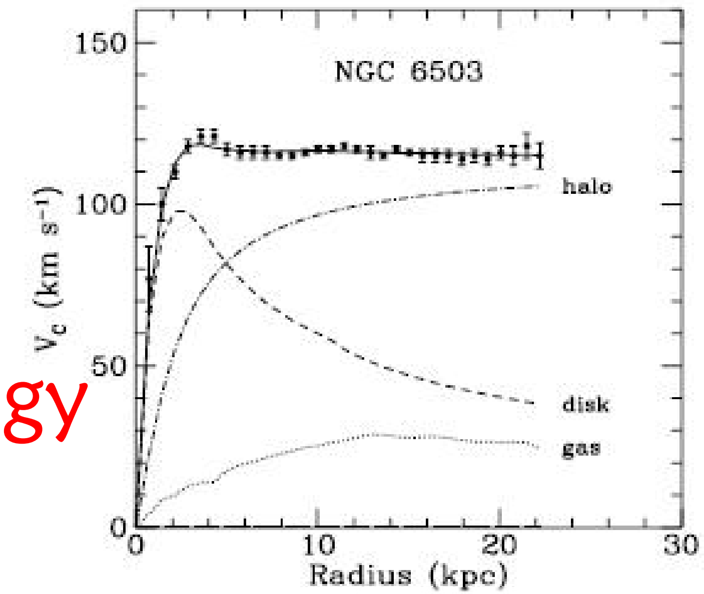
高能中微子和 PeV 暗物质

冯　磊
紫金山天文台

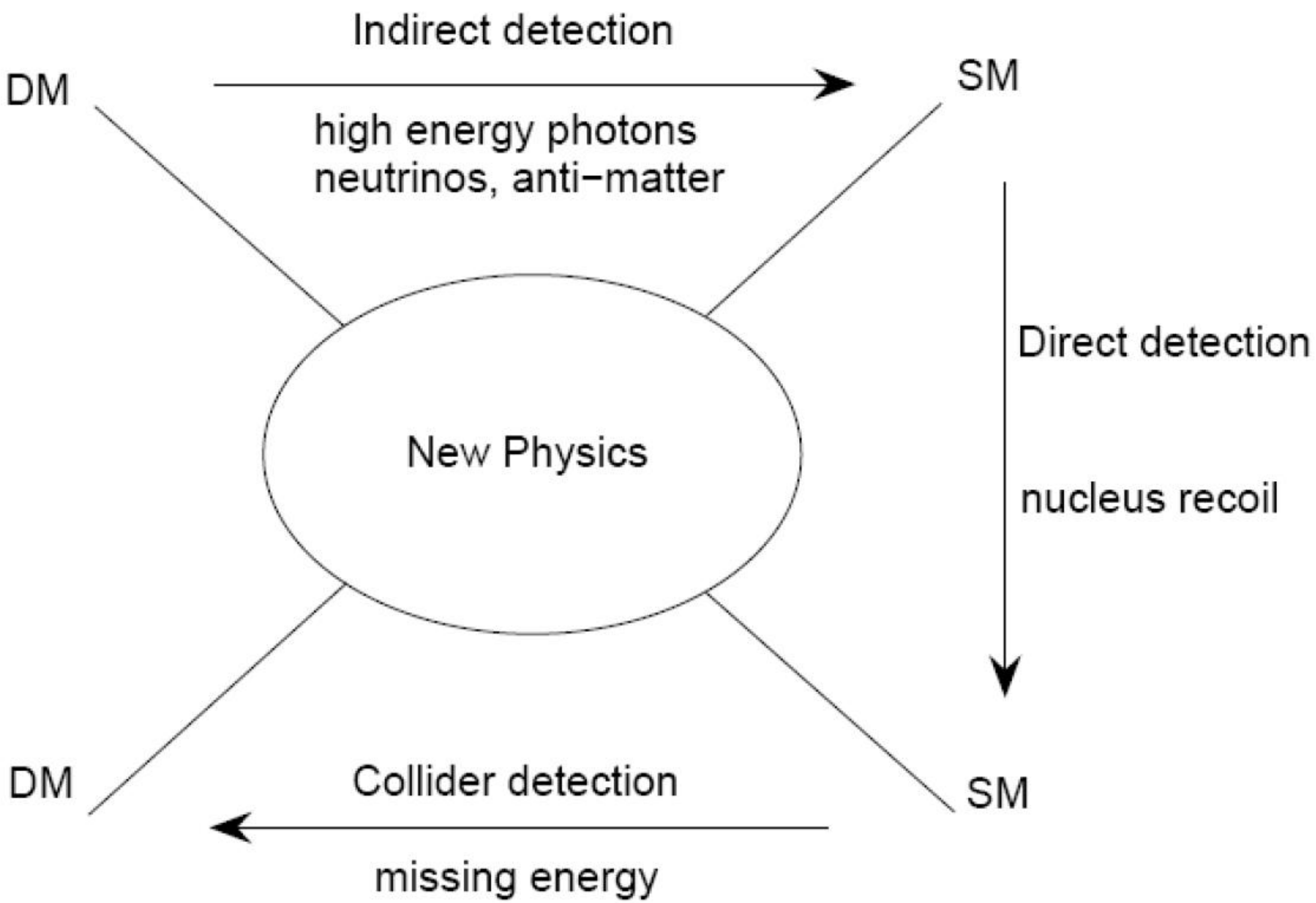
The Evidence of Dark Matter

- Rotation Curve
- Gravitational lensing
- The Observation of cosmology
- Large scale structure
- …… and so on



