

U-boson at linear collider after Pamela/Atic/DAMA

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This talk is based on

- Pamela data and leptonically decaying dark matter, P.F.Yin et.al., PRD(2009), arXiv:0811.0176.
- Prospects on neutrino signals..., J. Liu et.al., PRD(2009)
- Discriminate different DM scenarios..., J. Zhang et.al., arXiv: 0812.0522
- U-boson at BESIII detector, S.H. Zhu, PRD2007, hep-ph/0701001
- Detecting $H \rightarrow hh$ in mirror model at LHC, W.S.Li et.al., PRD(2007)

Content

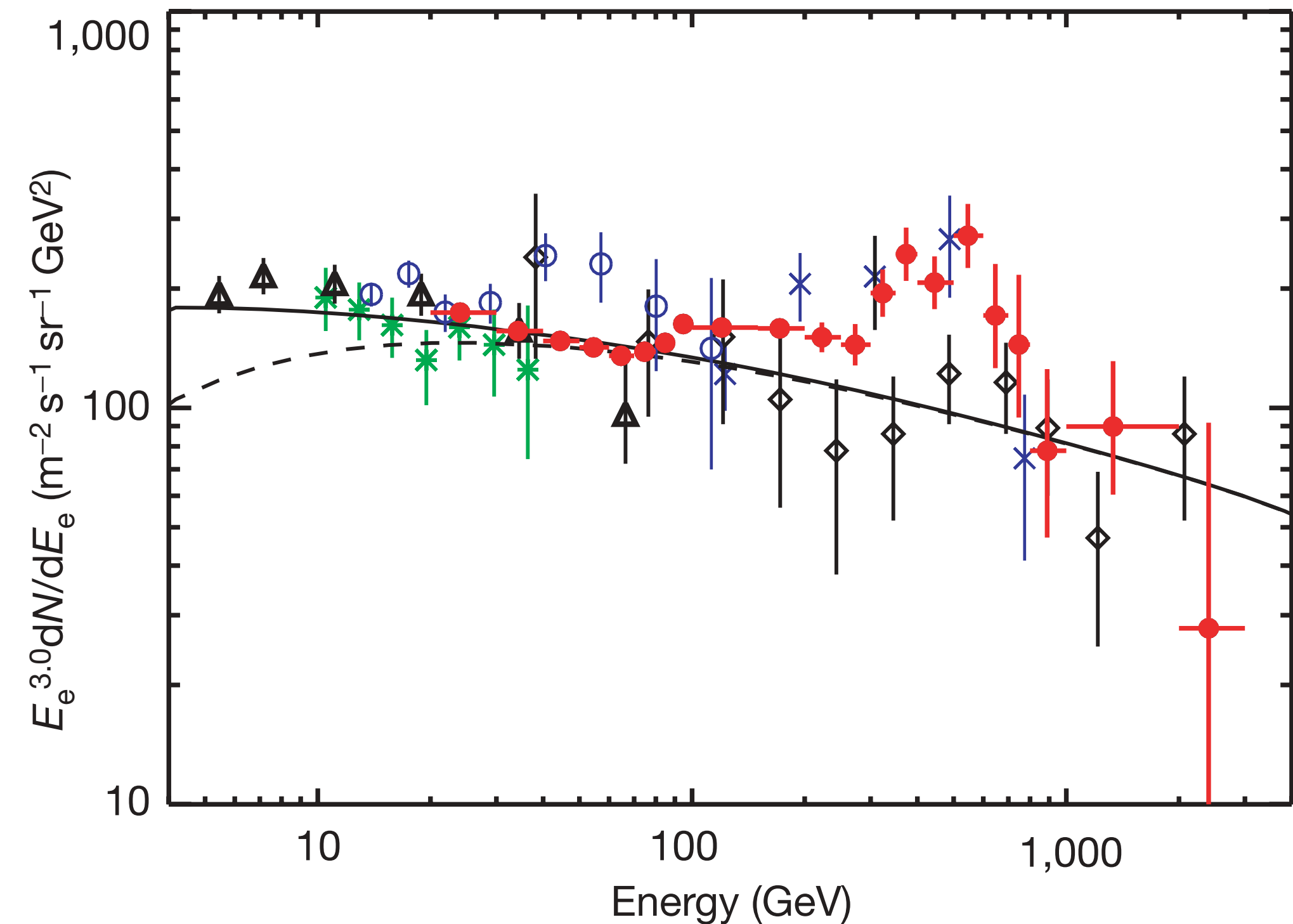
- The physical picture after Pamela/Atic/DAMA
- U boson at colliders
- Discussions

