

An anomalous positron abundance in cosmic rays with energies 1.5–100 GeV

O. Adriani et al.

Nature 458, 607-609 (2 April 2009)

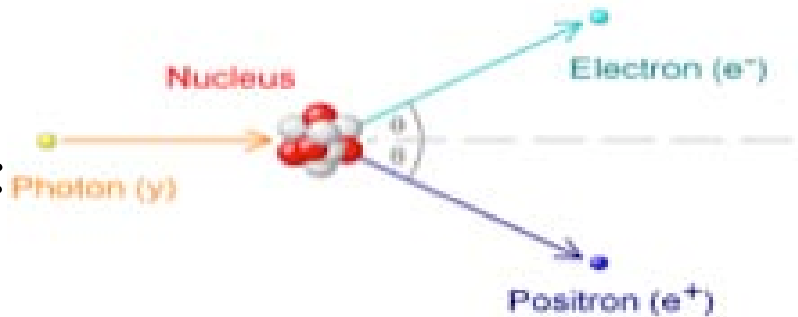
AstroNews
Phyllis Yen
2009/06/25
HEAG@NTHU



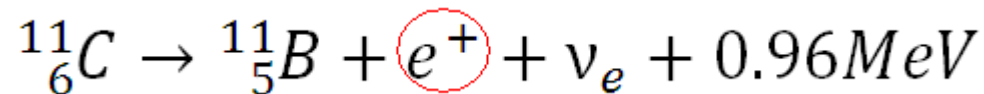
Positrons: How are they produced?

- Antiparticle of electron, charge: +1, spin: 1/2
- A positron is created

(a) in a pair production event :



(b) in beta⁺ nuclear decay (called positron emission) :



(c) **Dark matter annihilation** :

Dark matter particles (WIMPs)

+

Anti-matter



(annihilation)

A variety of subatomic particles (electrons, positrons...etc)

Positron: Where do they come from?

- Primary source: possible sources include
 - (a) Pulsar-magnetosphere is a cosmic particle accelerator
 - (b) Microquasars-relativistic jet emitting VHE gamma rays
 - (c) dark matter annihilation-mechanism unclear
- Secondary source
 - (a) Cosmic-ray nuclei (hydrogen protons or helium alpha particle)
INTERACT WITH
 - (a) Diffuse interstellar medium

Their spectral profile are different!!!

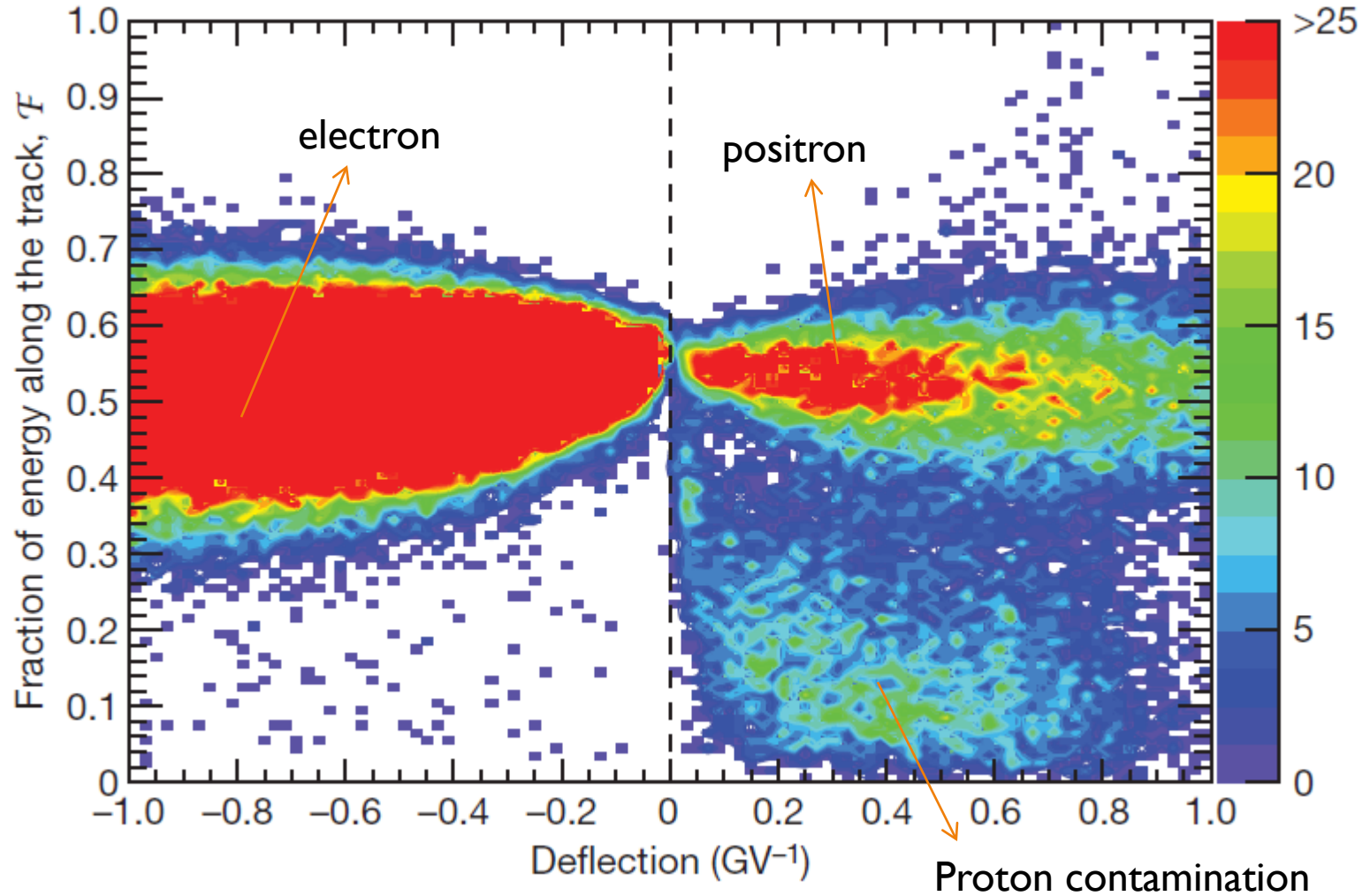
PAMELA

- Payload for **A**ntimatter **M**atter **E**xploration and **L**ight-nuclei **A**strophysics
- 10^9 triggers, ~ 500 days observation: 151672 e^- and 9430 e^+ within 1.5 – 100 GeV
- PAMELA measures the positron fraction:

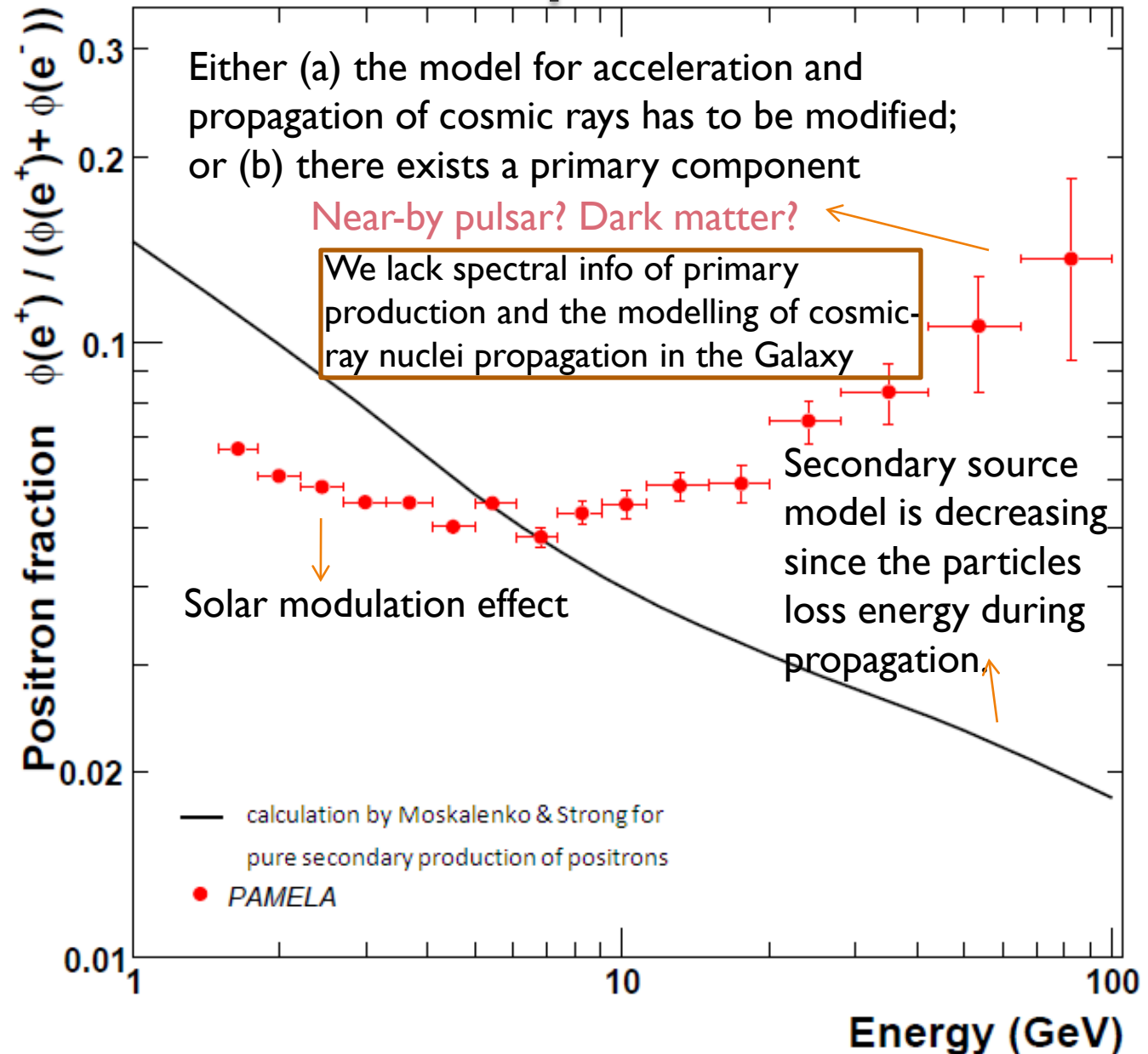
$$\frac{\phi(e^+)}{(\phi(e^+) + \phi(e^-))}$$

- A magnet spectrometer determines the rigidity and sign-of-charge of incident particles.

- The fraction of calorimeter energy as a function of deflection.



Observation of positron fraction



Solar Modulation Effect

- Solar wind modifies the energy spectra of cosmic rays in Solar System, especially on energies less than 10GeV.
- Depends on solar activity: sinusoidal time dependence with a period of 11 years.
- Complete solar cycle: 22 years, since the polarity changes every 11 years.
- Can explain the discrepancies in the lower energy branch ($<10\text{GeV}$)

Conclusions

- The observed spectral profile of positron does not match that from a secondary production model.
- Consequently, the positron abundance may be due to

Not yet able to distinguish between (a) and (b)

- (a) The magnetospheres of near-by pulsar:
the first observation of positron production from near-by pulsars
- (b) Dark matter annihilations in the galactic halo:
the first indirect evidence of dark matter particle annihilations



~thank you for your attention~