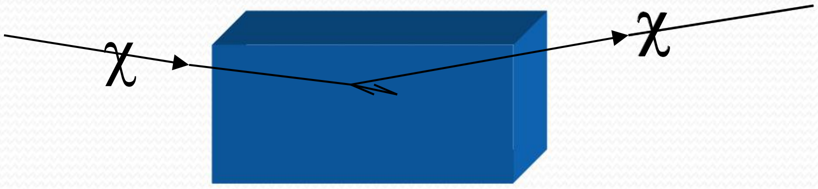
The methods of detecting Dark Matter

Detection of particle dark matter

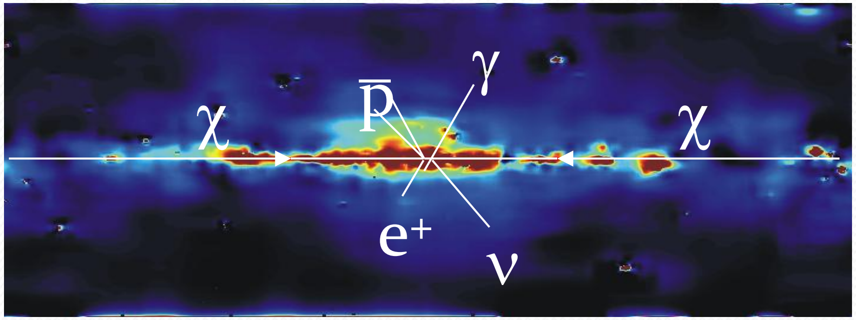


The detection of dark matter

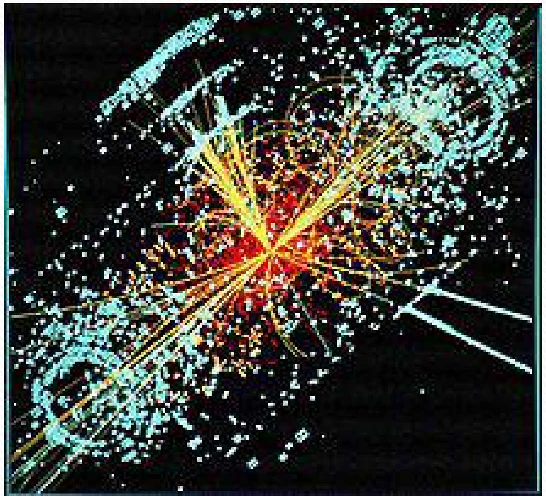
- Direct detection：
  PandaX， CDEX，
  Xenon, CDMS, DAMA,
  COGENT and so on

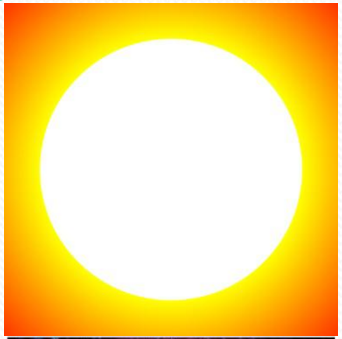


- Indirect detection ：
  Pamela ,ATIC, Fermi,
  HESS， AMS02， DAMPE,
  CALET and so on