Possible unified picture after Pamela/Atic/DAMA

- If **all these observations are due to dark matter...**
- Dark matter mass is around 600-800 GeV (Atic)
- Need **light particle (like U-boson)** to induce observed flux of electron/positron due to dark matter annihilation, i.e. Sommerfeld enhancement (Atic and Pamela)
- Dark matter annihilates into electron/positron other than quark (Pamela)
- **Light boson (like U-boson)** needed to get large cross section of dark matter and electron scattering (DAMA)

Atic

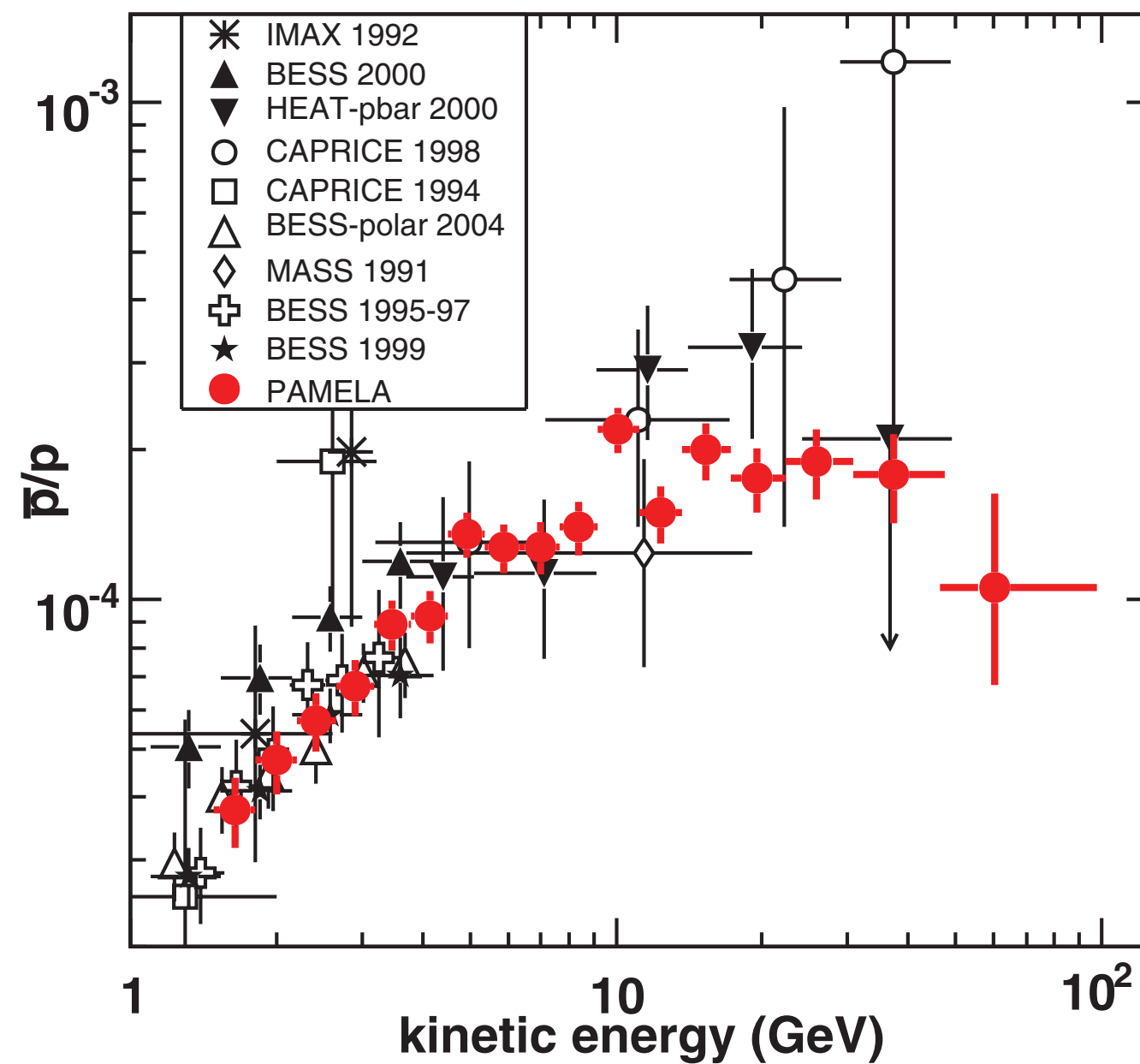
- Electron/positron comes from DM annihilation
- Dark matter scale 600-800 GeV
- If KK state (B1) annihilates into electron/positron, an **unknown boost factor (BF) ~200** is needed.
- BF arising from DM sub-halo is not sufficient!



