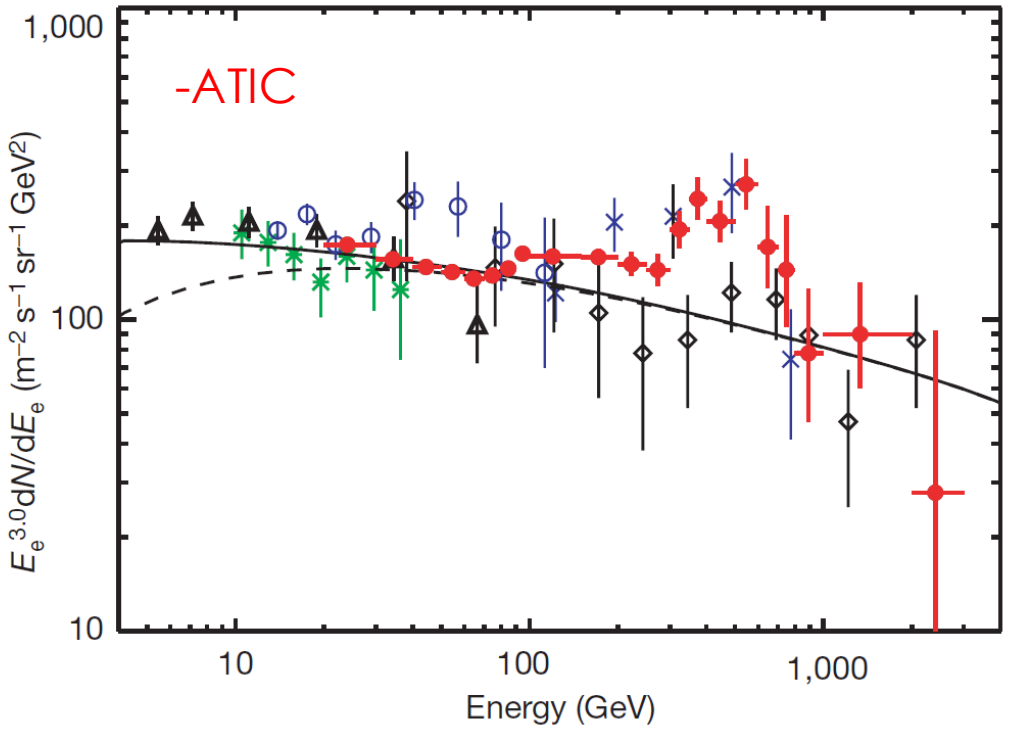
Leptophilic DM model

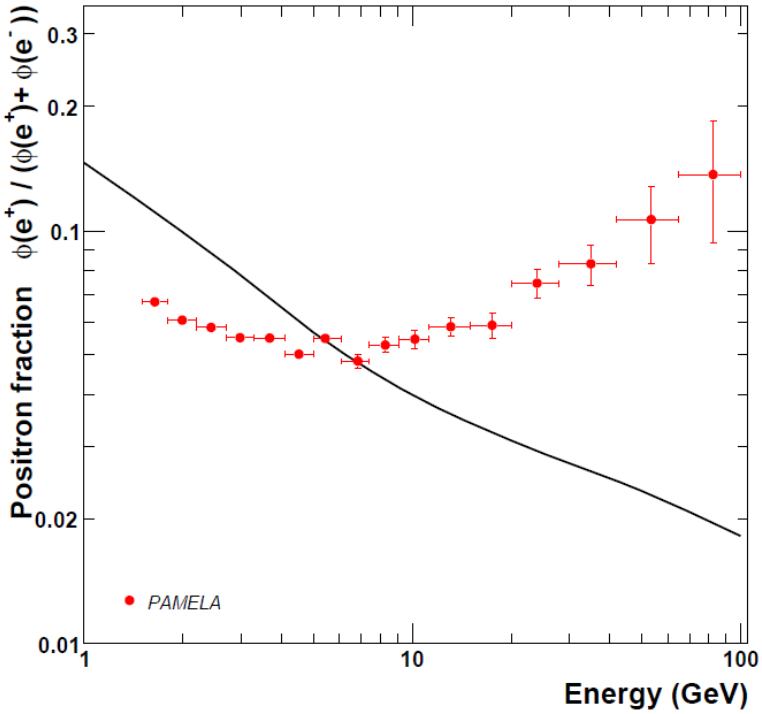
Phys. Rev. D 79, 083528 (2009)

