# Recent Suzaku results on Galactic diffuse sources


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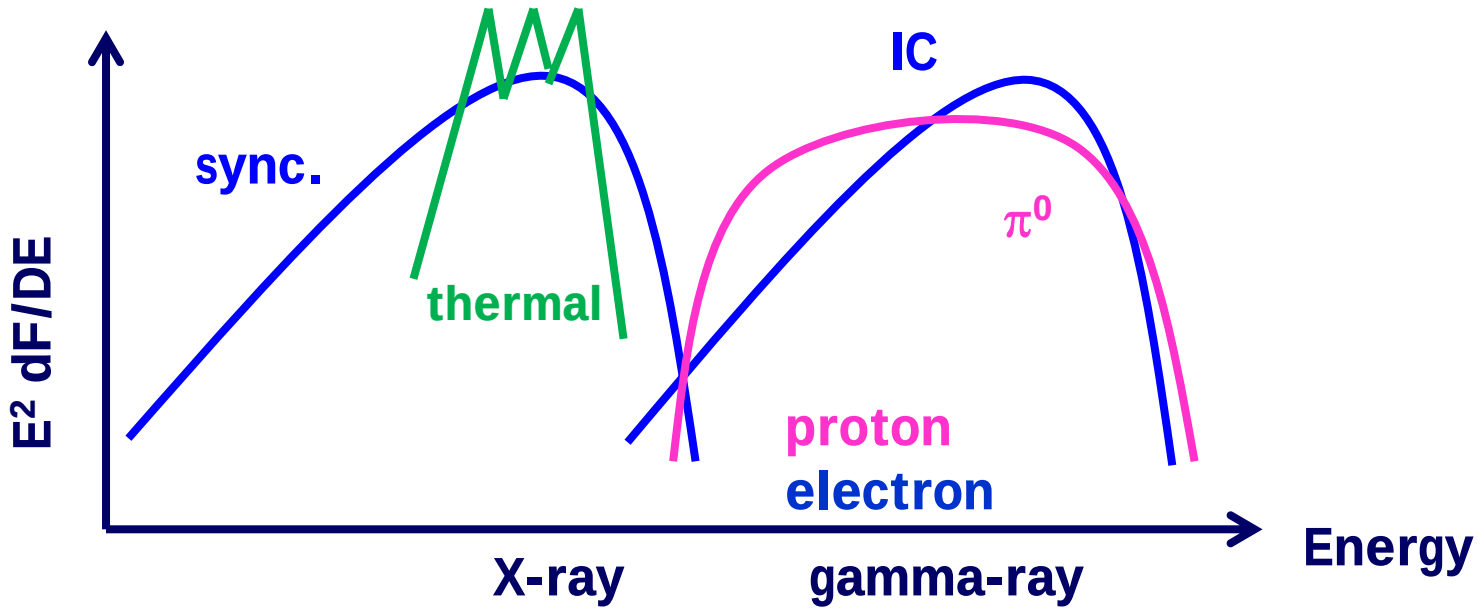
# 1.1. X-ray and Gamma-ray astrophysics

## high energy particles emits X-ray – gamma-rays



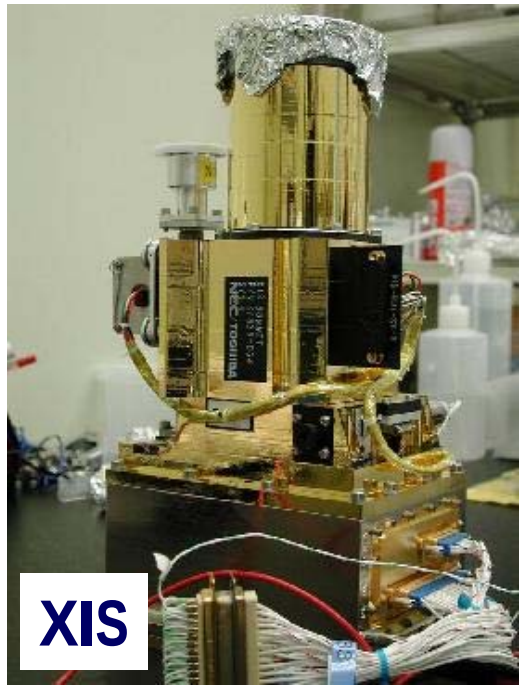

**gamma-ray:** IC emission from e — info. on accelerated e/p
emission from p

**X-ray:** synchrotron from e — info. on T and NT e
thermal emission — info. on environment of acc.

**Combination of X and gamma-ray is important**

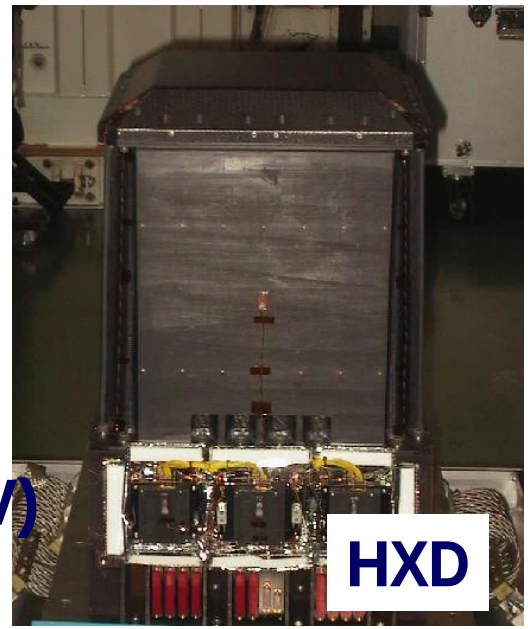
# 1.2. Suzaku: Jp-US X-ray satellite

**Successfully launched on 2005 July 10th.**




**XIS (X-ray Imaging Spectrometer)**
**Improved X-ray CCD with high efficiency and good energy response**
**Low and stable background**
**Energy band : 0.2-12keV**


**XRT (X-Ray Telescope)**
**Large effective area**
**410cm$^2$ @1.5keV**




**HXD (Hard X-ray Detector)**
**Wide energy band**
**Si-PIN (10-70keV) & GSO Scinti. (40-600keV)**
**Non-imaging detector, but low background**

# 1.3. Suzaku strong points and topics

## Suzaku strong points:

low and stable background
wide band coverage (0.2-600 keV)

→ Good for diffuse and faint sources
SNRs, GC diffuse emission,
clusters of galaxies,
unID sources, ...

