
FA51

FA51 – FISICA ASTROPARTICELLARE
COORDINATORE NAZIONALE: GIANLUIGI FOGLI

- Francesco DE PAOLIS (coordinatore locale)
- Gabriele INGROSSO
- Achille NUCITA
- Daniele VETRUGNO
- Pietro ROTELLI
- Daniele MONTANINO

PRINCIPALI ATTIVITÀ DI RICERCA

- Microlensing gravitazionale (De Paolis, Ingrosso, Nucita, Vetrugno)
- Fisica della radiazione cosmica di fondo (De Paolis, Ingrosso, Nucita, Vetrugno)
- Astrofisica delle alte energie (De Paolis, Ingrosso, Nucita, Vetrugno)
- Fenomenologia delle oscillazioni di neutrino (Montanino)
- Oscillazioni fotone assione in ambiente astrofisico (Montanino)
- Tunnelling laser risonante (Rotelli)
- Diffusione Dirac planare e tunnelling (Rotelli)
- Scattering potenziale in teorie di campo (Rotelli)

ALTRE ATTIVITÀ

- 3rd Italian-Pakistani workshop on relativistic astrophysics (Lecce, 20-22 giugno 2011)
- NOW2012 Neutrino Oscillation Workshop (Otranto, 9-16 settembre 2012)

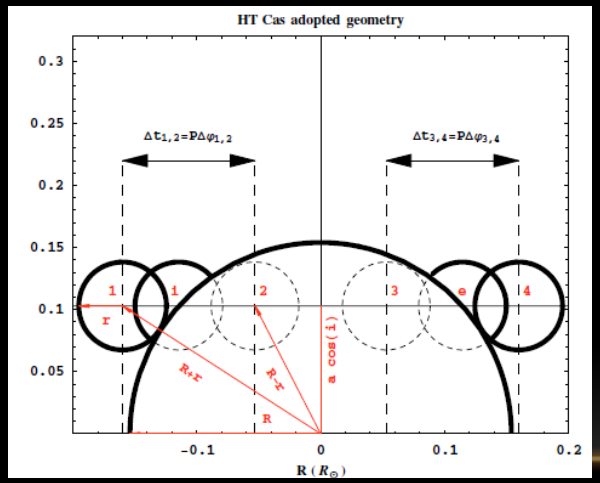
High energy astrophysics

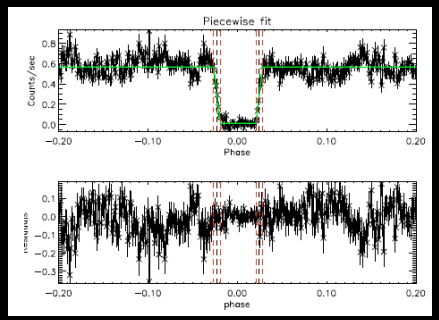
XMM-Newton, Chandra, Suzaku, RXTE, *INTEGRAL* observations of interesting astrophysical sources

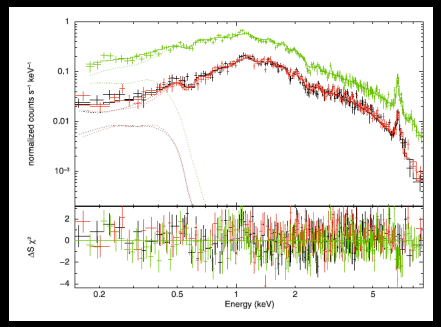
When possible, follow up observations, from ground based telescopes

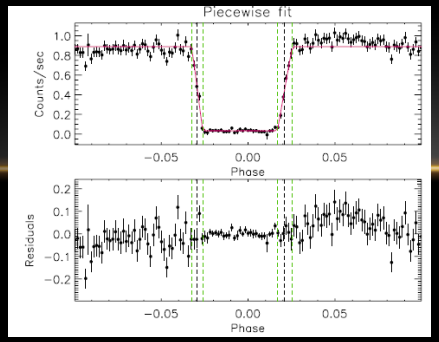
Cataclysmic Variables, i.e. white dwarfs accreting from normal stars via 1) an accretion disk (dwarf novae like), 2) low magnetic field accretion (Intermediate Polars) and 3) high magnetic field (Polars) with curtains and ballistic accretions. Archive searches for good candidates: many of them for each of which a detailed study is required.

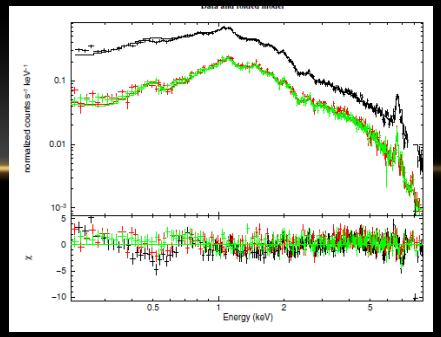
The goal is the detailed study of the accretion around moderately compact objects and test of the bounday layer model. Prototype sources: HT-CAS and Z-CHA, fully studied in recent appeared papers.











Methods:

Spectral analyses,

Accurate Timings,

Modelizations

Searches for Intermediate mass black holes in Globular clusters where we have suspects of their existence.

Archive studies via high energy satellites. Examples: NGC 6388

TABLE 2

GC CANDIDATES THAT COULD CONTAIN IMBHs

Name	Central Slope	$\log M_C$ ($M_\odot$)	$R_{h,\,\mathrm{pro}}$ (pc)	R_C (pc)	$R_C/R_{h,\,\mathrm{pro}}$	c	$\log T_{r,h}$ (yr)
NGC 5286.....	-0.20 ± 0.02	5.67	2.44	0.18	0.08	1.46	9.72
NGC 5694.....	-0.21 ± 0.10	5.35	3.28	0.34	0.10	1.84	9.76
NGC 5824[a]	-0.38 ± 0.08	5.15	3.35	0.20	0.06	2.45	9.67
NGC 6093.....	-0.13 ± 0.04	5.51	1.89	0.24	0.13	1.95	9.48
NGC 6266.....	-0.15 ± 0.04	5.90	1.92	0.20	0.08	1.70	9.68
NGC 6388.....	-0.14 ± 0.03	5.99	1.53	0.20	0.10	1.70	9.58
NGC 6397[a]	-0.29 ± 0.03	4.87	1.94	0.03	0.02	2.50	9.17
NGC 6541[a]	-0.36 ± 0.07	5.56	2.42	0.13	0.05	2.00	9.67
NGC 6715[a]	-0.16 ± 0.07	6.23	3.58	1.30	0.34	1.84	10.26

NOTE.—From the List of Noyola & Gebhardt (2004).