F

M1 الله

PAMELA( ) $\rightarrow e^+/(e^+ + e^-)$ excess
ATIC( ) $\rightarrow e^+ + e^-$ total flux 500GeV
(-> Fermi)





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doi:10.1038/nature07477

arXiv:0810.4995v1 [astro-ph] 28 Oct 2008

1,

2, DM

e^+ e^-

~~DM→SM~~

DM→ new state →SM

new state

new state tree-level

(×)

Leptophilic DM model

لحي leptophilic

excess

The model

$U(1)_{DS}$ dark sector(DS) SM

DS

$U(1)_{DS}$ Dirac fermion DM

/technicolorlike DS

vectorlike

$$\mathcal{L}_{DS} = -\frac{1}{4}F'^{2}_{\mu\nu} + \bar{\chi}\gamma^{\mu}D_{\mu}\chi + |D_{\mu}\phi|^{2} - M_{\chi}\bar{\chi}\chi - V_{DS}(\phi). \quad (1)$$

DM

SM DS U(F')

U

SM وسلم U vectorlike(

)

$$x\tilde{x} \rightarrow (U\ boson) \rightarrow e^{-}\tau^{+}$$

Mass & cross section

PAMELA ATIC excess
DM Mx O(~700GeV)

DM

DM TeV

Mx 700-800GeV

DM U

$$\langle \sigma_{\rm ann} v \rangle = g_\chi^4 \left(\frac{800\ {\rm GeV}}{M_\chi} \right)^2 \times 31\ {\rm pb}, \qquad (2)$$

g_x leptophilic U
DM

DM g_x~0.4 M 700-800GeV

g_l

g_l leptophilic U SM

P. Fayet, Phys. Rev. D 75, 115017 (2007)

$$\Delta(g-2)_l \sim \frac{g_l^2}{4\pi^2}\frac{m_l^2}{M_U^2}. \quad (3)$$

$e<\sim 10^{-11}$ $\mu<\sim 10^{-9}$ $\tau<\sim 10^{-2}$ Mu U

$$g_e \lesssim 4\times 10^{-2}\frac{M_U}{\mathrm{GeV}}, \quad g_\mu \lesssim 2\times 10^{-3}\frac{M_U}{\mathrm{GeV}}, \quad g_\tau \lesssim 0.4\frac{M_U}{\mathrm{GeV}}. \quad (4)$$

U e-v

$$g_e \lesssim 3\times 10^{-3}\frac{M_U}{\mathrm{GeV}}. \quad (5)$$

ee->γU

(2009) babar

$M_U \leq 7.8\mathrm{GeV}$ $g_e \leq \sim 10^{-3}$

mixing

tree level U SM DS
loop-level
SM U (kinetic mixing)

$$\left[\epsilon_{UV} + \frac{e g_e}{16\pi^2} \log\left(\frac{m_\tau}{m_e}\right)\right] F'_{\mu\nu} F^{\mu\nu}, \qquad (6)$$

$F'_{\mu\nu}$:U $F_{\mu\nu}$:
ε_{UV}: mixiing

U e τ

UV/IR q U
$g_q \sim 10^{-2} g_e q$

UV/IR DM ضر

ضر

U SM PAMERA/ATIC

excess DM U

(~1pb)

