GLAST versus PAMELA

a comparison between gamma and positron detection in supersymmetry

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Outline

I) Neutralino Dark Matter

II) Gamma-rays fluxes

- Detection
- Background

III) Positron fluxes

- Detection
- Background

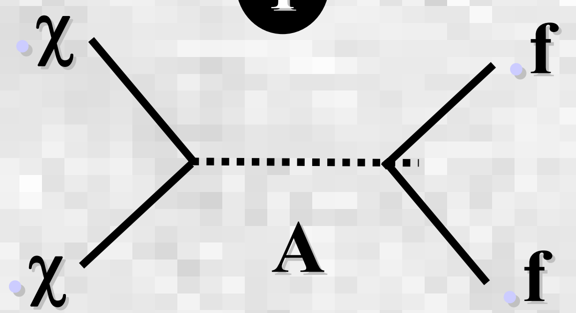
IV) Results

V) Conclusion and Outlooks

Neutralino Dark Matter

$$M = \begin{array}{c} \begin{array}{cccc} \tilde{Z} & \tilde{W} & \tilde{H}1 & \tilde{H}2 \end{array} \\ \begin{pmatrix} M1 & 0 & . & . \\ 0 & M2 & . & . \\ . & . & 0 & -\mu \\ . & . & -\mu & 0 \end{pmatrix} \\ \begin{array}{cc} \tilde{W} & \tilde{H}_{+} \end{array} \end{array}$$