## Topics for high energy galactic diffuse sources:

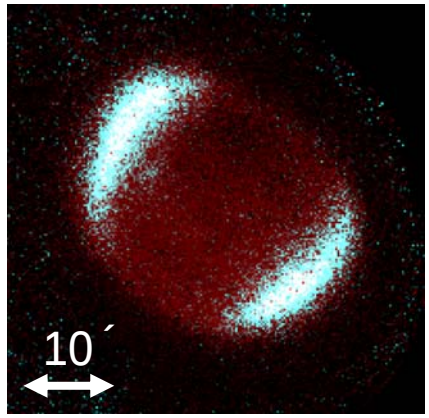
- Study of synchrotron X-rays from young SNRs
- Counterpart search of HESS unID sources
-(Study of environment of young SNRs)

# Topic 1:
# Study of synchrotron X-rays from young SNRs

# 2.1. CR acceleration on shocks of SNRs

**Shocks of SNRs are CR accelerators !**

**discovery of sync. X-rays from shells of SN1006 (Koyama et al. 1995)**




**Detected sync. X-rays were just power-law like. It should have cut-off.**

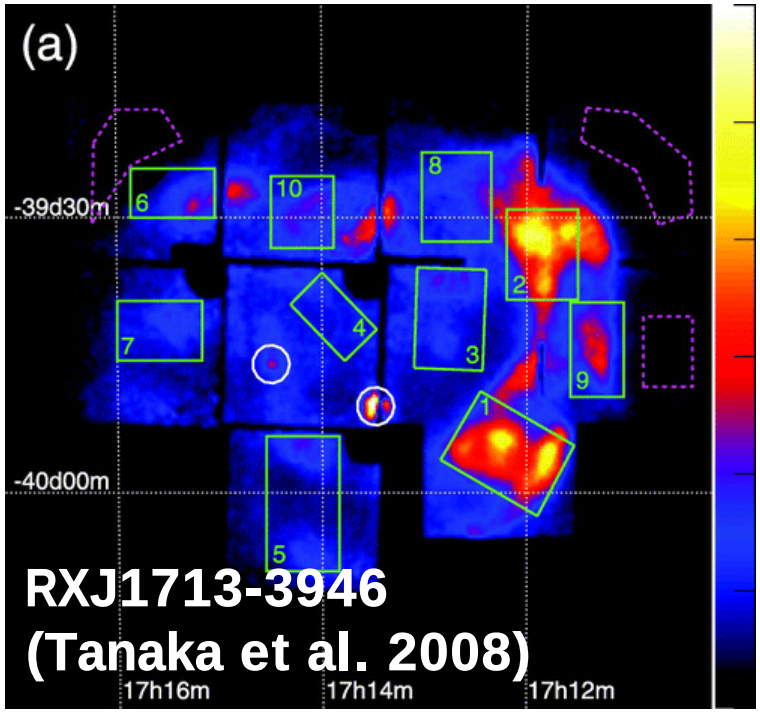
$$\text{cut-off } E = 0.06 \left( \frac{B}{10\ \mu G} \right) \left( \frac{E_{max}}{10 TeV} \right)^2 \quad [keV]$$

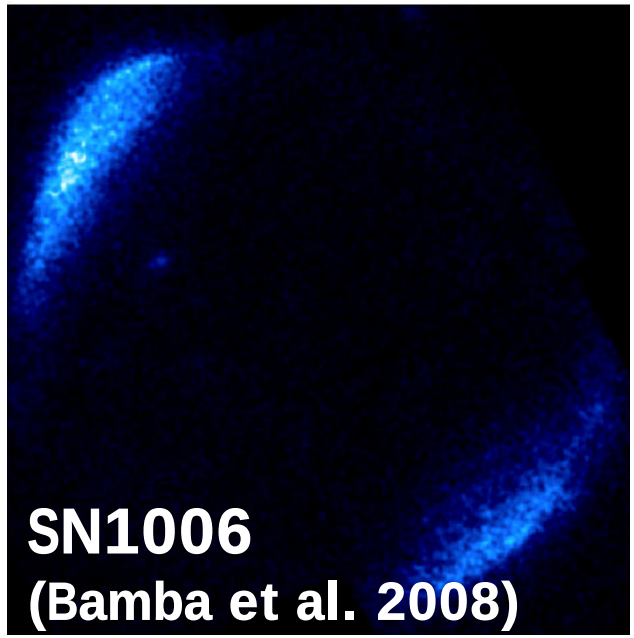
**(Reynolds 1998)**

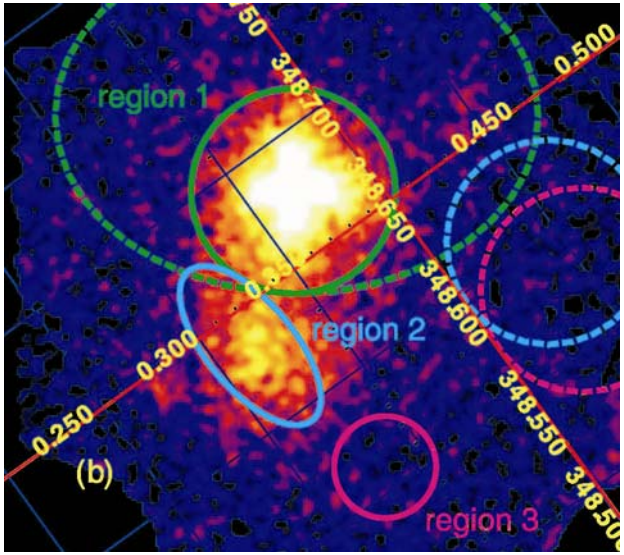
**B: magnetic field $E_{max}$: the maxmimum E of e**