DM

DM →OK

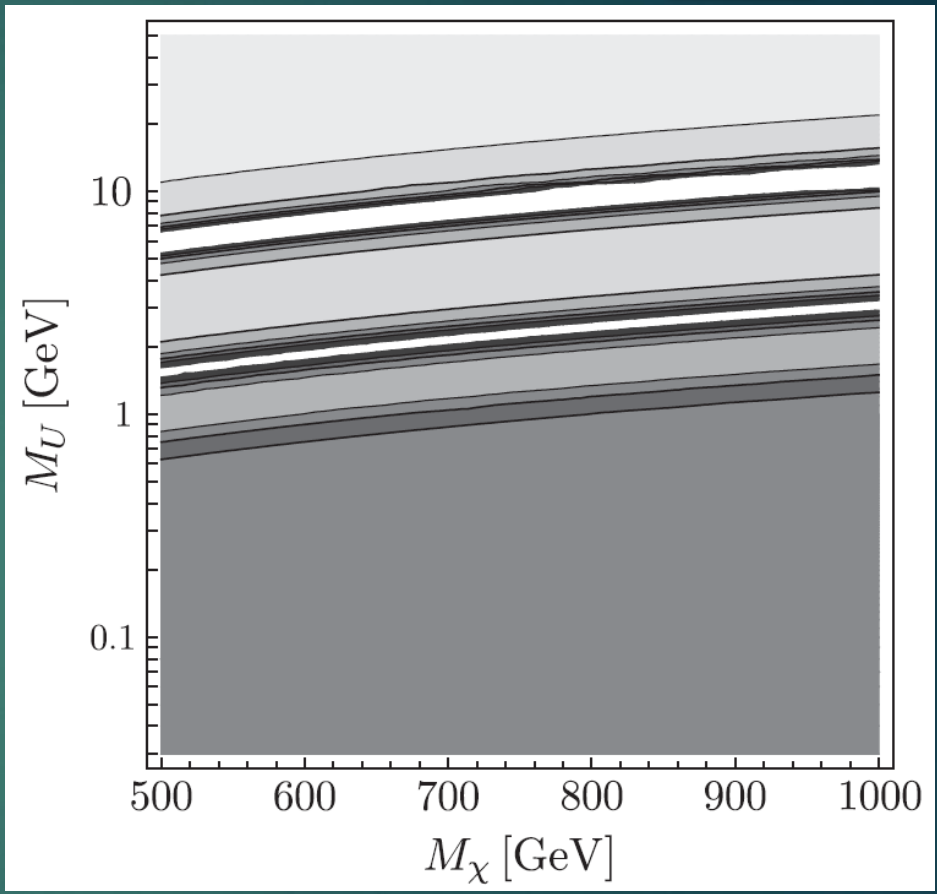
كمي $M_U \leq M_x g^2_x / 4\pi$ O(10GeV)

DM
Sommerfeld enhancement

DM

U DM enhancement

$v=10^{-3}$ $g_x=0.5$



enhancement( )

10,50,100,150,200 enhancement
200
$v=10^{-3}$ $g_x=0.5$

≥ 50
شح
≥ 1000 محي

DM
enhancement

DM 800GeV

1 10GeV U

DM
ضر

ضر

DM ضر

∵ veto

DAMA شخ طمح
DM
PAMELA/ATIC excess DAMA - CDMS

DAMA DM pb

U-mediated DM-e

$$\sigma^0_{\mathrm{DM}-e} \equiv \frac{|\bar{\mathcal{M}}|^2}{16\pi M_\chi^2} = \frac{g_\chi^2 g_e^2}{\pi}\frac{m_e^2}{M_U^4}$$
$$= 0.5\ \mathrm{pb}\left(\frac{g_\chi}{0.4}\right)^2\left(\frac{g_e}{3\times 10^{-5}}\right)^2\left(\frac{10\ \mathrm{MeV}}{M_U}\right)^4, \quad (7)$$

DM

M_U=O(10GeV) g_x~0.5 g_e≤~10^{-5} g_l excess
DAMA

DAMA-CDMS

CDMS ضر CDMS
→U U-
DM

DM DM

$$\frac{\sigma^0_{\mathrm{DM}-N}}{\sigma^0_{\mathrm{DM}-e}} \sim \left(\frac{g_q}{g_e}\right)^2 \left(\frac{m_N}{m_e}\right)^2 \sim \left(\frac{g_q}{g_e}\right)^2 \times 10^6. \qquad (8)$$

CDMS DM DM 700-800GeV ~$2*10^{-43}cm^2$
limit
→ $g_q \leq 10^{-6} g_e$

- UV/IR U-

DM DAMA $10^{-36}cm^2$

كمي DM-DM
$M_U \leq 10MeV$ كمي DM

excess

PAMELA/ATIC excess

10GeV U

enhancement

$g_e \lesssim \sim 10^{-2}$

$$g_e \lesssim 3 \times 10^{-3} \frac{M_U}{\mathrm{GeV}}. \qquad (5)$$

tree-level U $g_x \sim 0.5$ $g_e \sim 10^{-4}$

$g_q \sim 10^{-6}$ ($g_q \sim 10^{-2} g_e$q?)