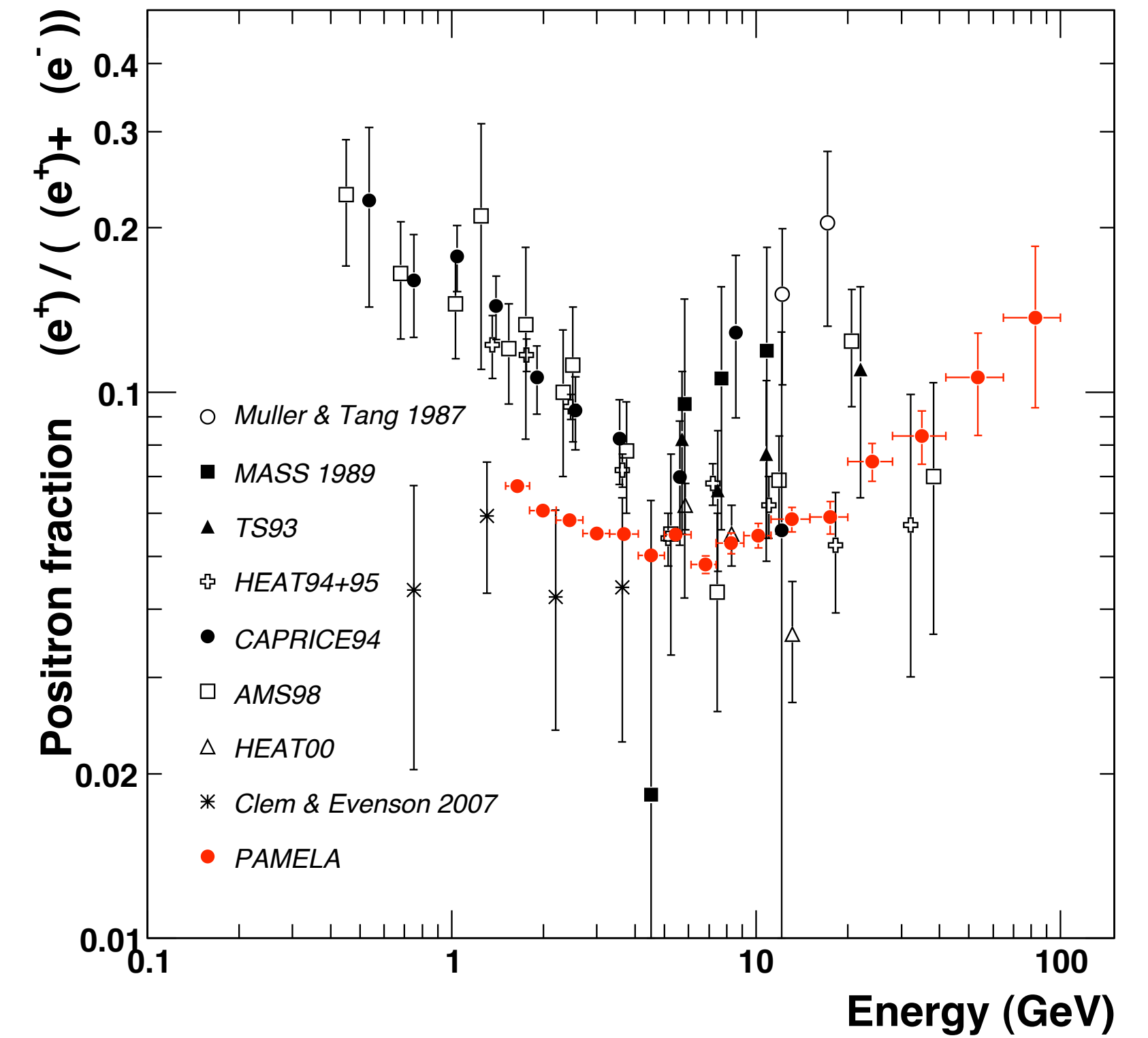
J. Chang et.al., Nature 456,362 (2008)

Pamela

- Electron/positron comes from DM
- DM is greater than 100 GeV
- Consistent with Atic, HEAT and AMS01
- DM not annihilate into quark
- BF is needed also!