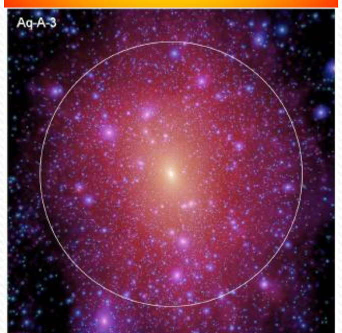


- Collider： LHC

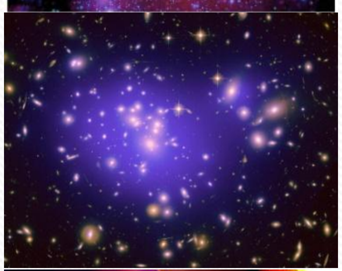




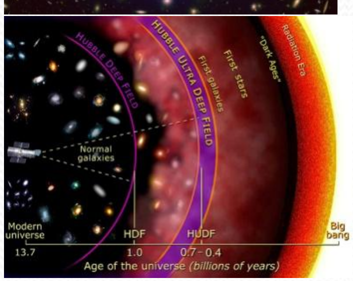
Sun and earth



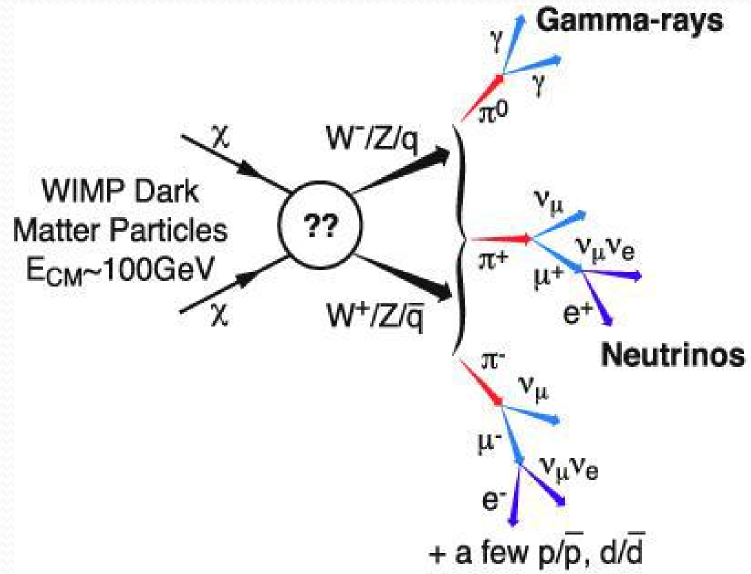
Galaxy

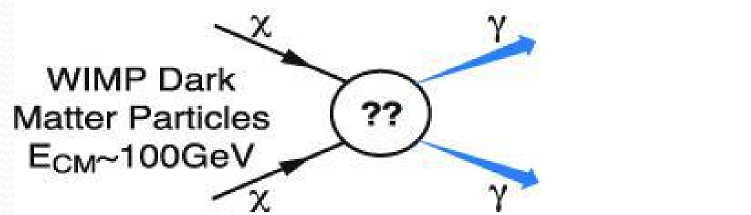


Cluster

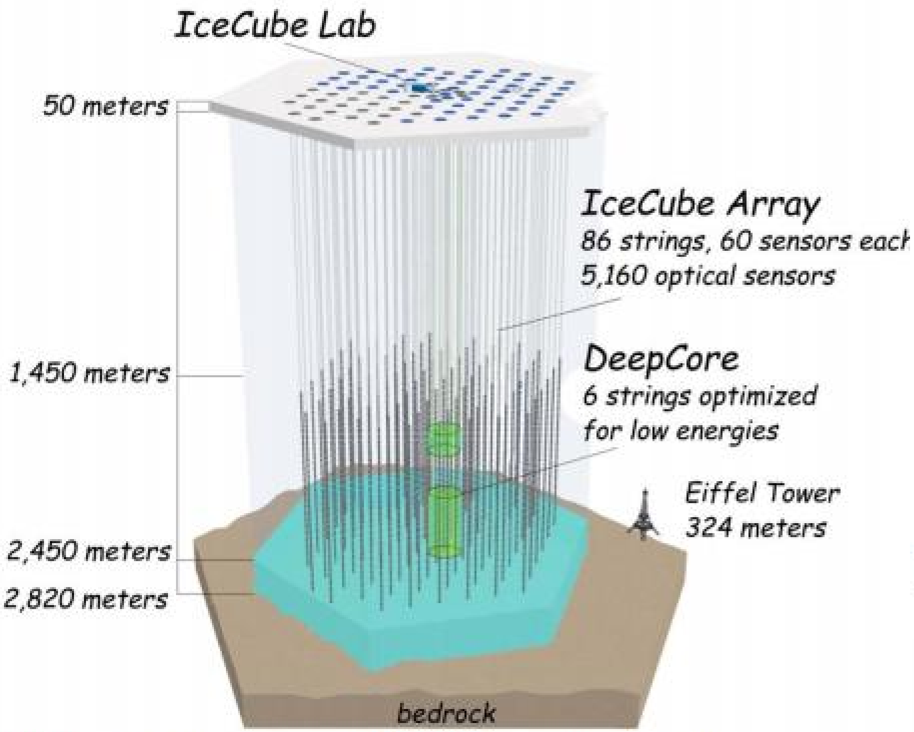