[a] Unlikely to contain IMBHs, see text.

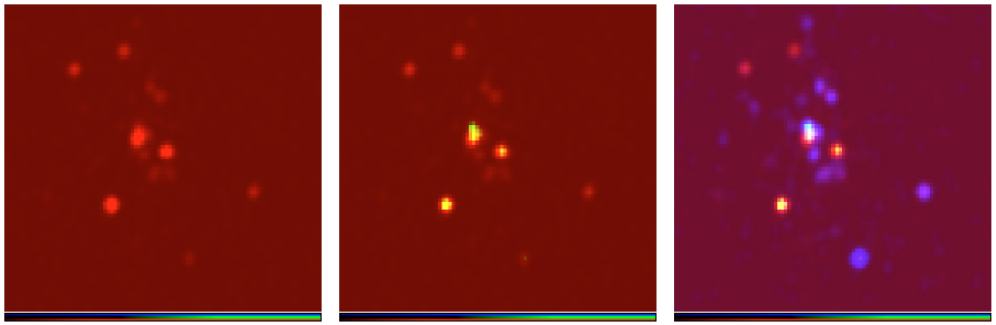


Fig. 3. *Chandra*/ACIS images in the soft, medium and hard bands. *From the left to the right*, the soft, soft+medium and soft+medium+hard images are shown. (This figure is available in color in electronic form.)

1 year INTEGRAL dedicated observation is currently under acquiring!

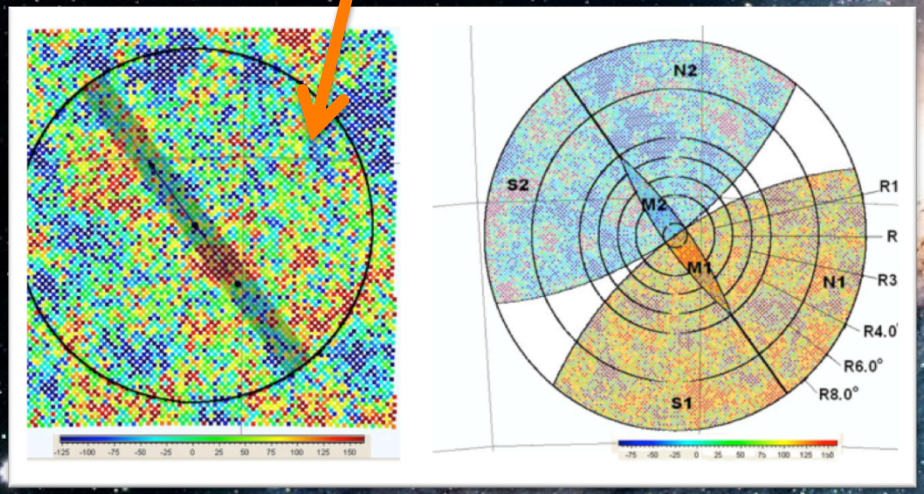
Several Collaborations Activated with international groups.

- Nucita, A. A.; De Paolis, F.; Saxton, R.; Read, A. M.
  The XMM-Newton slew view of IGRJ17361-4441: A transient in the globular cluster NGC 6388, New Astronomy, 2012
- Del Santo, M.; Romano, P.; Ferrigno, C.; Sidoli, L.; Mereghetti, S.; Wijnands, R.; Bozzo, E.; Tarana, A.; Nucita, A.; Degenaar, N.; Kuulkers, E.
  New INTEGRAL and Swift observations of the faint neutron-star X-ray transient SAX J1806.5-2215, Atel 4017, 2012
- Nucita, A. A.; De Paolis, F.; Ingrosso, G.
  X-rays from eclipsing cataclysmic variable systems: the eclipse profile, Journal of Physics, Conference Series, 2012.
- Nucita, A. A.; Kuulkers, E.; Maiolo, B. M. T.; de Paolis, F.; Ingrosso, G.; Vetrugno, D.
  The XMM-Newton view of the eclipse and dips of the dwarf nova Z Chamaleontis, A&A, 2011
- Del Santo, M.; Romano, P.; Sidoli, L.; Mereghetti, S.; Ferrigno, C.; Degenaar, N.; Wijnands, R.; Kuulkers, E.; Nucita, A.; Savchenko, V.
  First hard X-ray detection of the neutron star X-ray transient SAX J1806.5-2215 with INTEGRAL, Atel 3210, 2011
- Nucita, A. A.; Maiolo, B. M. T.; Kuulkers, E., Z-Chamaleontis: an XMM-Newton's view, Atel 3032, 2010
- Nucita, A. A.; de Paolis, F.; Ingrosso, G.; Carpano, S.; Guainazzi, M.
  XMM-Newton and Chandra observations of the globular cluster NGC 6388, A&A, 2008