Pamela, 0810.4995



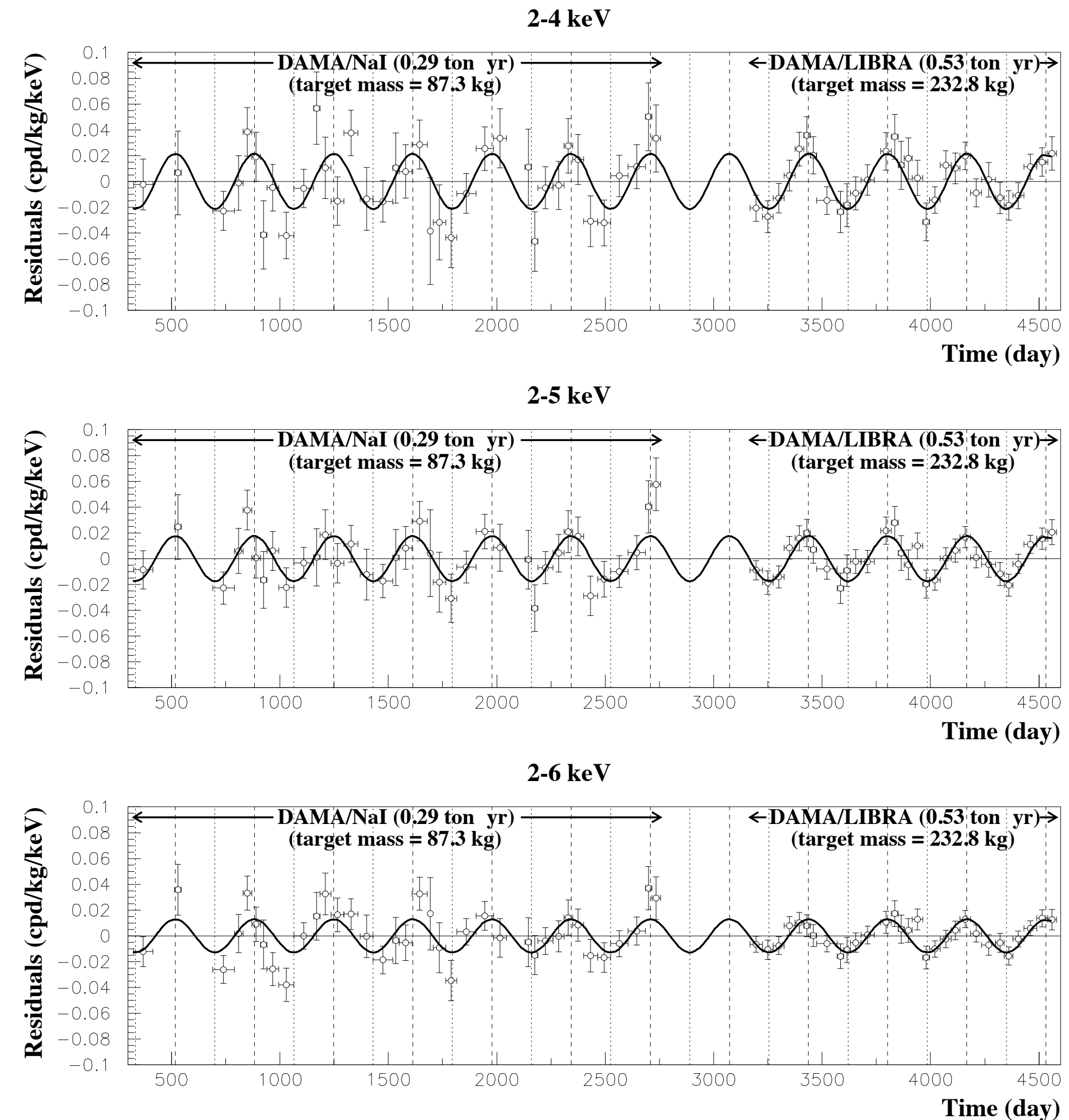
Pamela, PRL(2009)

Boost factor(BF) in indirect DM search

- WIMP DM was in chemical equilibrium with usual matter at relatively higher temperature; however DM is annihilating now at lower temperature to produce flux of observed SM particles.
- If interpreting Pamela/Atic, a mysterious mismatch exists, namely BF is introduced!
- Sommerfeld enhancement, **light particle is needed**
- Alternative approach: Breit-wigner enhancement, new particle twice dark matter mass!