Deep extragalactic space and early Universe

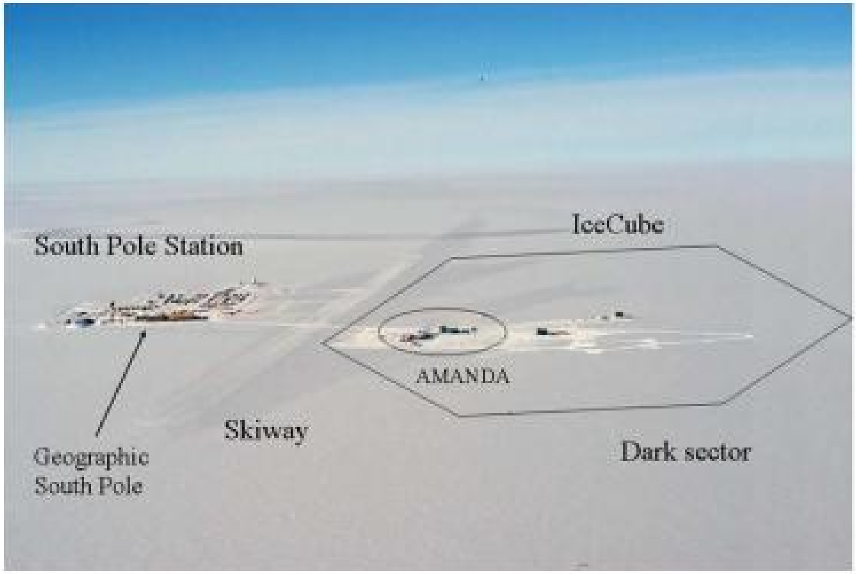




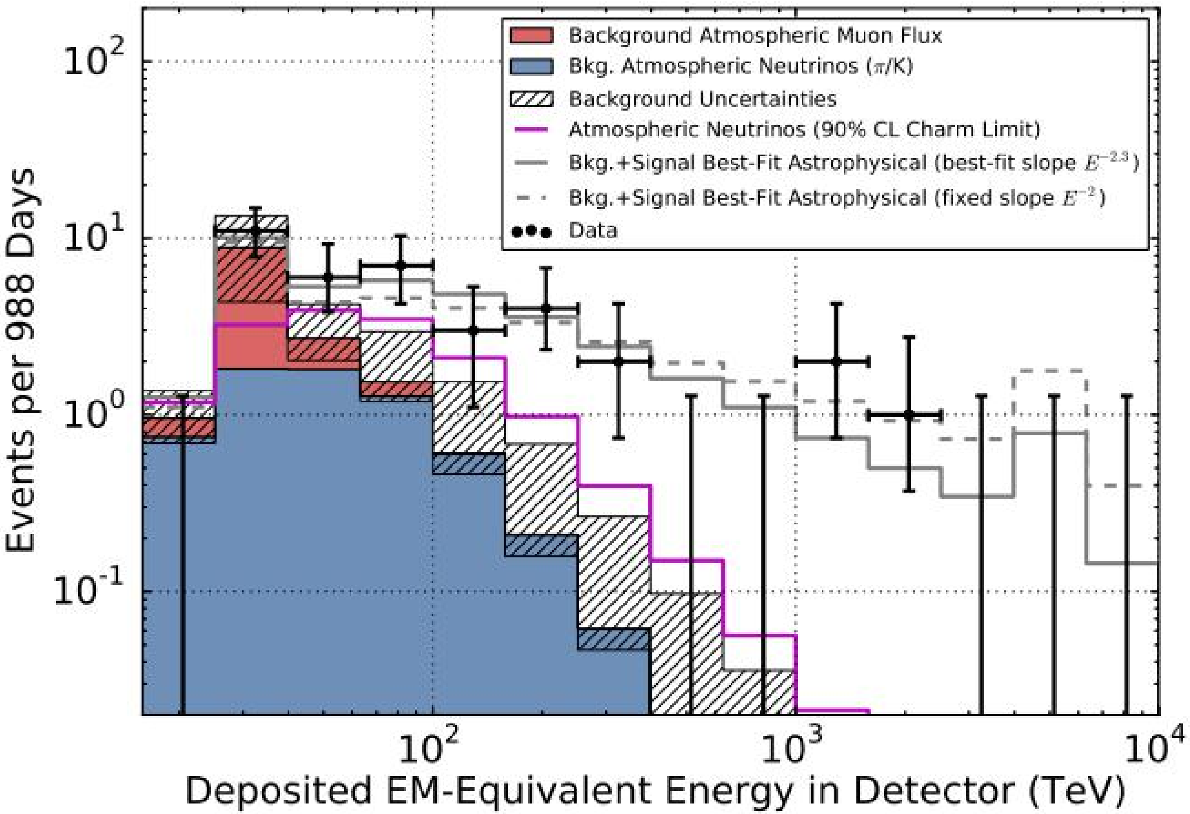
Baltz et al. 2008



[http://newscenter.lbl.gov/2010/12/17/completing-icecube/]



[http://www.icecube.umd.edu/~goodman/IceCube.htm]



5.7 sigma deviation from Atmospheric neutrino background!