**We need more statistics and wide-band observations ...**

# 2.2. Suzaku observations of SNRs



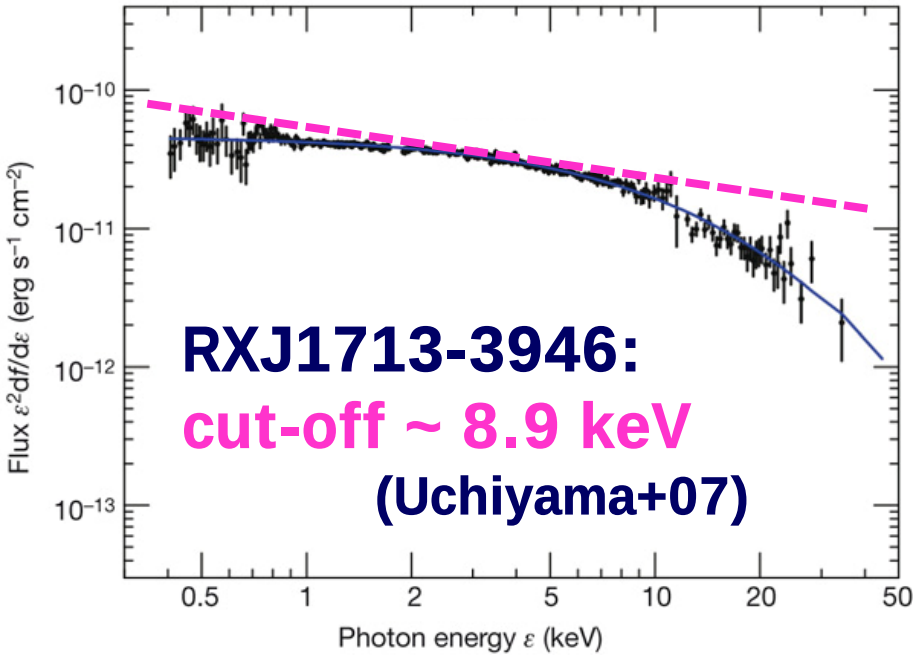



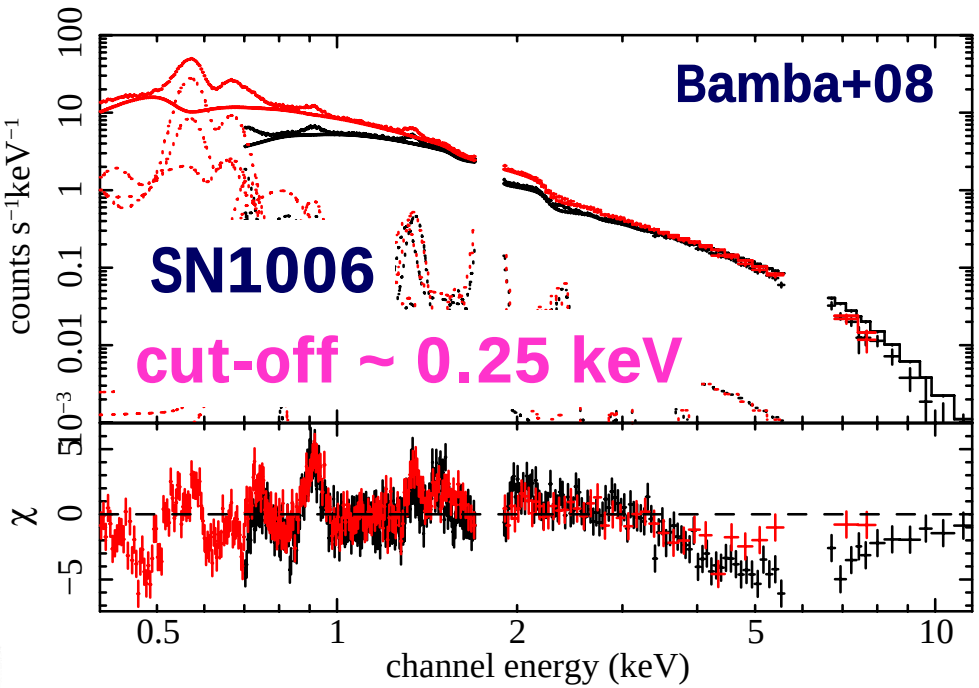



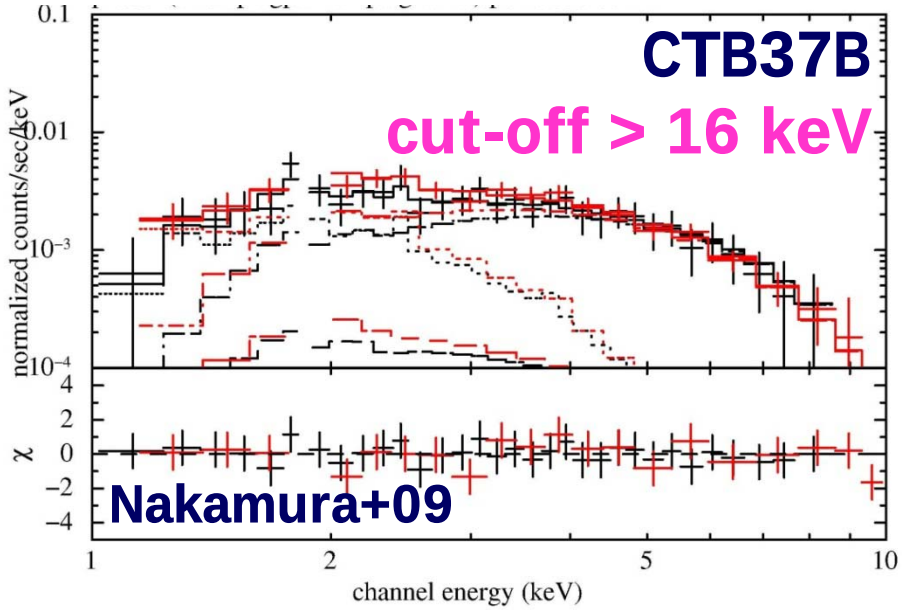

**CTB37B**
**(Nakamura et al. 2009)**

**Suzaku detected synchrotron X-rays from several SNRs**

# 2.3. cut-off energy determined by Suzaku




**Suzaku detected cut-off of sync. X-rays**

**cut-off ~ 0.2 – 10 keV**

**$E_{max}$ ~ 10-80TeV ?**

**density is low !**

**..not so bright in Fermi band..**

# Topic2:
# Counterpart search of TeV unID sources

# 3.1. TeV unID sources

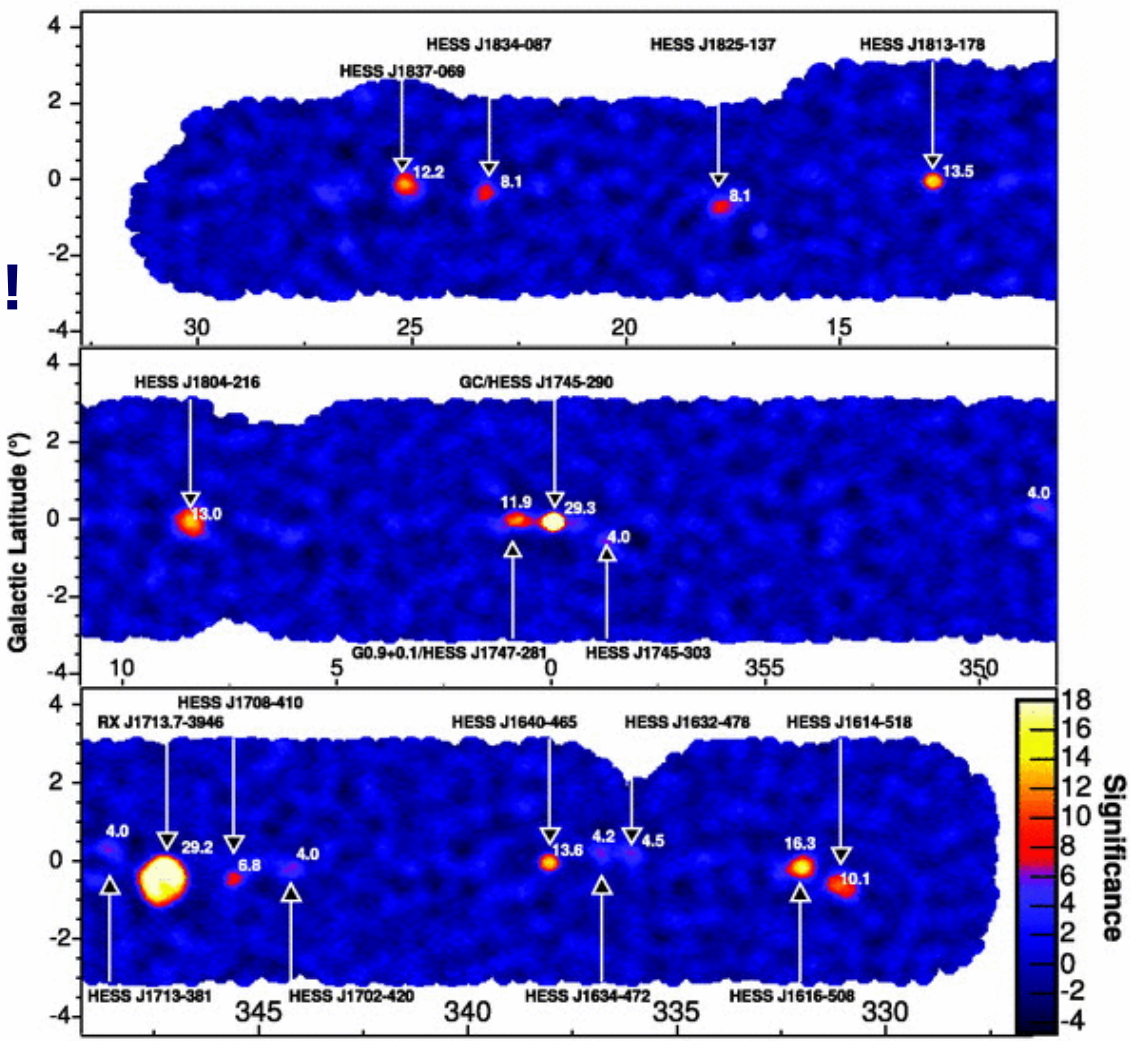