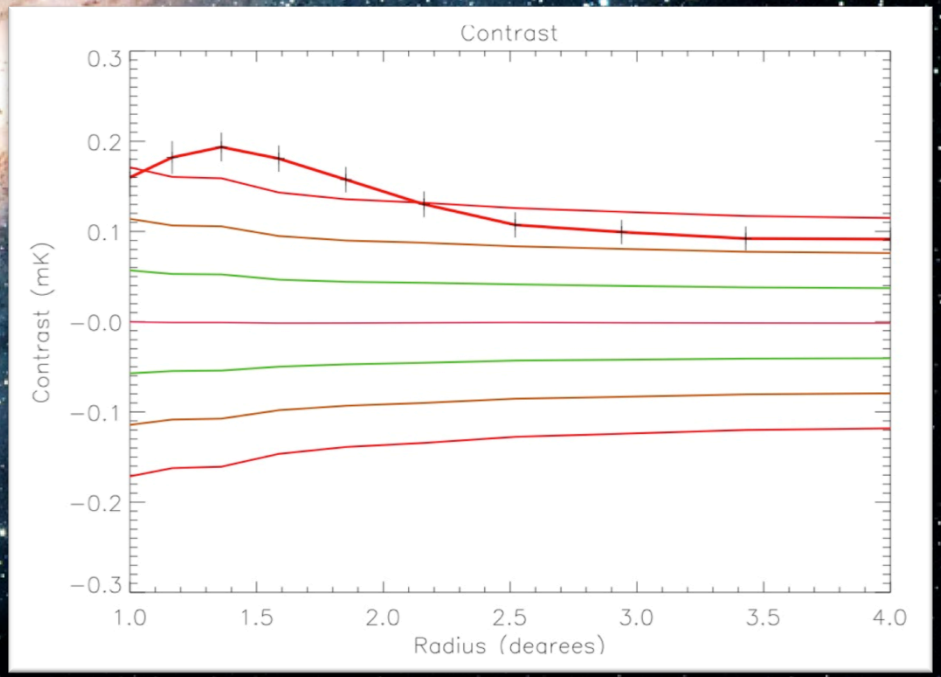
M31 HALO ROTATION USING WMAP DATA

DE PAOLIS *ET AL.*, A&A 534, L8 (2011)

WMAP sky around Andromeda



Temperature contrast as function of radius (compared with a WMAP equivalent sky map



Less than 1% probability that the observed temperature contrast is due to a CMB fluctuation

POTENTIAL SCATTERING IN QFT

GRAPHENE TESTS OF KLEIN PHENOMENA

Stefano De Leo* and Pietro Rotelli†

• Journal of Physics A **44**, 475305-9 (2011) •

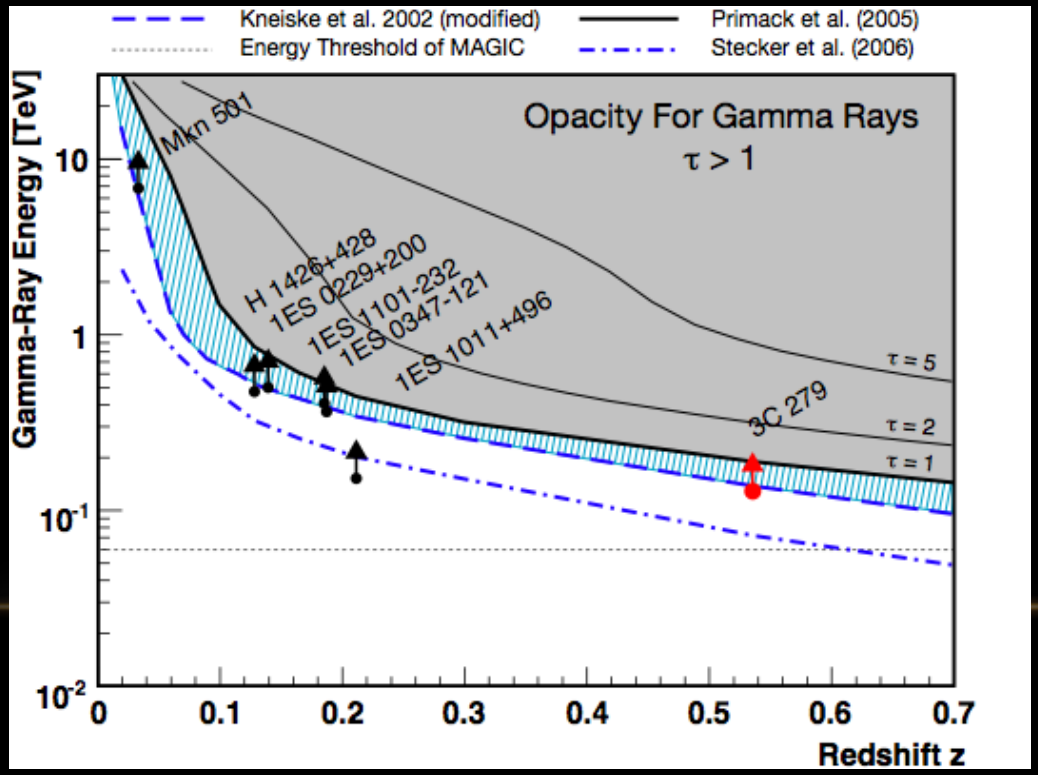
Abstract

Graphene is characterized by chiral electronic excitations. As such it provides a perfect testing ground for the production of Klein pairs (electron/holes). If confirmed, the standard results for barrier phenomena must be reconsidered with, as a byproduct, the accumulation within the barrier of holes.

I. INTRODUCTION

PHOTON-ALP CONVERSION
(HORNS, MACCIONE,MEYER, MIIZZI, MONTANINO, RONCADELLI)

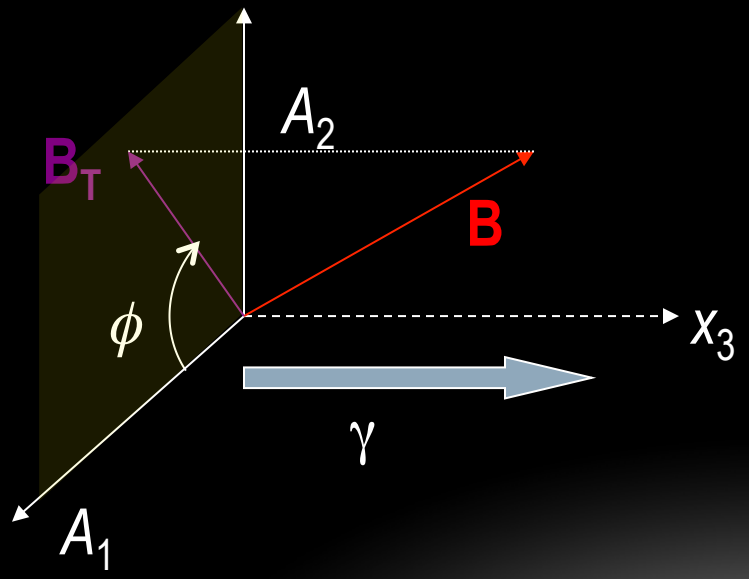
- universe should be opaque to VHE photons (>100GeV) due to the scattering on the background photons: $\gamma^{VHE} + \gamma^{bgk} \longrightarrow e^+ + e^-$
- However It appears that the universe is exceptionally transparent for γ-rays: a smoking gun for new physics?