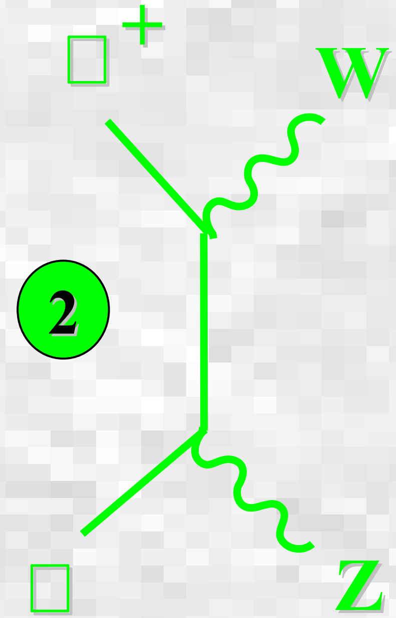
1



$M_A = 2\, m_\chi$

large $\tan\beta$

2



$M_{\chi^+} \sim m_\chi$

1 $\quad M_A^2 \sim M_{H1}^2 - M_{H2}^2$

$M_{H1}^2 = m_0^2\,(1 + \varepsilon_1)\,;\ \ (\varepsilon_1 < 0)$

$M_{H2}^2 = m_0^2\,(1 + \varepsilon_2)\,;\ \ (\varepsilon_2 > 0)$

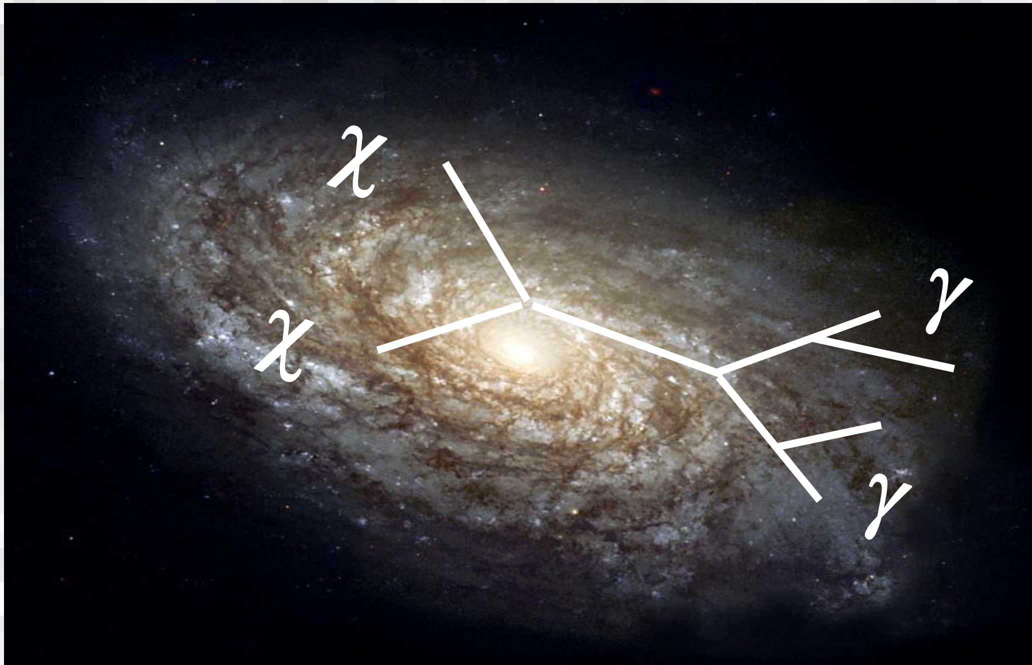
2 $\quad \mu^2 \sim -M_{H2}^2$

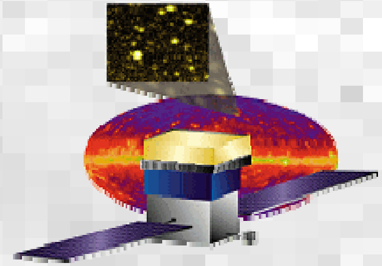
$M_3 = M_{1/2}\,(1 + \varepsilon'_3)\,;\ \ (\varepsilon'_3 < 0)$

[RGE on M_{H2}]

$M_2 = M_{1/2}\,(1 + \varepsilon'_2)\,;\ \ (\varepsilon'_2 < 0)$

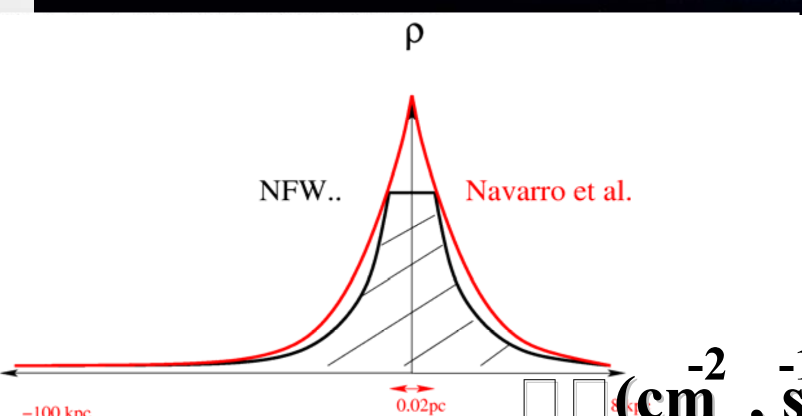
Gamma-rays from Galactic Center





GLAST (2007)

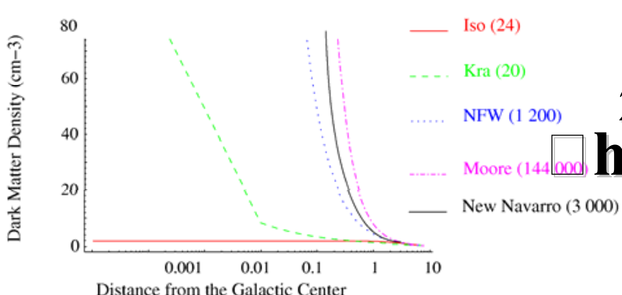
HESS (Namibie, 2004)



$$\frac{d\Phi_\gamma}{d\Omega\, dE} = \frac{1}{2}\frac{dN_\gamma}{dE_\gamma}\frac{\langle\sigma v\rangle}{4\pi M_\chi^2}\int \rho^2\, dl$$