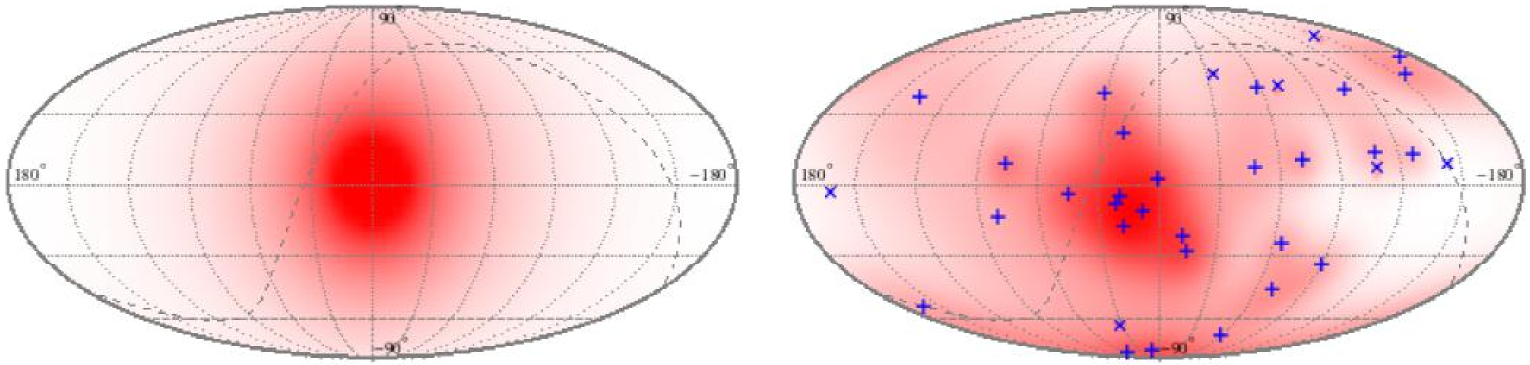
1405.5303v2

PeV neutrino的解释

- 天体物理过程

- PeV Dark Matter

空间分布



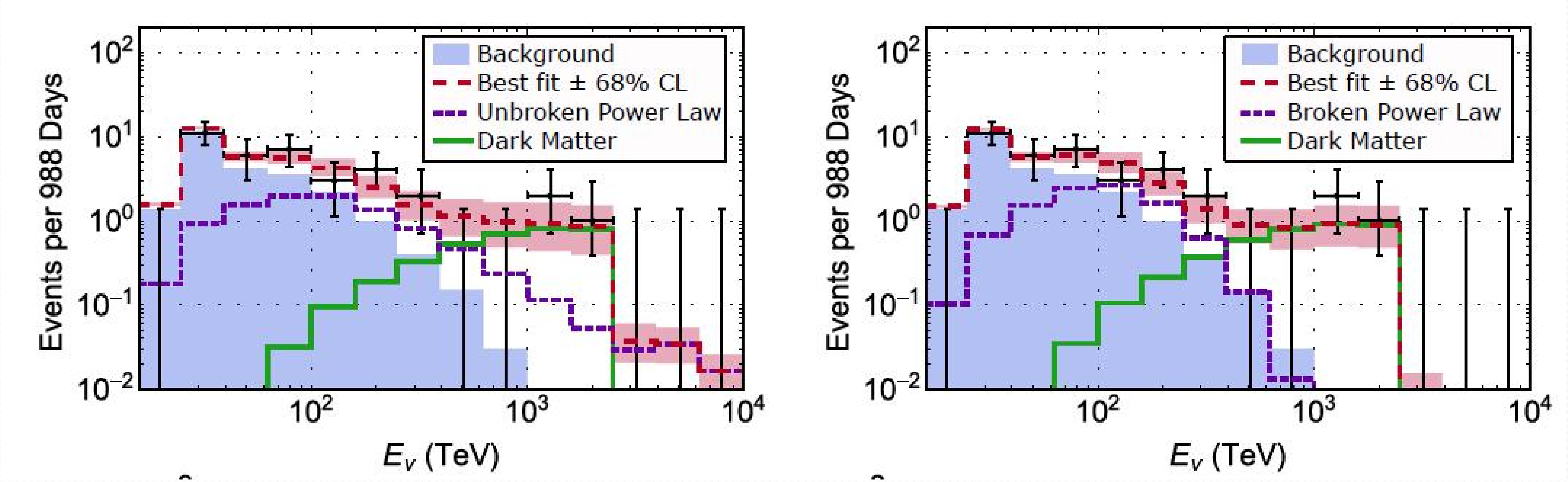
(a) PDF of DM decay (b) PDF of IceCube data

Figure 1. Illustrative sky map of: (a) DM PDF from eq. (2.4); (b) PDF of the IceCube data from eq. (3.1). Both figures are in Galactic coordinates. The $\times$ and $+$ in panel (b) correspond to track and shower events, respectively. The color codes (linear scale) in both panels are scaled for illustration purpose.

under different simplifying approximations. Our preliminary conclusions are the following: Either a likelihood method, see section 3.1, or a Kolmorogov-Smirnov test, see section 3.2 (including its Anderson-Darling variant in section 3.3), suggest that data prefer a DM-like distribution with respect to an isotropic one at the confidence level ranging from 89% to 98% C.L.; *i.e.*, roughly at the "$2\,\sigma$" level. In section 3.4 we discuss some of the possible limitations

Decaying Leptophilic Dark Matter

$$\frac{y_{\alpha\beta\gamma}}{M_{\rm Pl}^2}\left(\overline{L_\alpha}\ell_\beta\right)\left(\overline{L_\gamma}\chi\right) + {\rm h.c.}\,, \qquad \tau_\chi^{-1} = \frac{3y^2}{6144\,\pi^3}\frac{M_\chi^5}{M_{\rm Pl}^4}\,.$$