Possible solution: conversion of photons into scalars (Axion-like particles). For a photon of energy E propagating in the x_3 direction the evolution equation for the γ-a system is (Raffelt-Stodolsky, 1987)

$$i\frac{\partial}{\partial x_3}\begin{pmatrix} A_1 \\ A_2 \\ a \end{pmatrix} = \begin{bmatrix} \Delta_\parallel c_\phi^2 + \Delta_\perp s_\phi^2 & (\Delta_\parallel - \Delta_\perp) s_\phi c_\phi & \Delta_{a\gamma} c_\phi \\ (\Delta_\parallel - \Delta_\perp) s_\phi c_\phi & \Delta_\parallel s_\phi^2 + \Delta_\perp c_\phi^2 & \Delta_{a\gamma} s_\phi \\ \Delta_{a\gamma} c_\phi & \Delta_{a\gamma} s_\phi & \Delta_a \end{bmatrix} \begin{pmatrix} A_1 \\ A_2 \\ a \end{pmatrix}$$

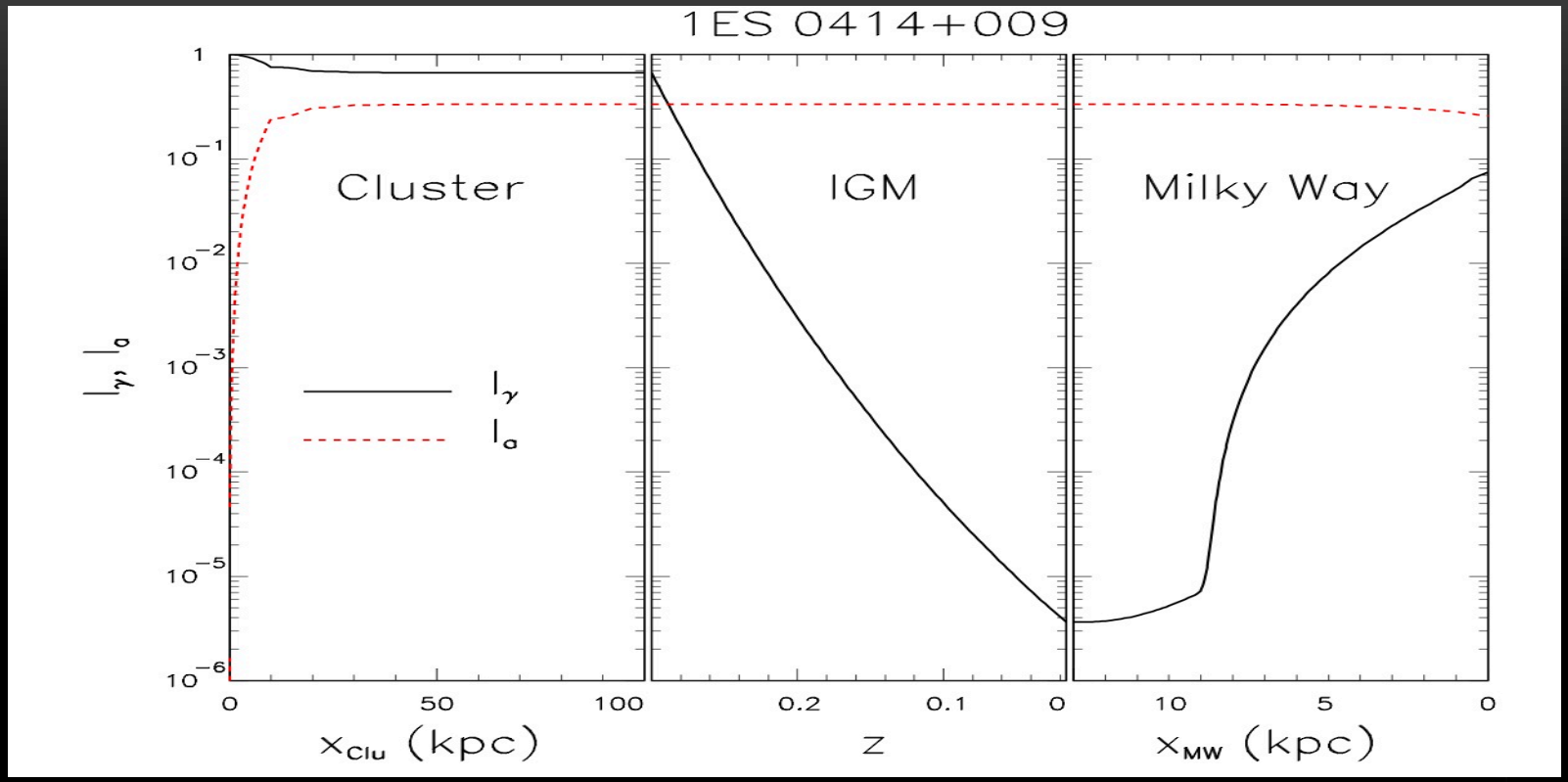
Where:

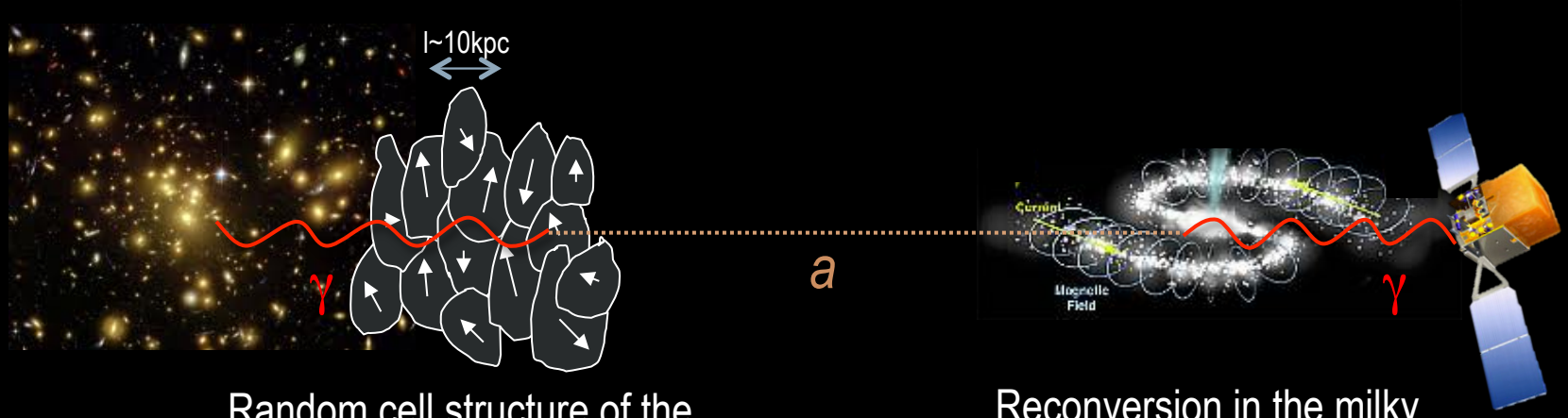


$$\Delta_\parallel = \Delta_{\rm plasma} + \frac{7}{2}\Delta_{\rm QED}$$
$$\Delta_\perp = \Delta_{\rm plasma} + 2\Delta_{\rm QED}$$
$$\Delta_{\rm plasma} = -\frac{2\pi\alpha n_e}{m_e E}$$
$$\Delta_{\rm QED} = \frac{\alpha E}{45\pi}\left(\frac{B_T}{m_e^2/e}\right)^2$$
$$\Delta_{a\gamma} = \frac{1}{2} g_{a\gamma} B_T$$
$$\Delta_a = -\frac{m_a^2}{2E}$$

n_e= electron density of the medium

THE MODEL: CONVERSION IN CLUSTER AND RECONVERSION IN MILKY WAY



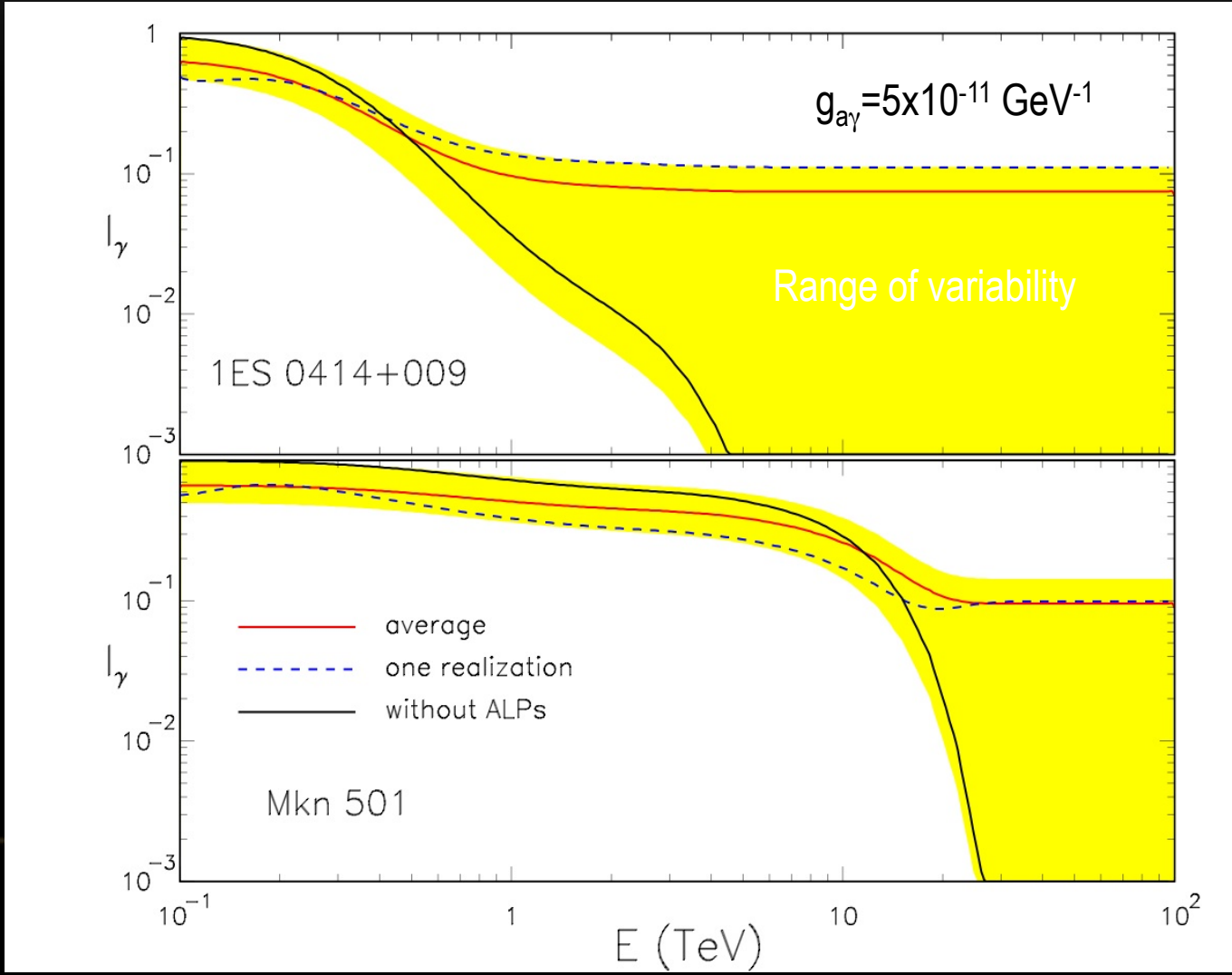


Random cell structure of the B field in cluster (B~μG)