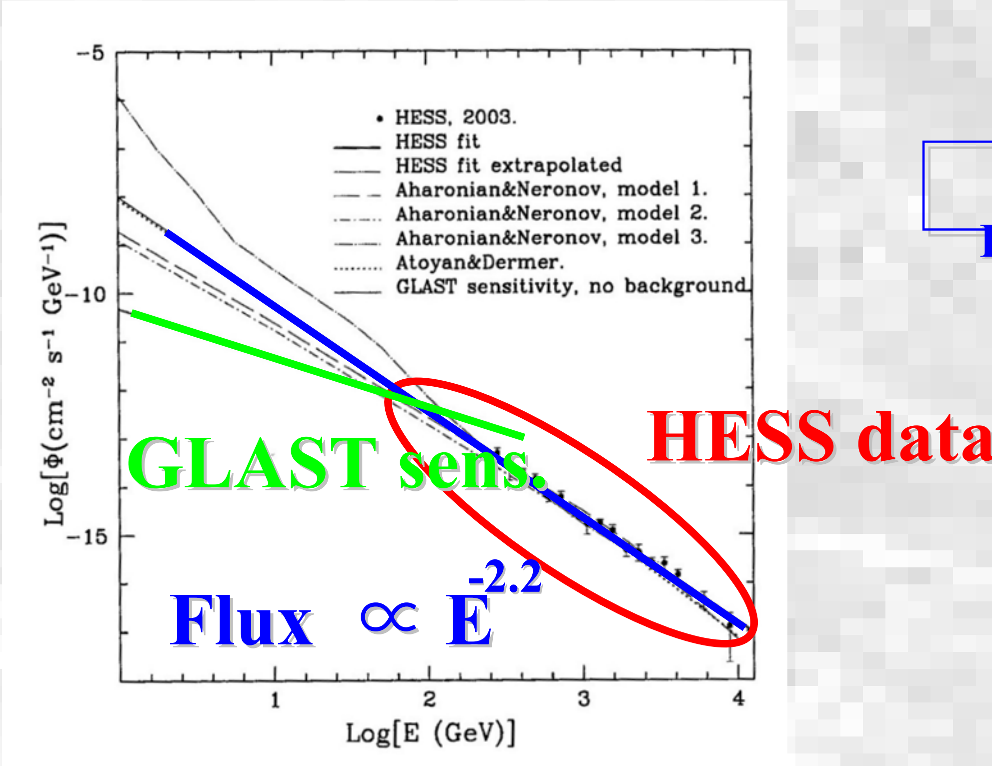
$$\Phi_\gamma(cm^{-2}, s^{-1}) \sim 10^{-13}\ 10\ \frac{\langle\sigma v\rangle}{10^{-29}\ cm^3\ s^{-1}}\ \frac{(100\ GeV)^2}{M_\chi^2}\ J\,\Delta\Omega$$

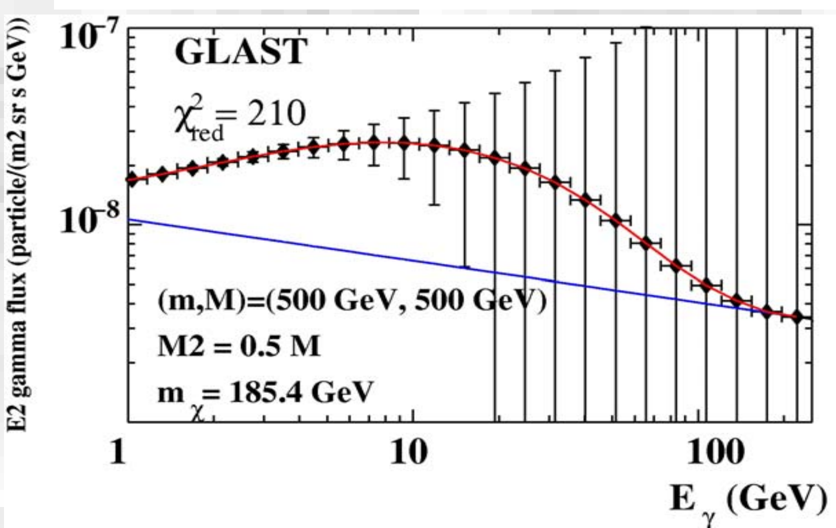
$$\rho(r) = \frac{\rho_0}{(r/R0)^\gamma\,[1+(r/a)^\alpha]^{(\beta-\gamma)/\alpha}}$$



$$\Omega h^2 \sim \frac{3.10^{-27}\ cm^3\ s^{-1}}{\langle\sigma v\rangle} \sim 0.1 \rightarrow \Phi_\gamma \sim 10^{-11}\ J\,\Delta\Omega$$

Gamma background





$$\chi^2_{Red} = \frac{1}{N} \sum \frac{(E^2 \Phi^{Tot} - E^2 \Phi^{Bkg})^2}{(\sigma)^2}$$