**HESS discovered 10s of new unidentified sources on the Galactic plane**

**On the GP**
**Some are diffuse**
**TeV emission**

**→Galactic accelerators !**

**PWNe?**
**SNRs?**
**star forming regions ?**
**more exotic sources ?**

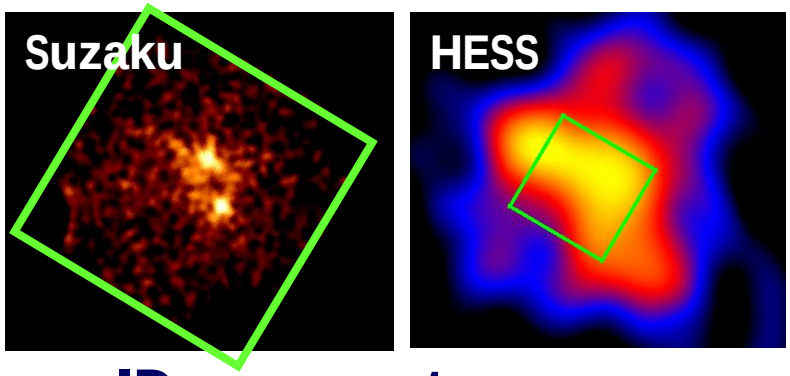
**Follow-ups are needed!**
**Suzaku is the best for such faint sources**




Aharonian et al. 2005

# 3.2. Suzaku follow-ups of TeV unID sources

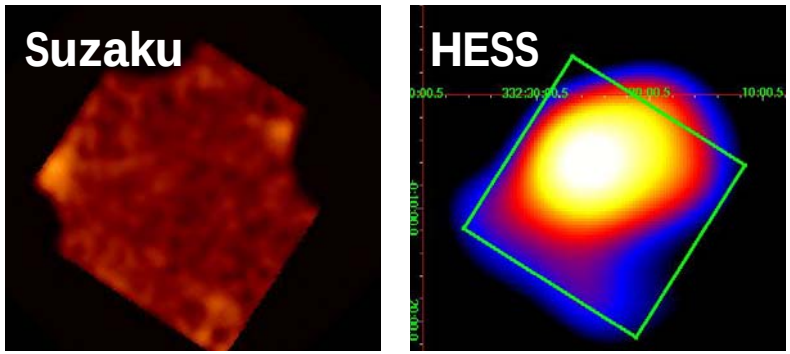
## HESSJ1804-216




unID compact sources

(Bamba+07)

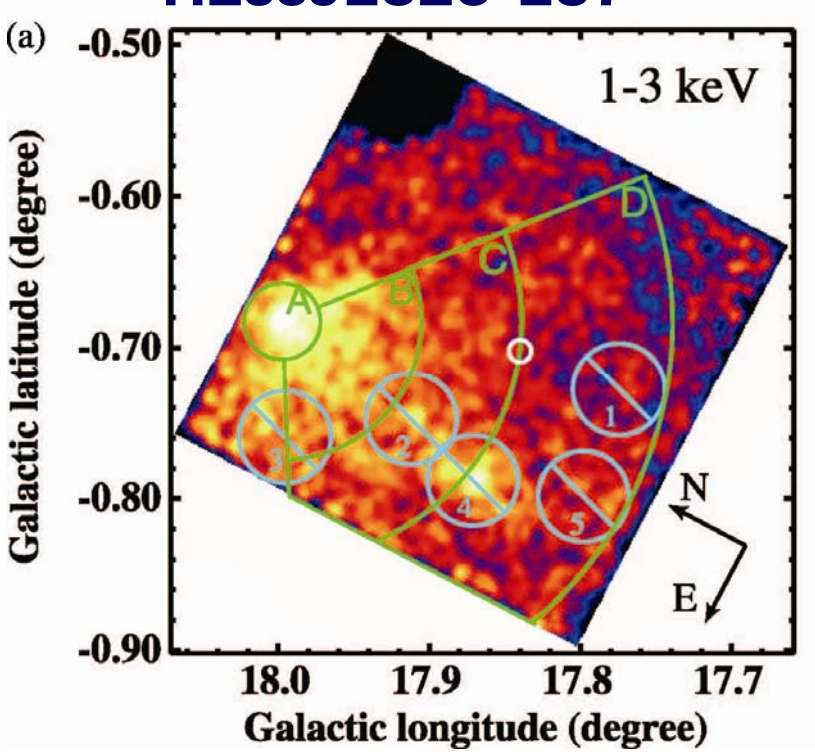
## HESSJ1616-508




upper-limit ! (Matsumoto+07)

Fermi detected the two !