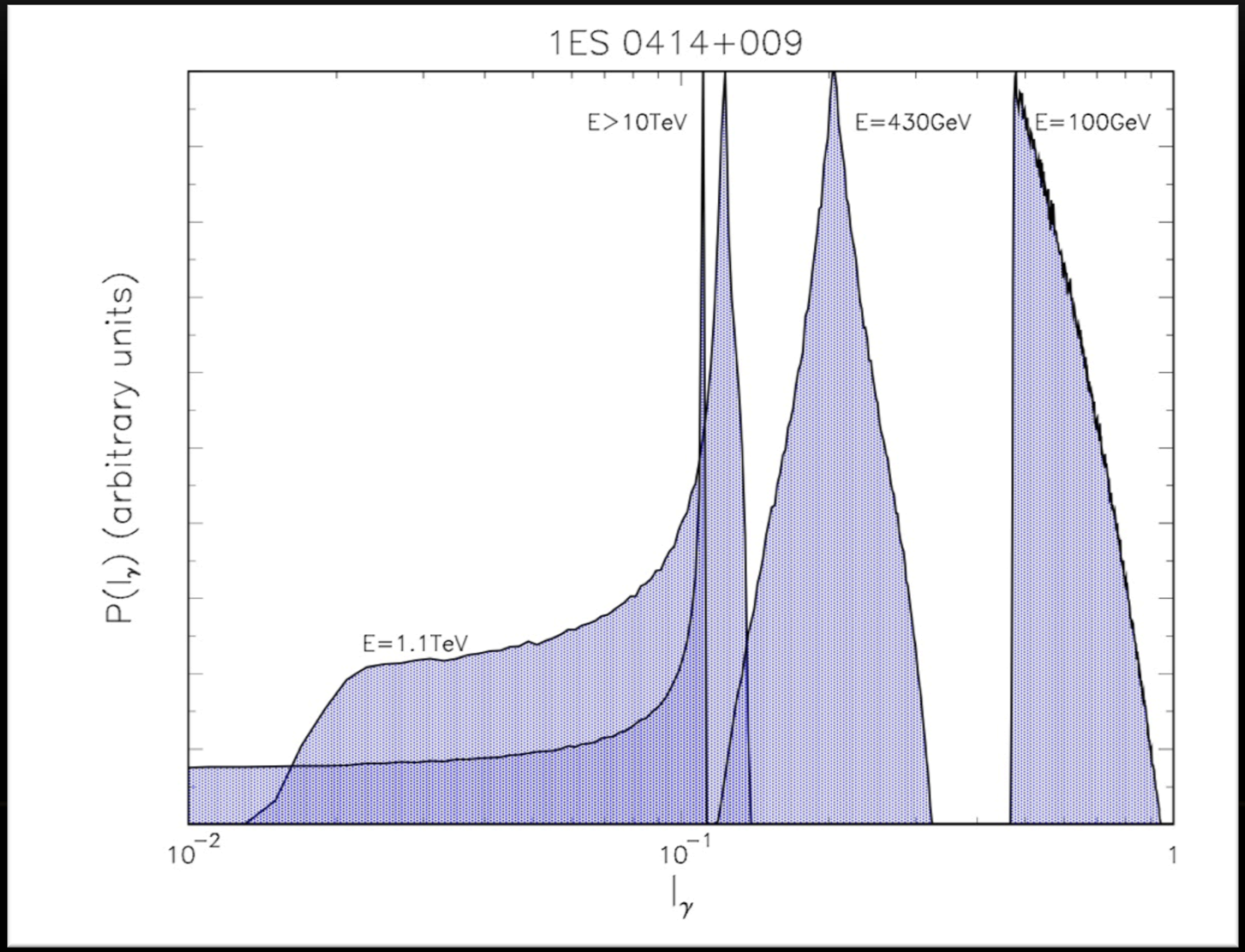
Reconversion in the milky way B field (B~μG)

NORMALIZED SPECTRUM FOR TWO SOURCES

$$I_\gamma(E) = S_{\mathrm{ALP}}(E)/S_0(E)$$

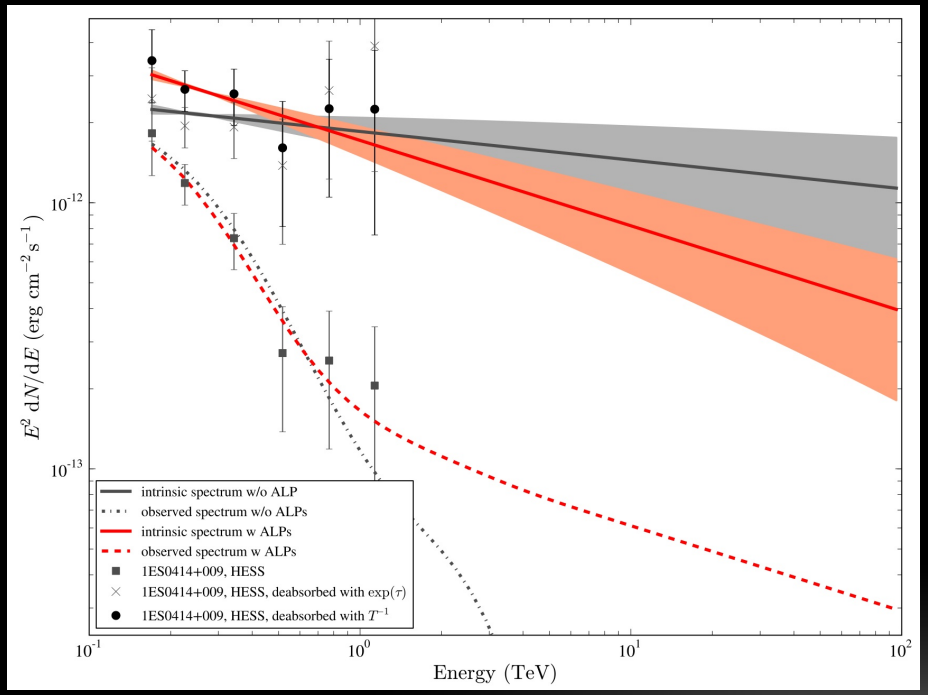


PDF OF I_γ AT VARIOUS ENERGIES (ONE SOURCE)



HINTS FOR PHOTON-ALP CONVERSION?