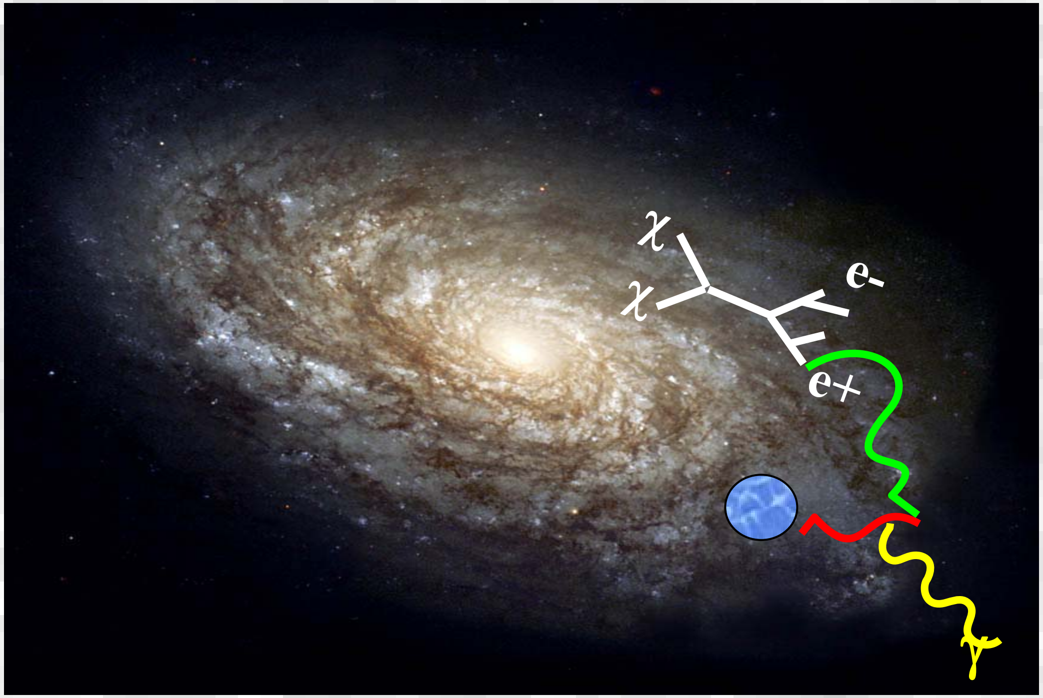
$$= \sum \frac{E^4 \Phi^{Tot}}{A\, T\, \Delta E}$$

$A = 1\ m^2\ sr$

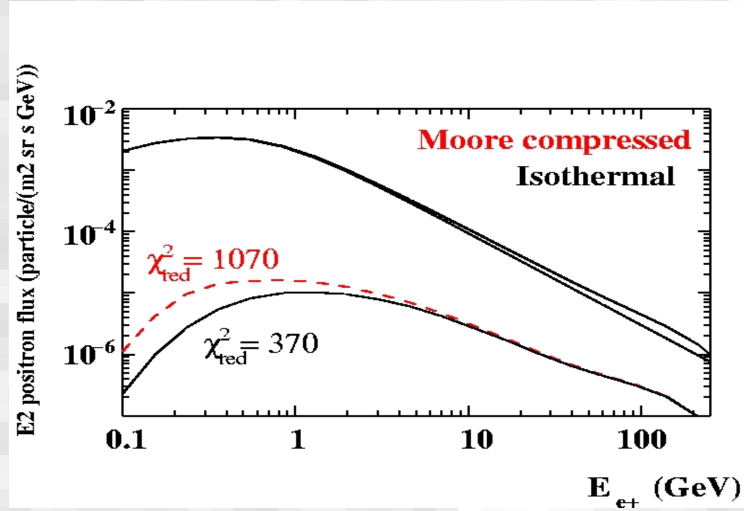
$T = 3$ years

$\chi^2_{Red} > 1$

Positrons flux



$$Q_{source} = \frac{1}{2}\,\frac{dN_{e+}}{dE_{e+}} < \quad v > \left(\frac{\quad}{M}\right)^2$$

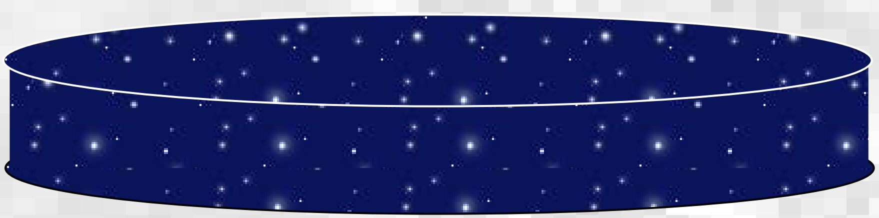


[particle/cm3]

$$\frac{df(E,r)}{dt} = \frac{db(E)}{dE} * f(E,r) + K(E) * \square\, f(E,r) + Q_{source}$$