DAMA annual modulation

- CDMS, Xenon etc. constrain dark **matter-nucleus** scattering
- DAMA annual modulation can be accounted by \sim pb DM and electron scattering. **Light particle (\sim GeV) is needed!**

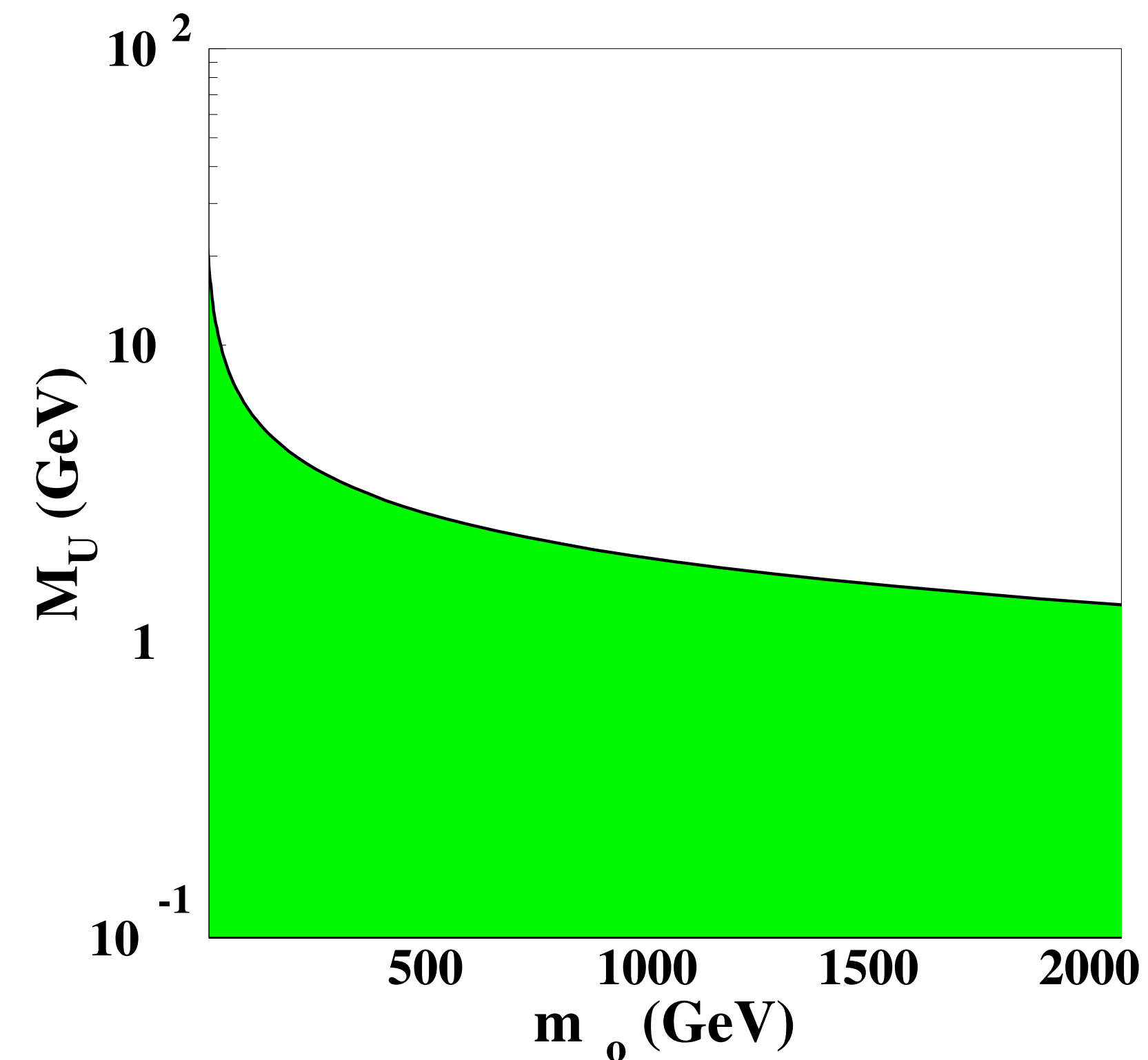


DAMA (2008)