## HESSJ1825-137




PWN ! (Uchiyama+09)

Suzaku found counterparts or made tight upper-limit !

# 3.3. X-ray vs. TeV gamma-ray

| Targets | $F_{(1\text{-}10TeV)}/F_{(2\text{-}10keV)}$ |
|---|---|
| HESSJ1804-216 | 23 |
| HESSJ1616-508 | >55 |
| Crab | 0.003 |
| RXJ1713-3946 | 0.06 |

TeV unID sources have very large flux ratio.

Assumption: TeV emission is from electrons (IC)

$F_{(1\text{-}10TeV)}/F_{(2\text{-}10keV)}$ = IC/sync. ~ $U_B^{-1}$ ~ $1/B^2$ (seed ph.: CMB )

-> Large ratio means small magnetic field.

-> $F_{(1\text{-}10TeV)}/F_{(2\text{-}10keV)}$ > 100 means B<1microG

-> too small for Galactic sources !

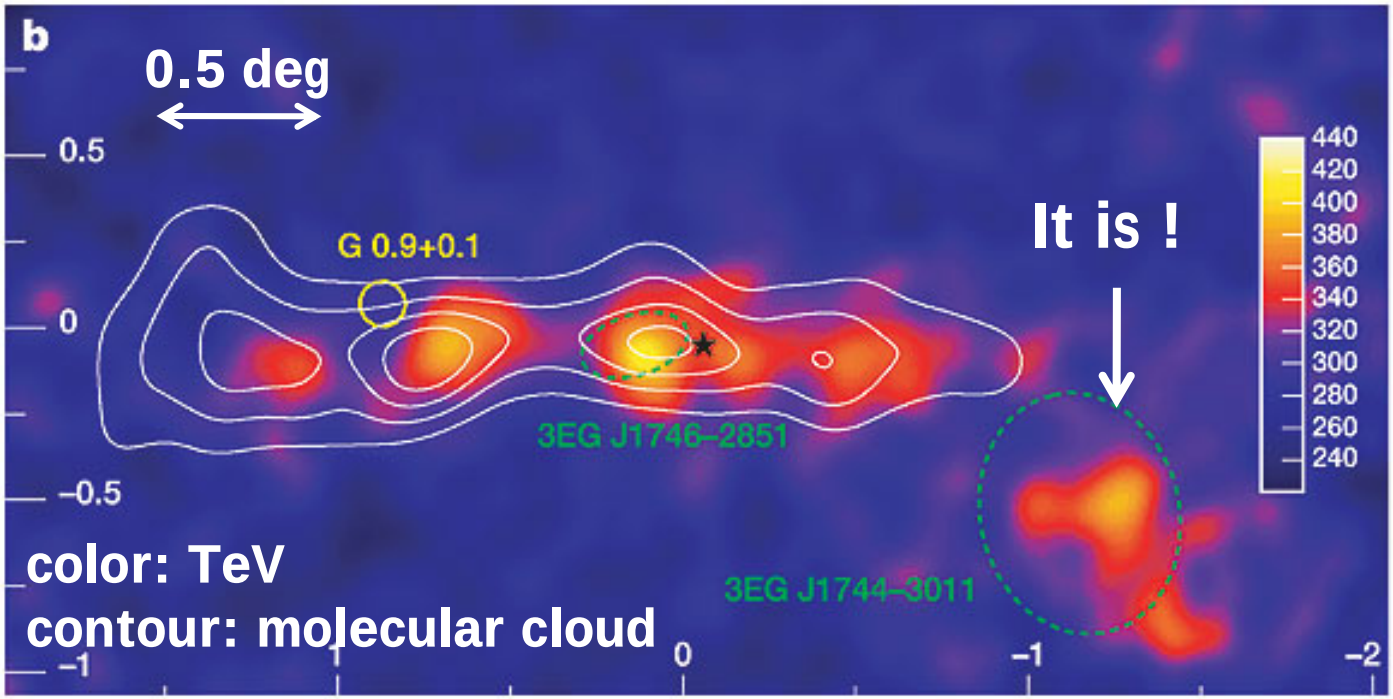
1 zone electron model
cannot reproduce large $F_{(1\text{-}10TeV)}/F_{(2\text{-}10keV)}$

~20 TeV unIDs observed, ~10 more approved.