20 kpc

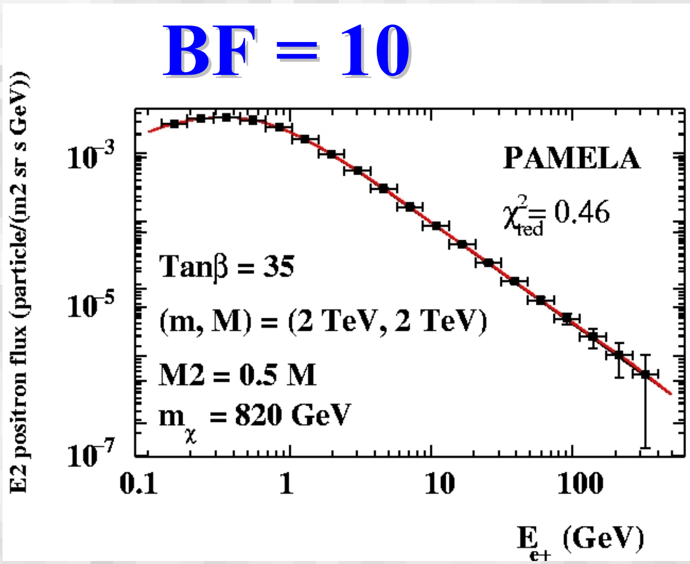
3 kpc

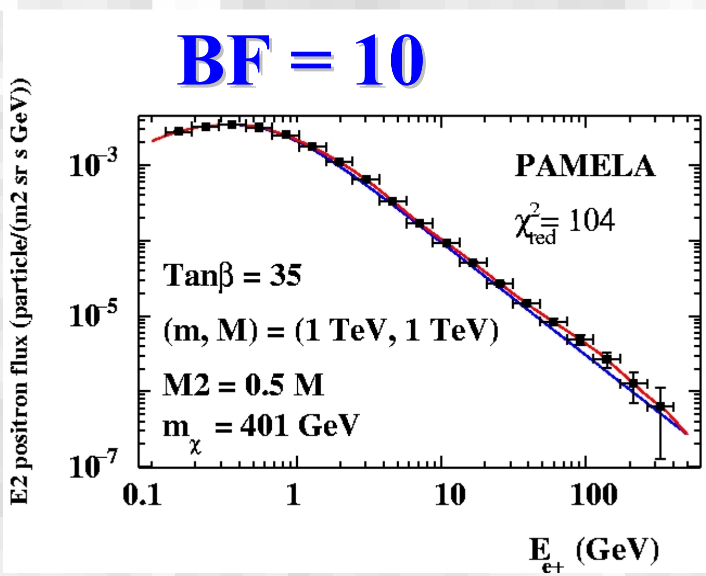


$$D_{source}(E) \sim \frac{E*K(E)}{b(E)}$$

$$\sim 1.8\,(E/1\mathrm{GeV})^{-0.2}$$

Positron signal





$$\Box^2_{Red} = \frac{1}{N} \Box \frac{(E^2 \Box^{Tot} - E^2 \Box^{Bkg})^2}{(\Box)^2}$$