DM σ^0DM-e=10^{-47}cm ^{2} (7)

→DAMA

DM- 10^{-45} cm^2 (8)

$$\sigma^0_{\mathrm{DM}-e} \equiv \frac{|\bar{\mathcal{M}}|^2}{16\pi M_\chi^2} = \frac{g_\chi^2 g_e^2}{\pi} \frac{m_e^2}{M_U^4}$$
$$= 0.5\ \mathrm{pb} \left(\frac{g_\chi}{0.4}\right)^2 \left(\frac{g_e}{3 \times 10^{-5}}\right)^2 \left(\frac{10\ \mathrm{MeV}}{M_U}\right)^4, \qquad (7)$$

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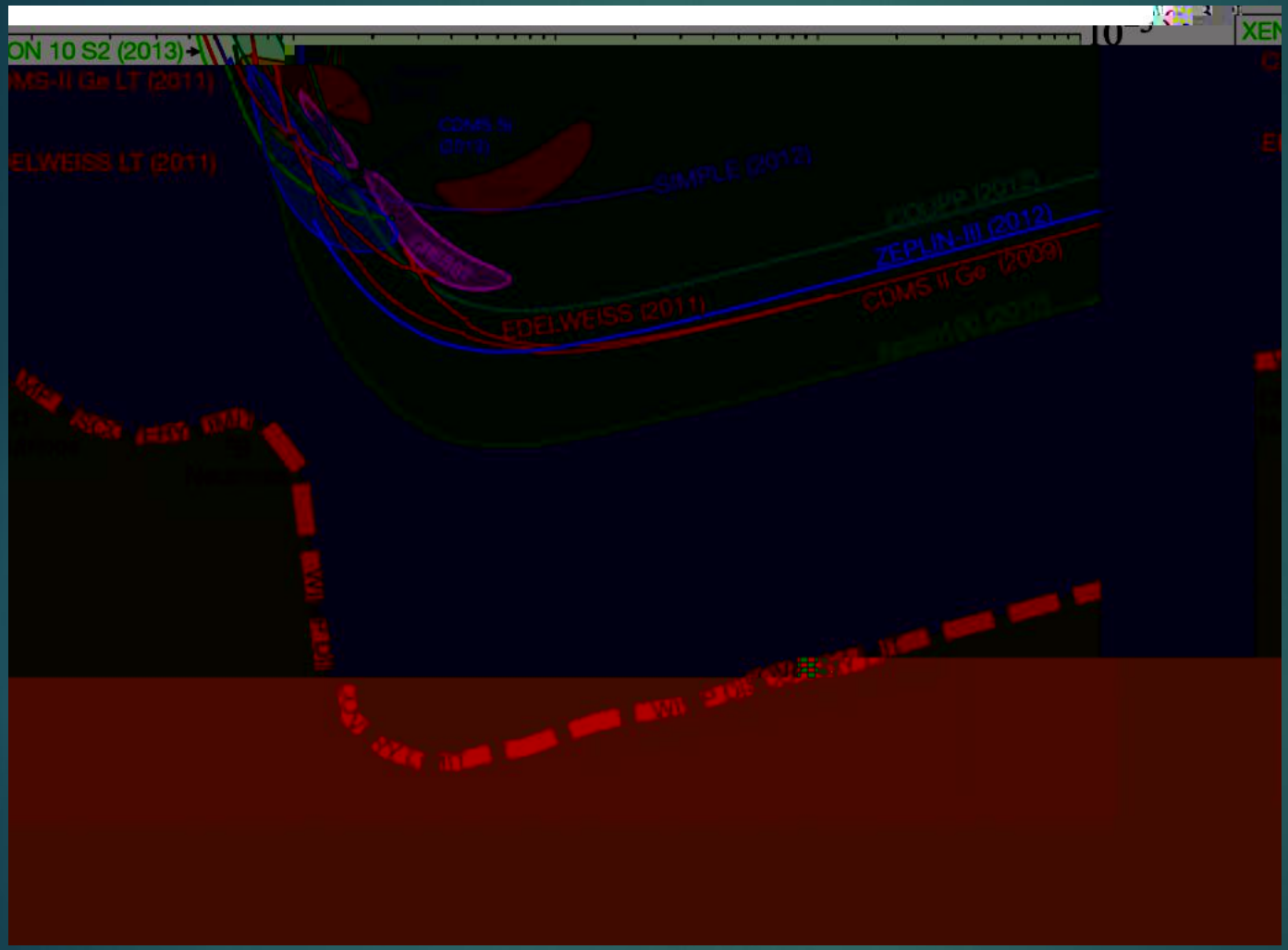
summary