1605.05749v1

Neutrinos at IceCube from Heavy Decaying Dark Matter

Brian Feldstein[a], Alexander Kusenko[a,b],
Shigeki Matsumoto[a], and Tsutomu T. Yanagida[a]

Case	Spin	$SU(2)_L$	$U(1)_Y$	Decay Operator	Coefficient for IceCube Data
1.	0	3	1	$\bar{L}^c \phi L$	9.5×10^{-30}
2.	1/2	0	0	$\bar{L} H^c \psi$	2.7×10^{-29}
3.	1/2	3	0	$\bar{L} \psi^a \tau^a H^c$	3.8×10^{-29}
4.	1/2	2	−1/2	$\bar{L} F \psi$	5.6×10^{-30} (PeV^{-1})
5.	1/2	3	−1	$\bar{L} \psi^a \tau^a H$	2.7×10^{-29}
6.	1	0	0	$\bar{L} \not{V} L$	3.3×10^{-29}
7.	3/2	0	0	$(\bar{L} i D_\mu H^c)\gamma^\nu \gamma^\mu \psi_\nu$	1.9×10^{-29} (PeV^{-1})

4.1 Gravitino Dark Matter with R-Parity Violation

4.2 Hidden Sector Gauge Boson

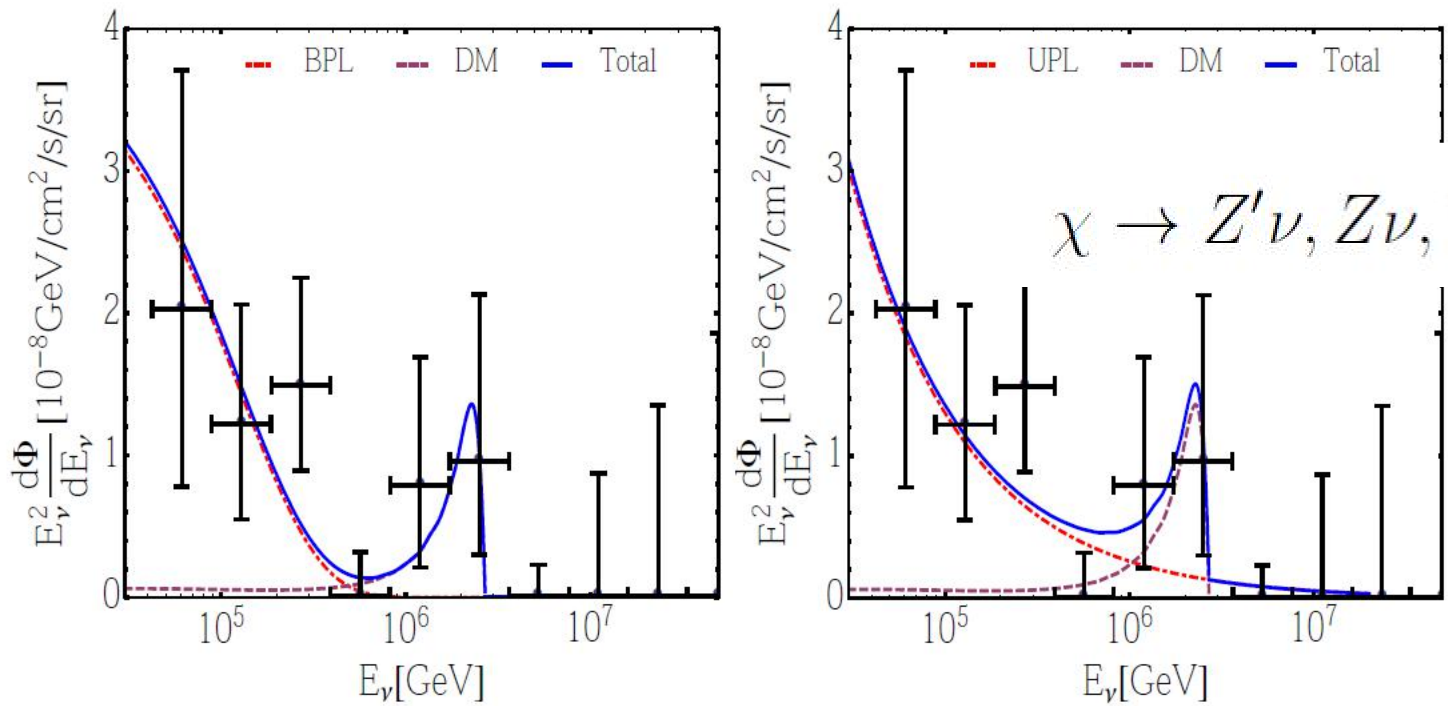
arXiv:1303.7320v2

4.3 A singlet fermion in an extra dimension