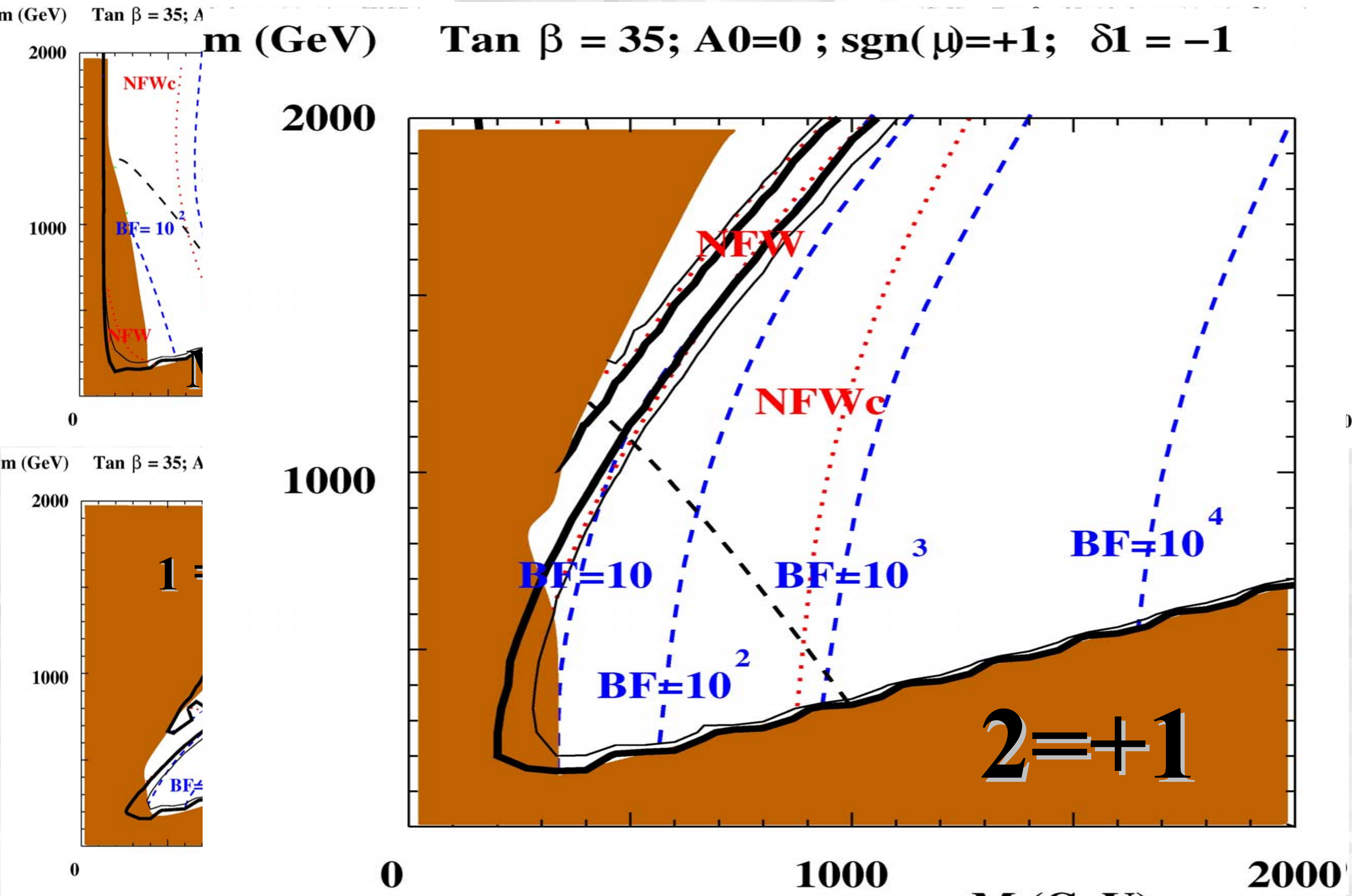
$$= \Box \frac{E^4 \; {}^{Tot}}{A\,T\,\Box\,E}$$

$A = 20\ cm^2\ sr$

$T = 3$ years

$^2_{Red} > 1$

In the (m ; M) plane



GLAST versus PAMELA : to sum up

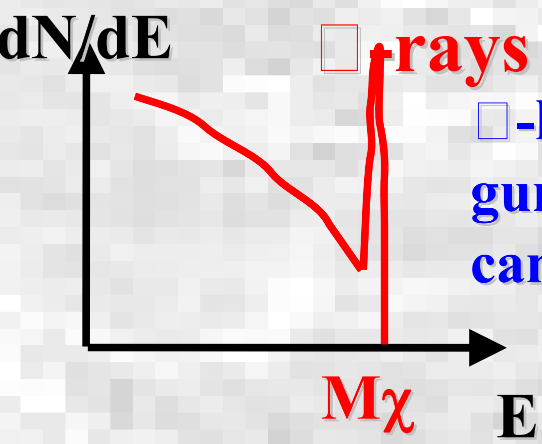
Advantages

Drawbacks

Advantages

Drawbacks

γ-rays



γ-line as a smoking gun signal for any DM candidate

Tight dependance on the profile (more than 3 orders of magnitude)

Independant from the ISM and no influence of the Clumpiness Factor.

HESS background affects propects for GLAST

Positrons

No lines as the positrons lose energy in the propagation process (IC, Brem.)

Positrons are coming from solar neighborhood : no profile dependance

Large uncertainties in the propagation process and tight dependance on the clumpy nature of the halo.

AMS much more sensitive than PAMELA (2 order of magnitude)

Conclusion

Study in general SUGRA framework => application
to string motivated models (D. Cerdeno)

GLAST sensitivity considerably reduced by HESS background

Need at least a NFW profile for GLAST
or a BF=7~10 for PAMELA

Conclusion mainly independent of the non-universal case

Complementarity between PAMELA and GLAST