1ES 0414+009



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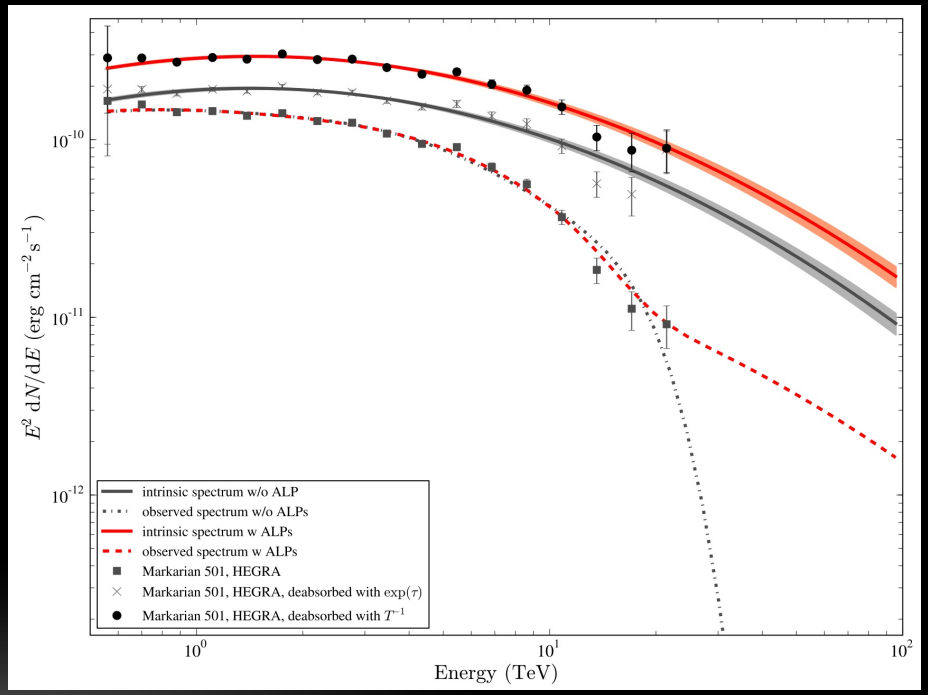
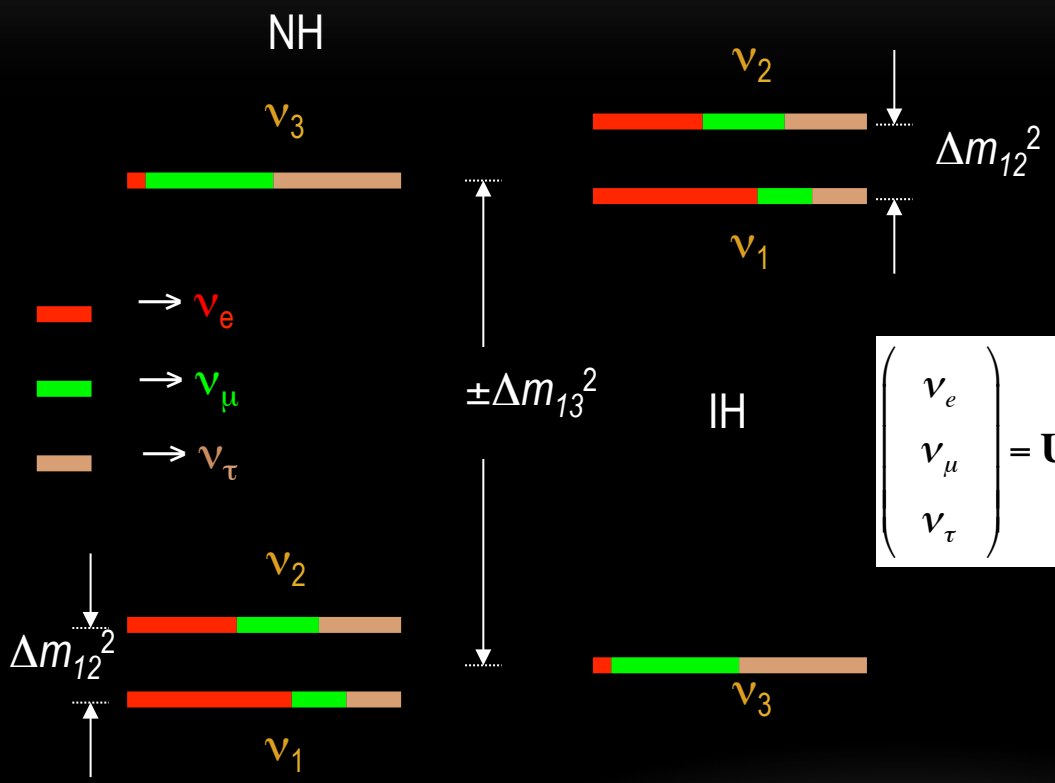


We need more data for the future. Waiting fo new experiments (CTA)