IceCube Events from Heavy DM decays through the Right-handed Neutrino Portal

P. Ko, Yong Tang

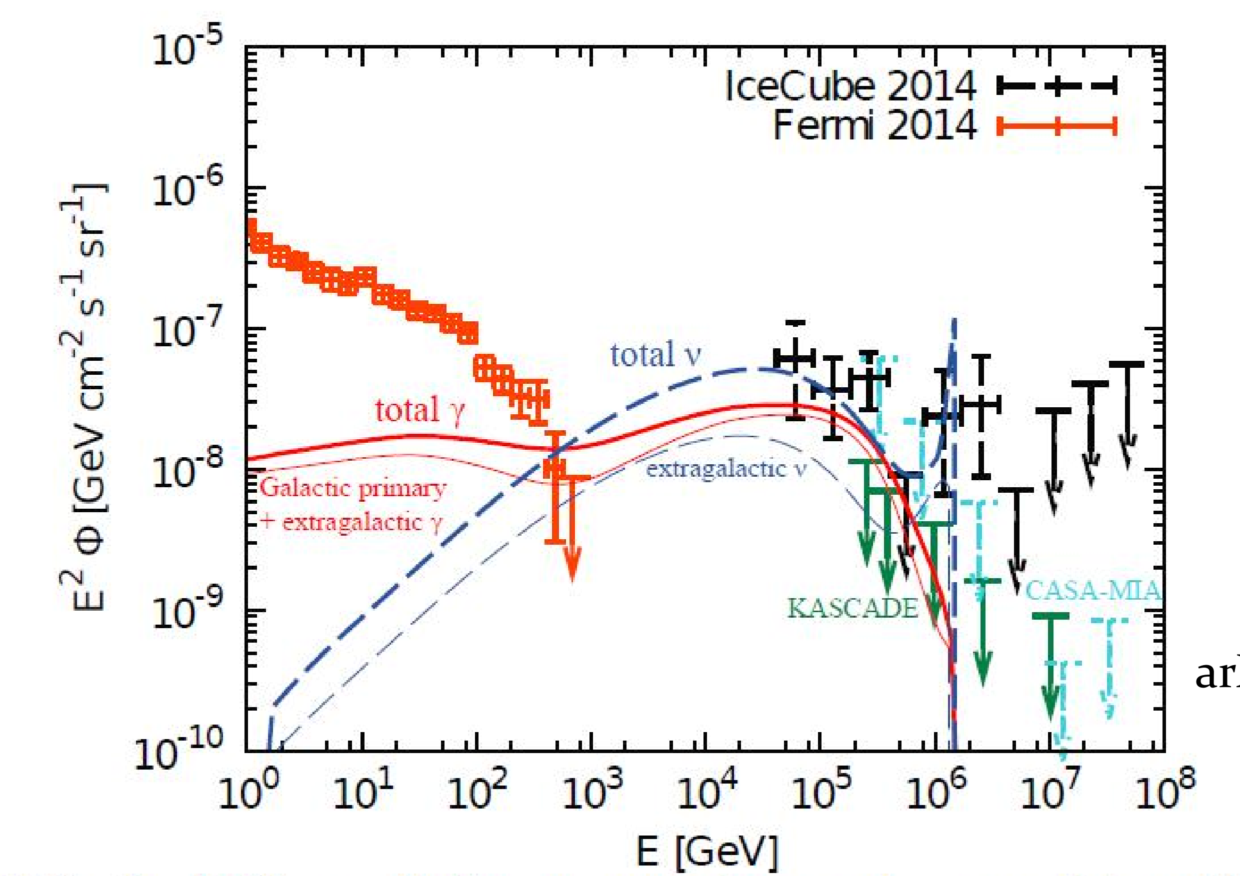
$$
\begin{aligned}
\mathcal{L} =& \mathcal{L}_{\rm SM} + \frac{1}{2}\bar{N} i\partial\!\!\!/ N - \left(\frac{1}{2} m_N \bar{N}^c N + y\bar{L}\widetilde{H}N + \text{h.c.}\right) - \frac{1}{4}X_{\mu\nu}X^{\mu\nu} - \frac{1}{2}\sin\epsilon X_{\mu\nu}F_Y^{\mu\nu} \\
&+ D_\mu\Phi^\dagger D^\mu\Phi - V(\Phi, H) + \bar{\chi}\left(iD\!\!\!\!/ - m_\chi\right)\chi - \left(f\bar{\chi}\Phi N + \text{h.c.}\right),
\end{aligned} \tag{2.1}
$$



$$\chi \rightarrow Z'\nu, Z\nu, W^{\mp}l^{\pm},$$

FIG. 2. Neutrino flux from DM χ's decay with $m_\chi \sim 5$PeV and lifetime $\tau_\chi = 1/\Gamma \sim 2\times 10^{28}$s and IceCube Data [1]. The left (right) panel used a broken (unbroken) power law (BPL) for