An possible explanation

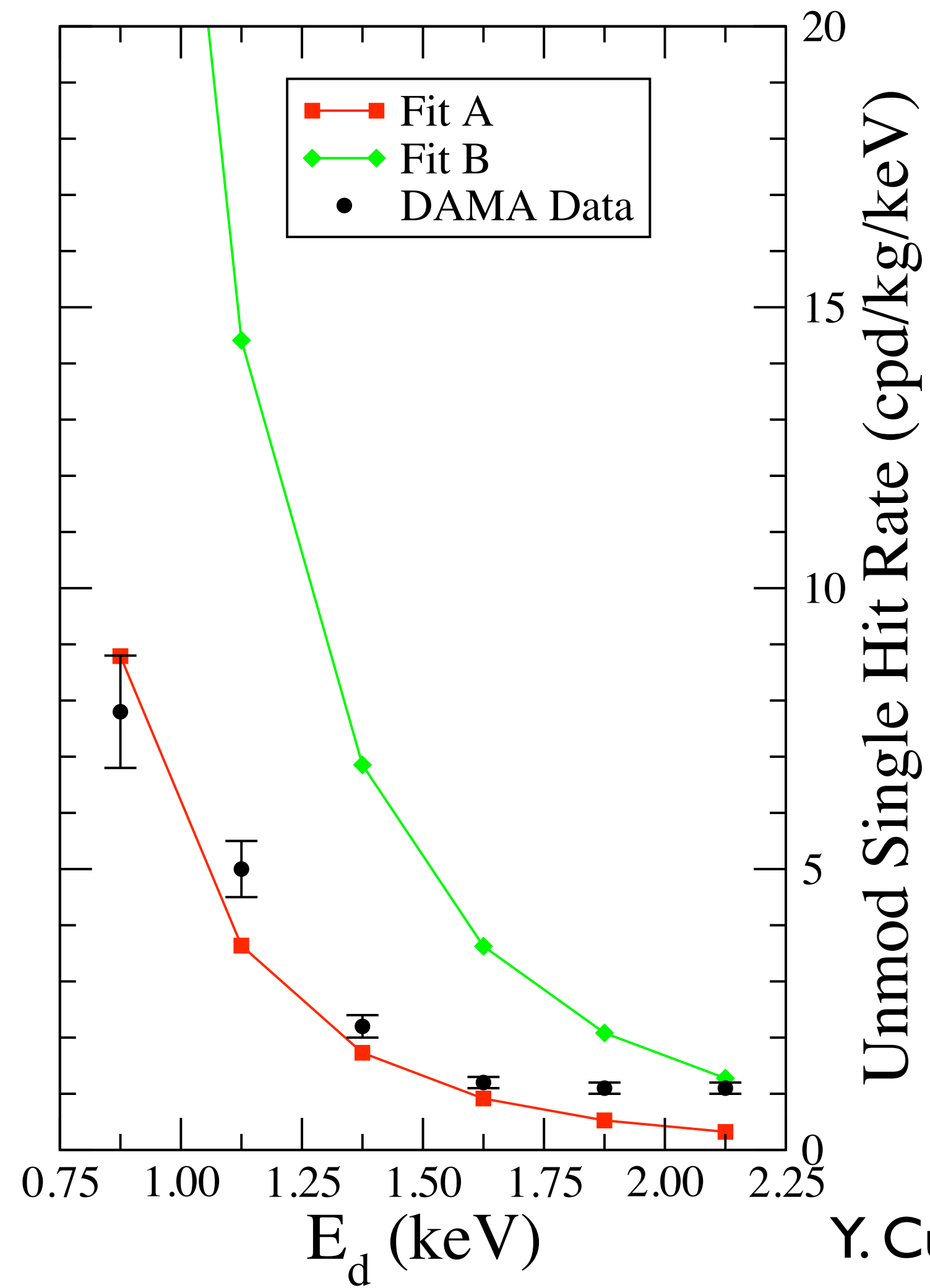