- PAMELA/ATIC excess tree-level
  DM
- e μ τ
- v-e
- CDMS veto
  DAMA

2009
ATIC Fermi

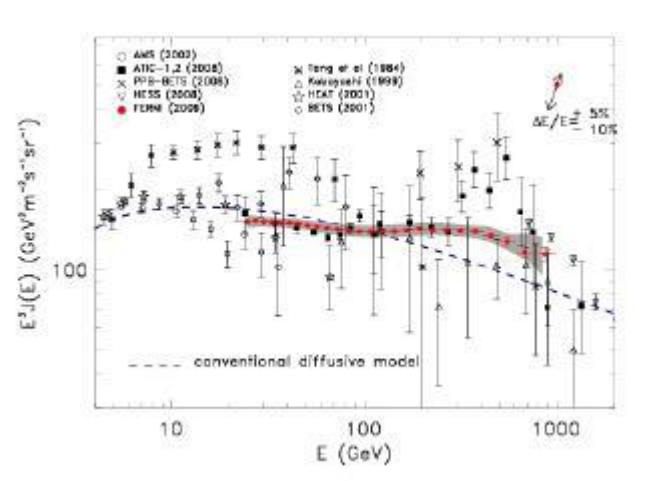
fin



$1pb=10^{-36}cm^2$

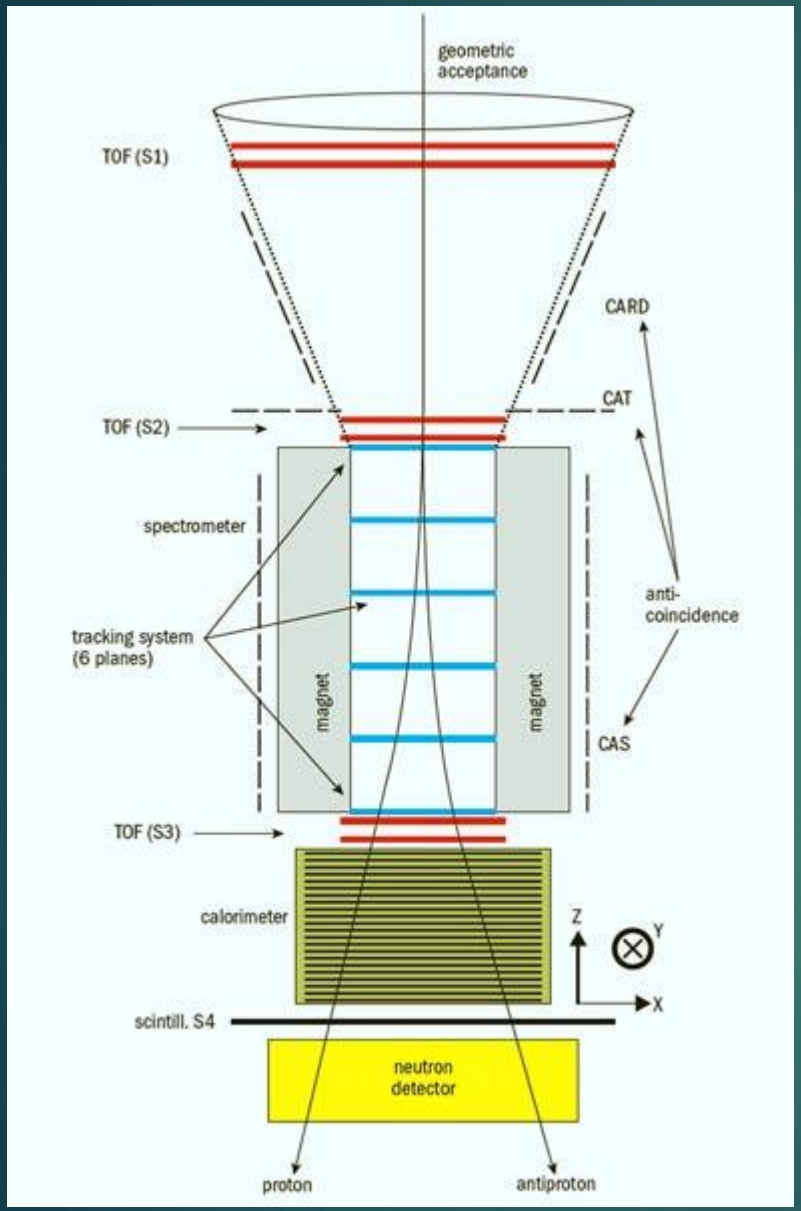
https://inspirehep.net/record/1243804/plots

Back up



arXiv:0905.0025

PAMELA



http://cerncourier.com/cws/article/cern/46875

ATIC