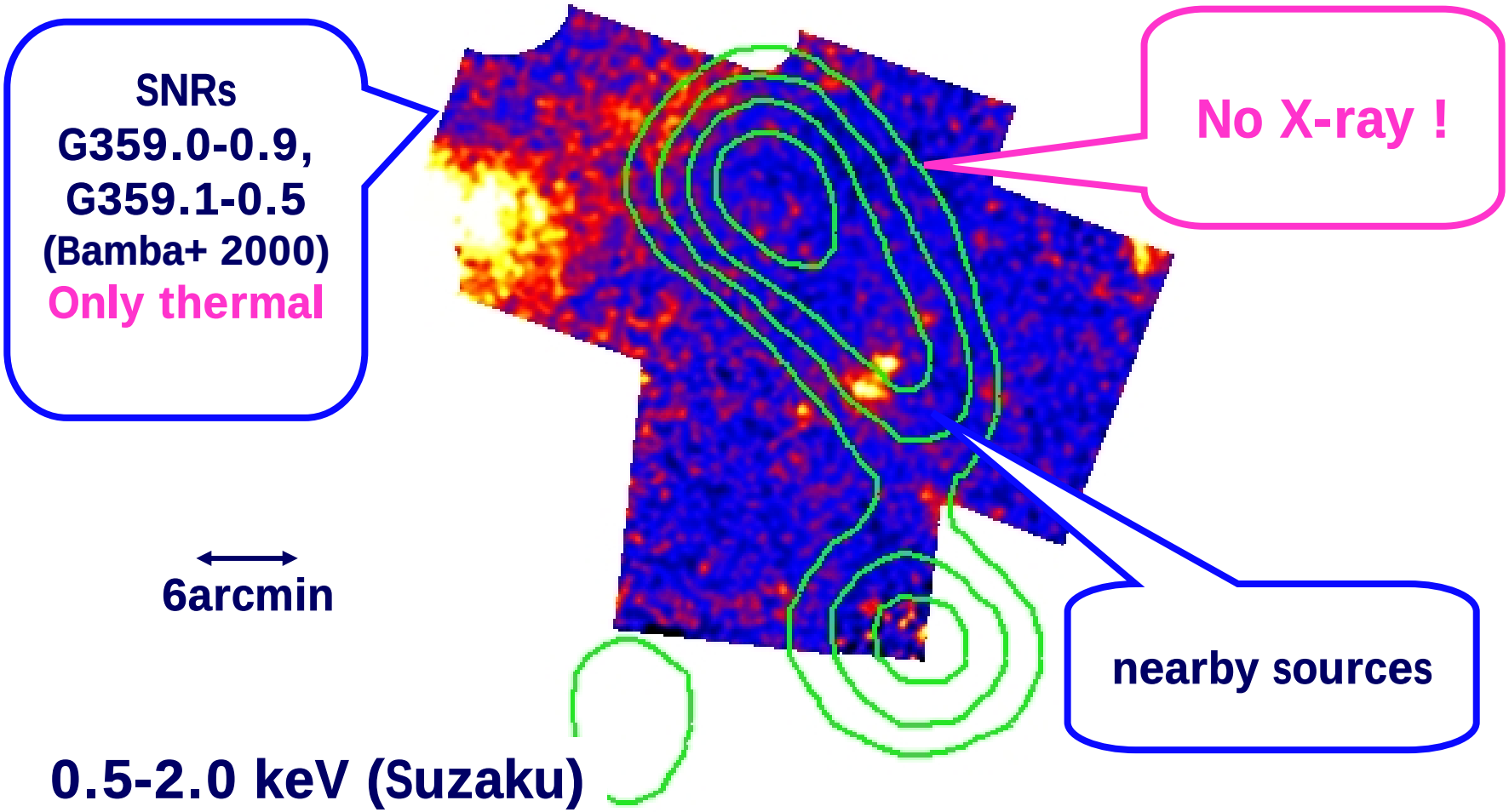
# 3.4. One of the most mysterious TeV unIDs: HESS J1745-303

- Discovered by H.E.S.S. (Aharonian+ 2005)
- Near the Galactic Center
- One of the most extended source (~0.5 deg)
- No couterpart in X-rays (XMM; Aharonian+ 2008) !