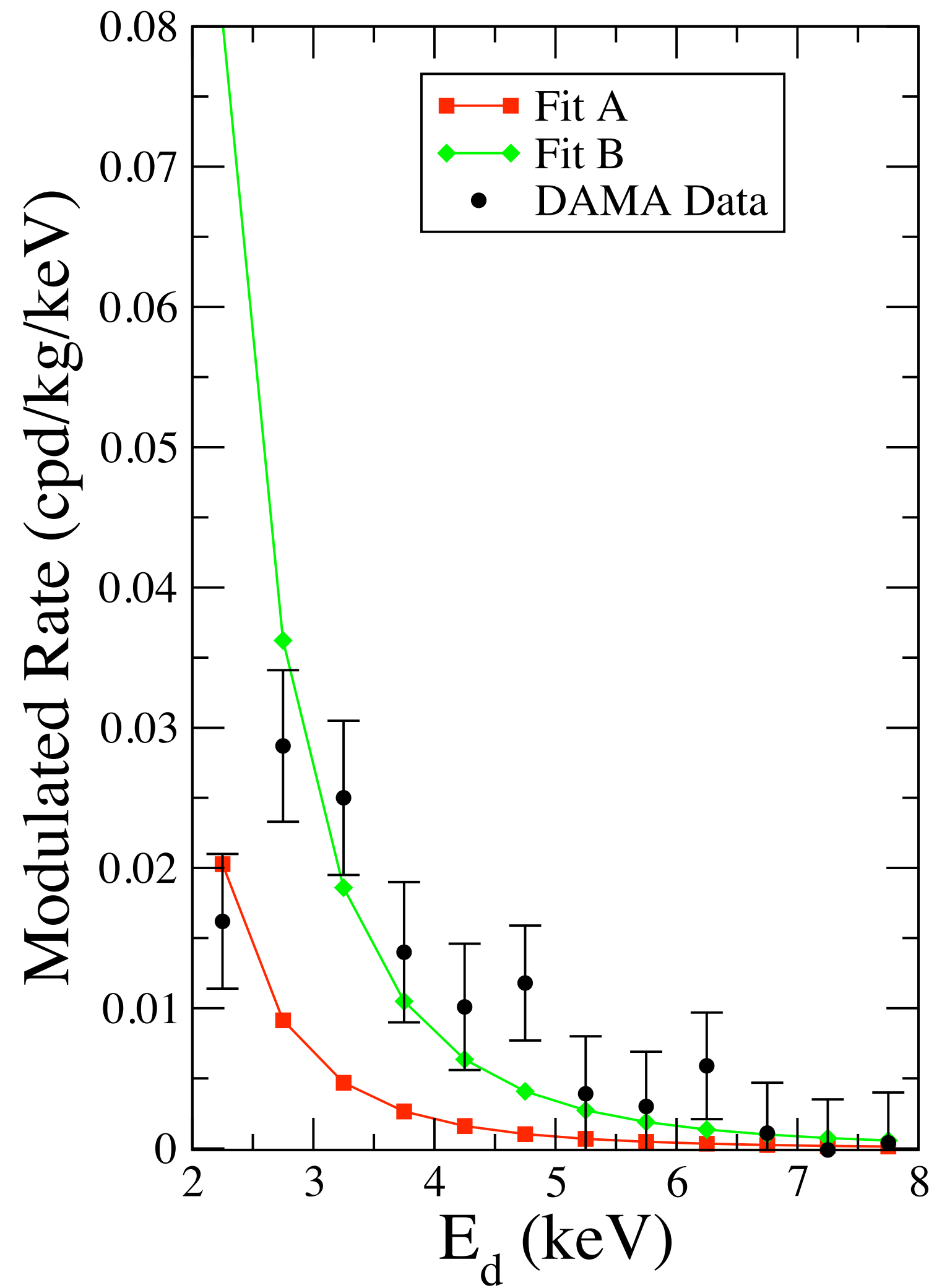
DM scattering off electrons