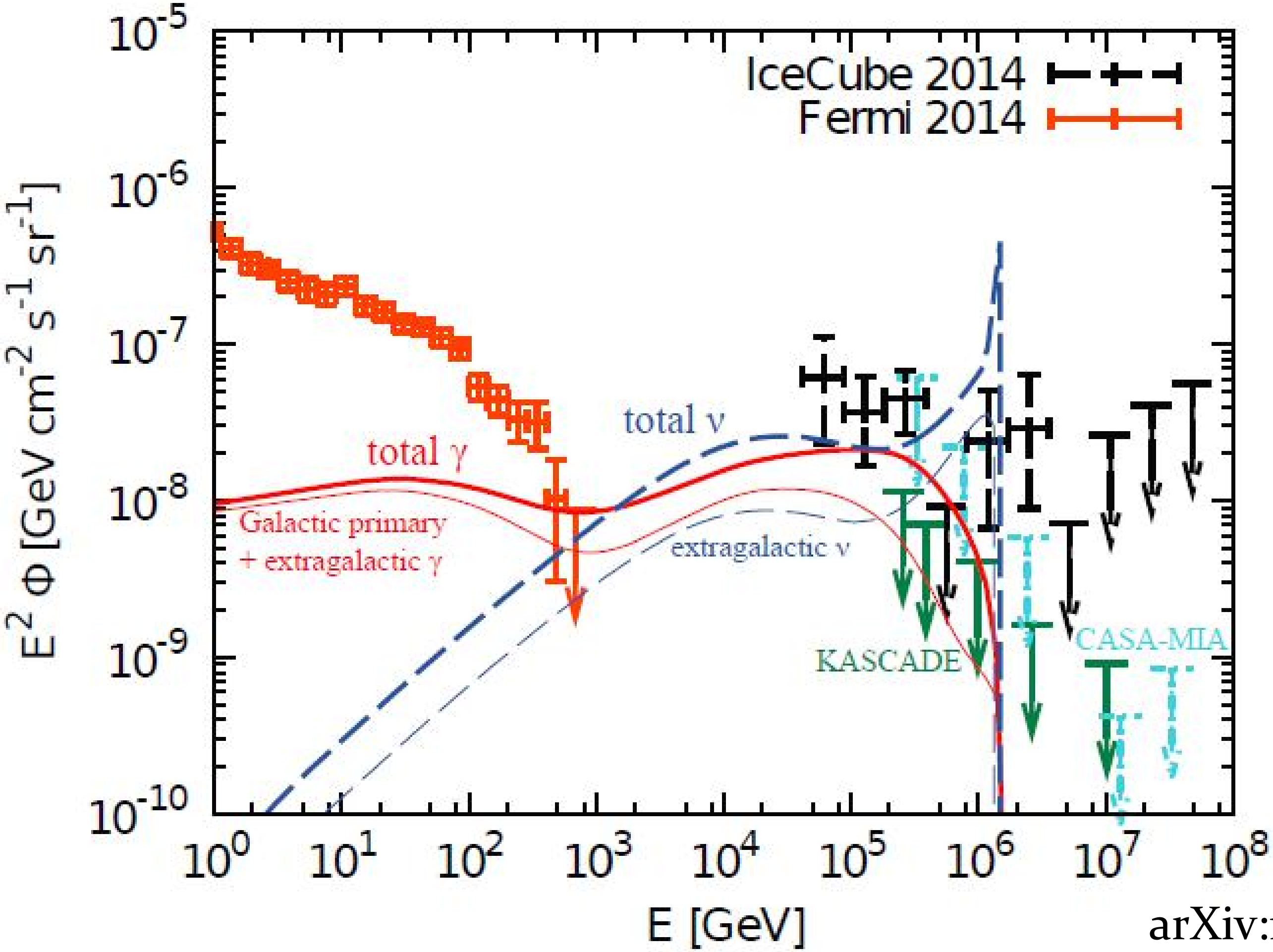
Gamma ray produced by PeV DM particles



arXiv:1503.04663v2

FIG. 1: Diffuse all-flavor neutrino and γ-ray intensities expected in the VHDM scenario. The ES13 model is assumed with $\tau_{\rm dm} = 3.0 \times 10^{27}$ s. The total (thick dashed line) and

mass $m_{\rm dm} = 3.2$ PeV is used, we consider DM $\rightarrow \nu_e \bar{\nu}_e$ and DM $\rightarrow q\bar{q}$ with 12% and 88% branching fractions,



arXiv:1503.04663v2

FIG. 2: The same as Fig. 1, but for the RKP14 model with $\tau_{\rm dm} = 3.5 \times 10^{27}$ s.

$m_{\rm dm} = 2.4$ PeV, assuming branching fractions DM $\rightarrow l^{\pm}W^{\mp}$: DM $\rightarrow \nu Z$: DM $\rightarrow \nu h \approx 2 : 1 : 1$, where the here show, the proposed VHDM models can be critically tested by near-future TeV-PeV γ-ray observations with the High-Altitude Walter Cherenkov Observatory (HAWC), Tibet AS+MD, and perhaps by *Fermi*. Our

-----------K. Murase, R. Laha, S. Ando, and M. Ahlers

arXiv:1503.04663v2

LHAASO 可以在 PeV Dark Matter 领域有一番作为！