**Follow-up observations are needed!**

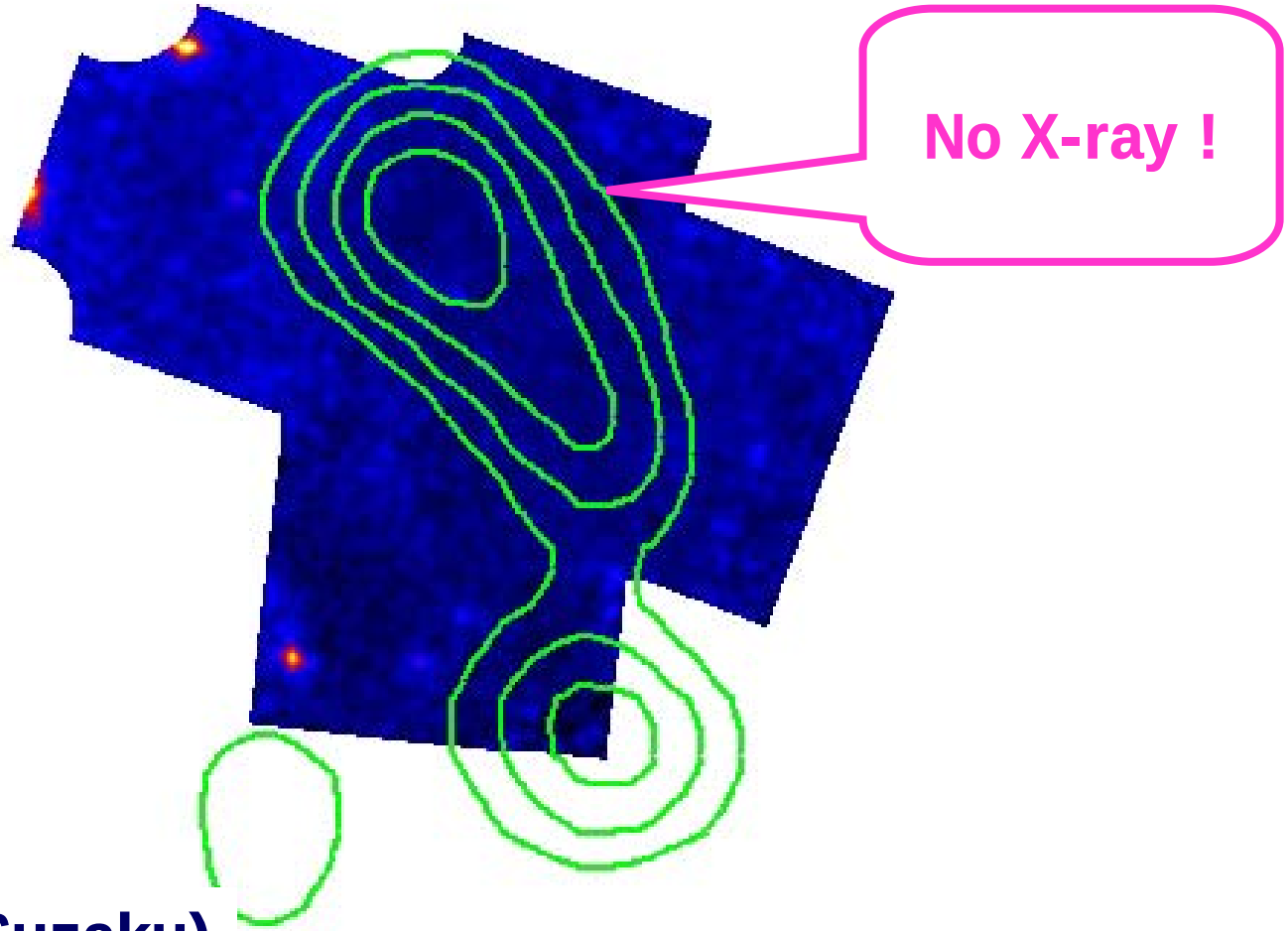


# 3.5. Suzaku XIS image of HESS J1745-303 (1)



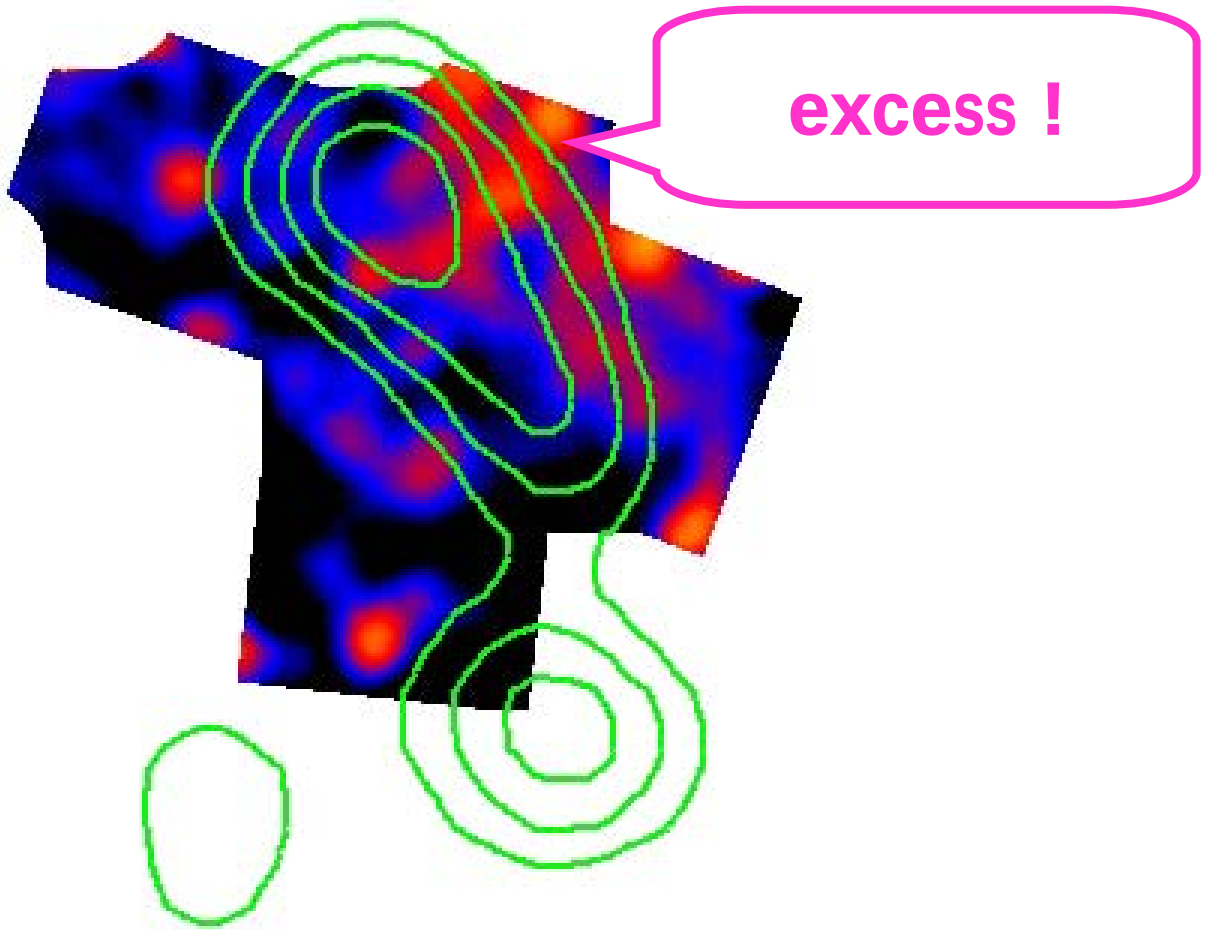

(Bamba+09)

# 3.6. Suzaku XIS image of HESS J1745-303 (2)




(Bamba+09)

# 3.7. Suzaku XIS image of HESS J1745-303 (3)



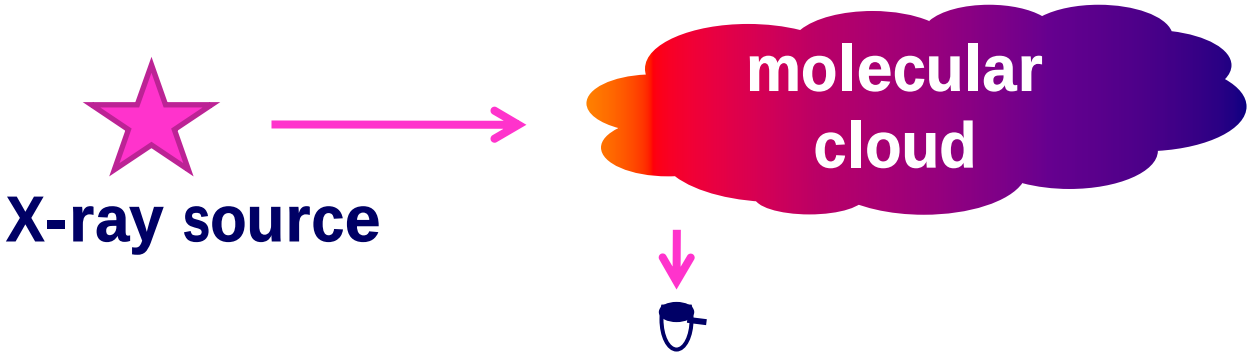

neutral (cold) iron line (Suzaku)
contour: HESS

total int. :
1.1e-5 ph $cm^{-2}s^{-1}$

(Bamba+09)