- Not well studied scenario compared with DM scattering off nucleus
- Heavy polluted by cosmic and natural radiation



R. Bernabei et.al., PRD(2008)

Ruled out?



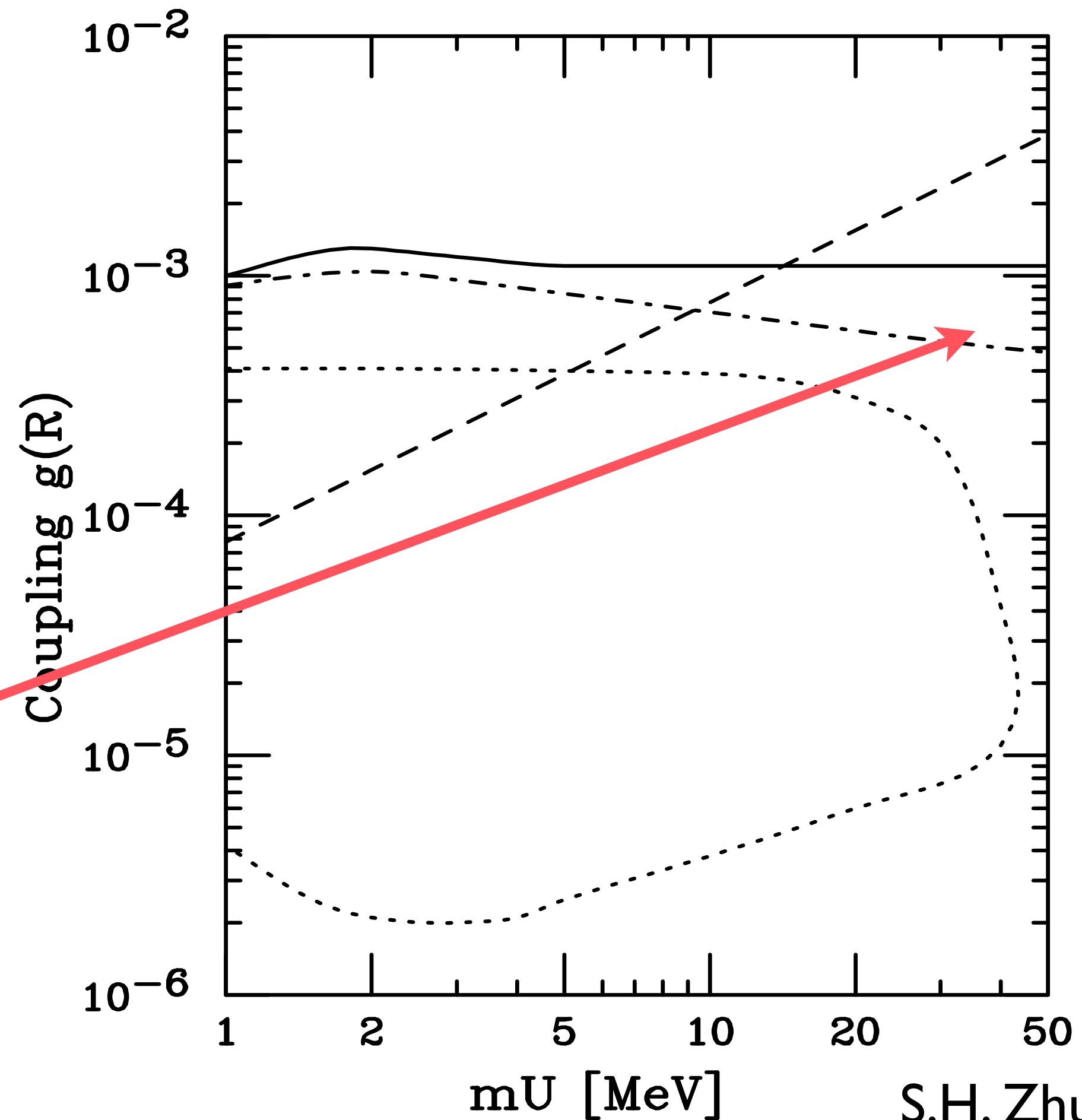
Y. Cui et.al., arXiv:0901.0557

U boson at low energy linear collider

$$e^+e^- \rightarrow U\gamma \rightarrow e^+e^-\gamma$$

- Promising at BESIII and Barbar!

$$\begin{aligned} \sigma_{DM-e}^0 &\equiv \frac{|\overline{\mathcal{M}}|^2}{16\pi M_\chi^2} = \frac{g_\chi^2 g_e^2 m_e^2}{\pi M_U^4} \\ &= 0.4 \text{ pb } g_\chi^2 \left(\frac{g_e}{10^{-4}}\right)^2 \left(\frac{30 \text{ MeV}}{M_U}\right)^4 \end{aligned}$$



S.H. Zhu, PRD (2007)

U boson at LHC

- DM prefers to couple with leptons. LHC is NOT the best machine to investigate DM.
- However possible other new particles associated with DM can be discovered at LHC!
- Work in progress!

U Boson at Multi-TeV ILC

- Exploring DM scale

$$e^+e^- \rightarrow U\gamma \rightarrow \chi\bar{\chi}\gamma$$

- New motivation to construct ILC, other than exploring mechanism of electroweak symmetry breaking.

$$e^+e^- \rightarrow e^+e^-UU \rightarrow e^+e^-\chi\bar{\chi}$$

Discussions

- Pamela/Atic/DAMA have provided new insights on particle physics
- Colliders (BES/Babar/LEP/Tevatron/LHC/ILC) are necessary machines to pin down the picture.

Thanks for your attention!