# 3.8. Origin of neutral iron emission line ?

## "X-ray reflection nebula"



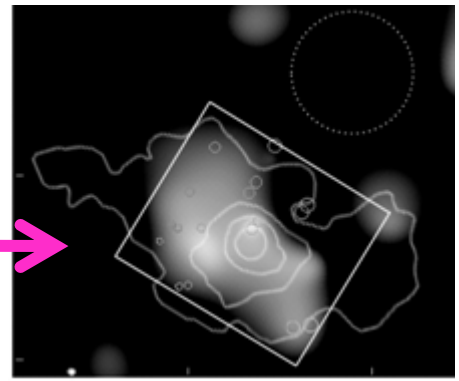

**X-ray irradiation -> scattered in MC -> strong emission line from cold iron**

## X-ray irradiator:

**past active GC SMBH itself !**

**(Koyama+ 2007)**

**It was very bright 300 years ago.**



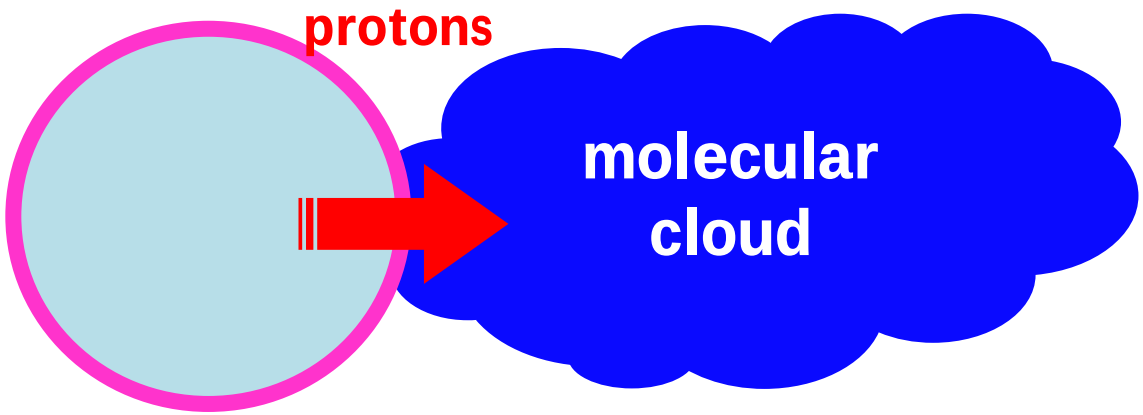
SgrB2: Murakami+ 2002)

**HESS J1745-303 coincides with MC.**

**(Bamba+09)**

# 3.9. SNR + MC = HESS J1745-303 ?

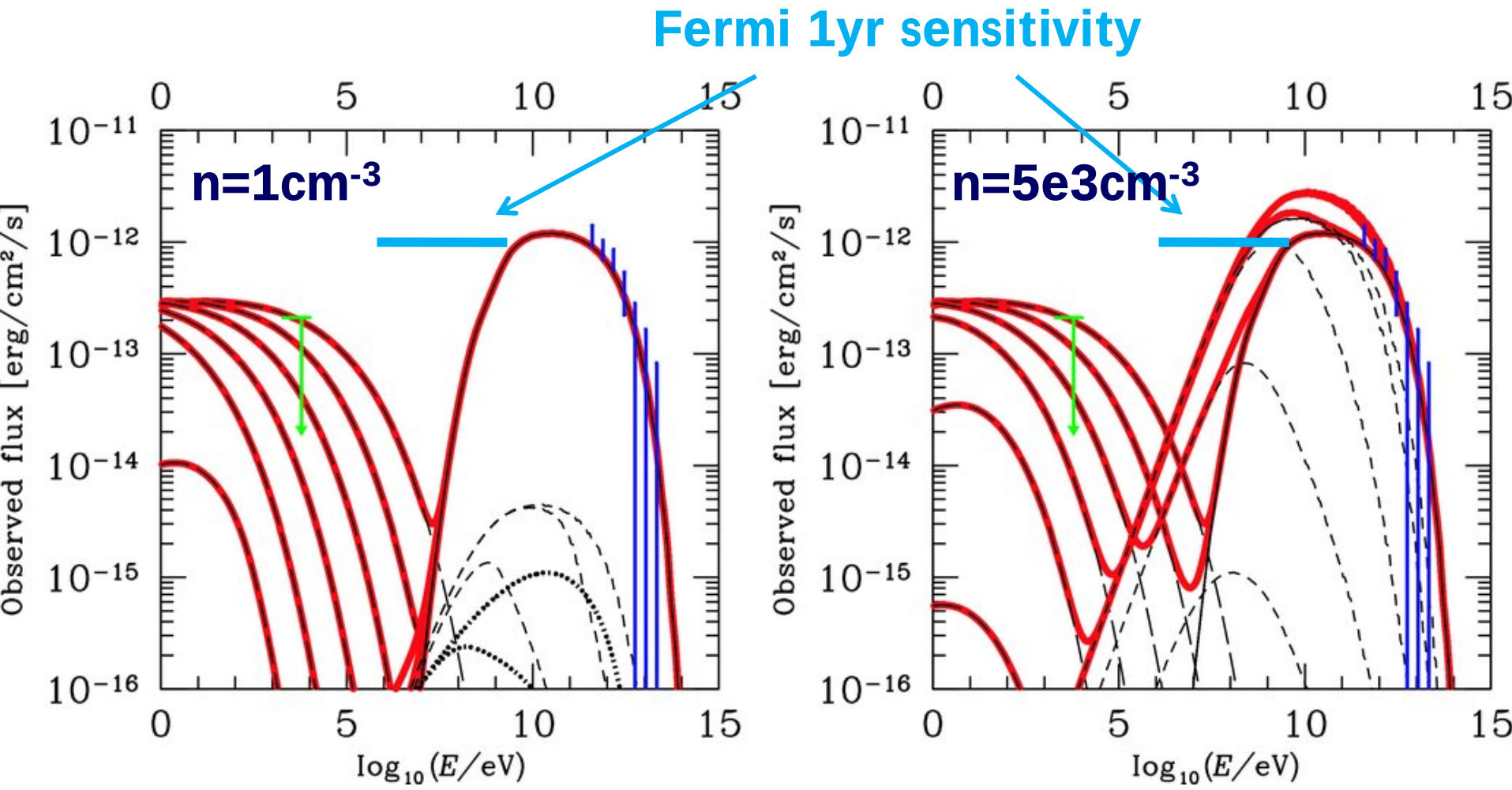
## Our scenario




- The SNR G359.1-0.5 is old enough to lose sync. X-rays. (Bamba+00)
- This SNR collides with MC. It has OH mesars.
- Protons emit gamma-rays via pi-0 decay.
- Only TeV gamma-rays are observed.

(Bamba+09)

# 3.10. Wide band spectra




(Bamba+09)

**Fermi will distinguish the situation of the "smoking gun".**

# 4. Summary

- Suzaku can achieve observations with low and stable background in wide X-ray band.

- Synchrotron X-rays from shells of young SNRs have clear cut-off on 0.2-10 keV.
  - We can estimate the maximum energy of electrons.

- Suzaku observed many TeV unID sources.
  - The wideband spectra cannot described with 1zone electron model.
  - TeV unID source with old SNR plus MC could be the new clue to understand proton acceleration.

# 3rd Suzaku conference

## “the Energetic Cosmos: from Suzaku to Astro-H”

**June 29 – July 2, Otaru, Hokkaido, Japan**

**Topics:**

- Particle acceleration in cosmic shocks and jets
- X-ray diagnostics of cosmic hot plasma
- High energy aspects of the Milky Way
- Magnetic activity in stellar objects
- Primary and reprocessed emission from accreting objects
- X-ray vies of the evolution of the universe
- Highlights from the Fermi Space Gamma-Ray Telescope
- Status of the MAXI experiment
- From Suzaku to ASTRO-H and other missions and further to IXO

**abstract deadline: Mar. 16**
**registration deadline: Apr. 13**

**Let us enjoy**
**fresh topics and Sushi !**