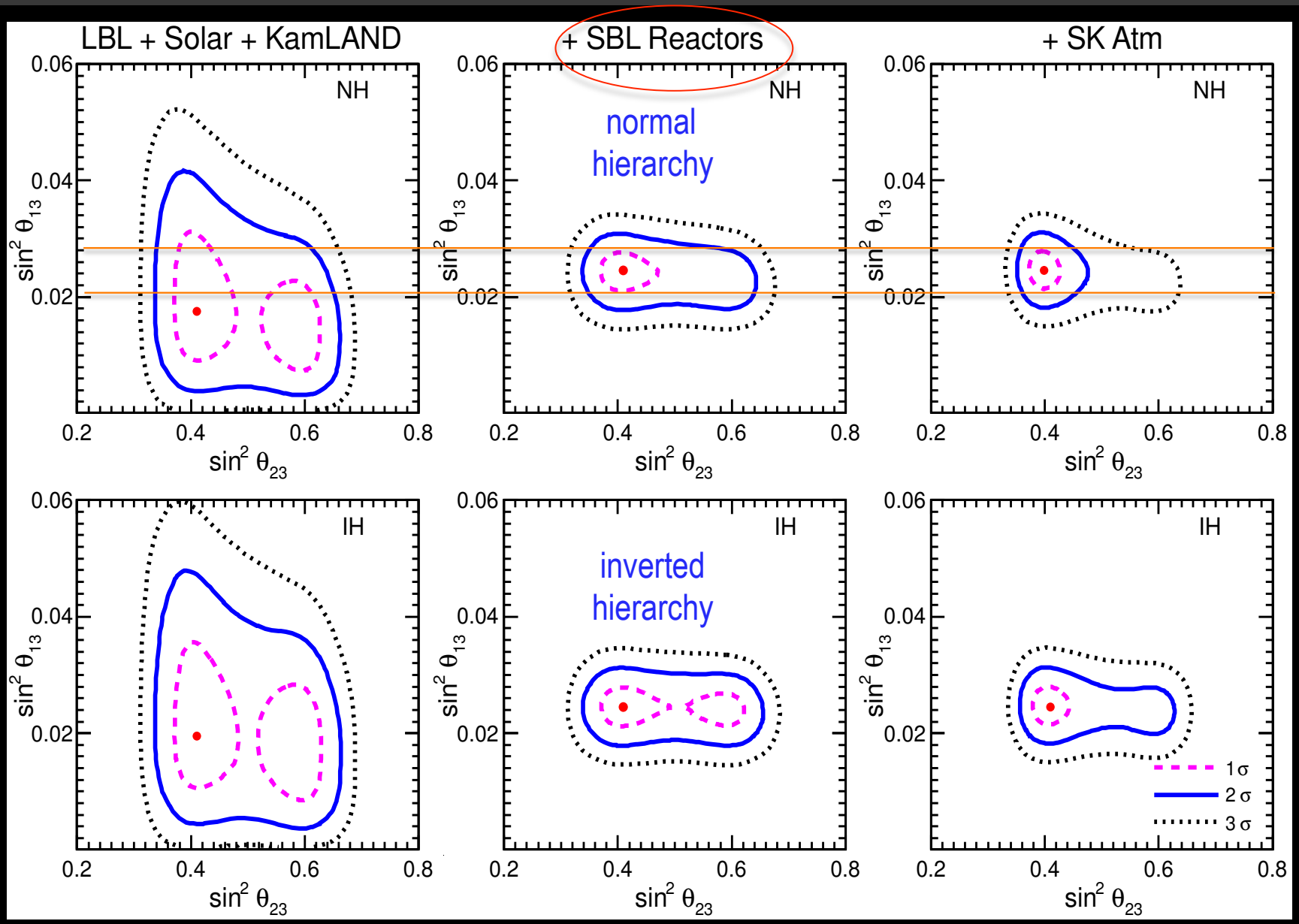
GLOBAL ANALYSIS OF NEUTRINO OSCILLATIONS EXPERIMENTS

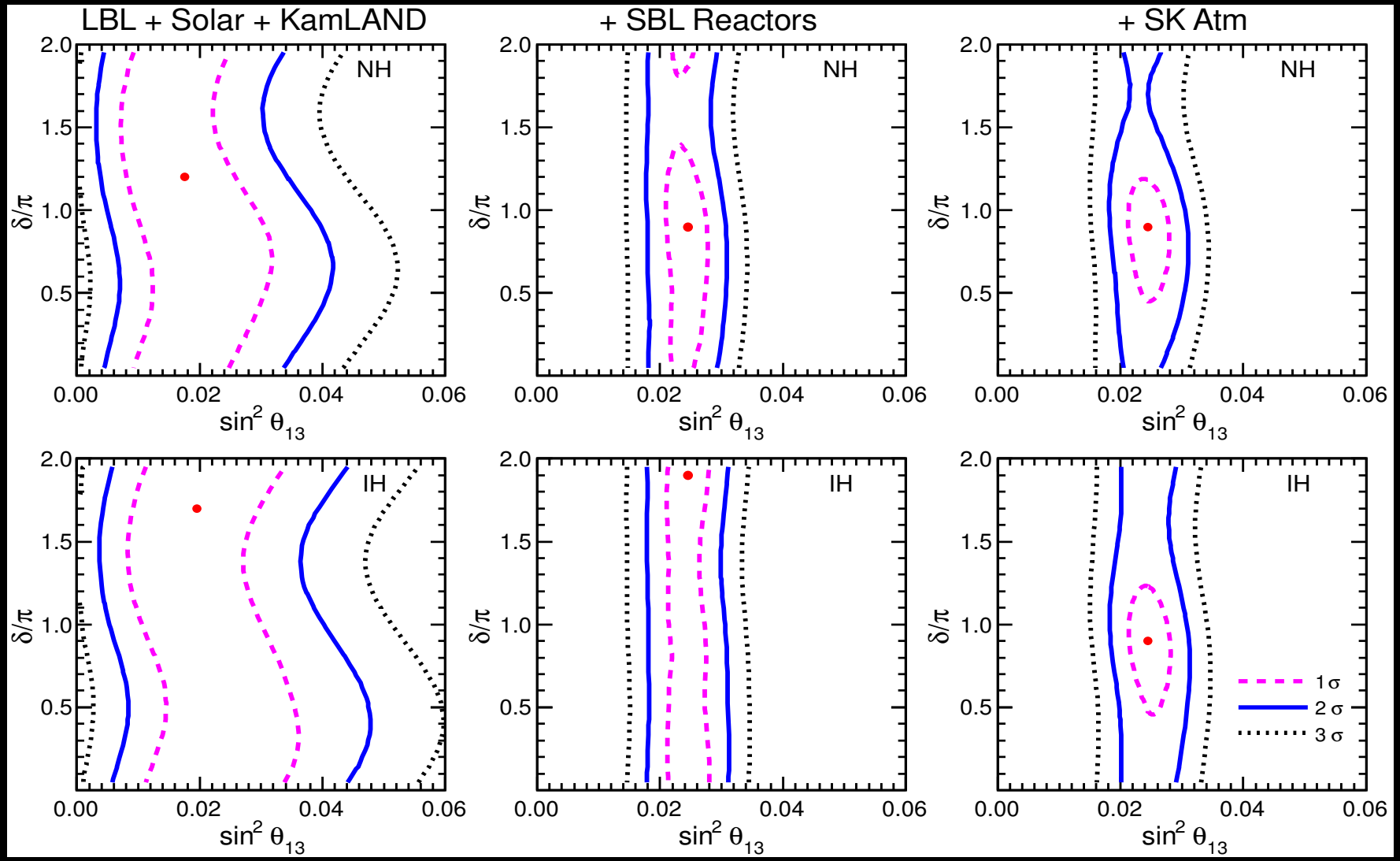
(FOGLI, LISI, MARRONE, MONTANINO, PALAZZO, ROTUNNO)



$$\begin{pmatrix} \nu_e \\ \nu_\mu \\ \nu_\tau \end{pmatrix} = \mathbf{U} \cdot \begin{pmatrix} \nu_1 \\ \nu_2 \\ \nu_3 \end{pmatrix} = \begin{pmatrix} U_{e1} & U_{e2} & U_{e3} \\ U_{\mu 1} & U_{\mu 2} & U_{\mu 3} \\ U_{\tau 1} & U_{\tau 2} & U_{\tau 3} \end{pmatrix} \cdot \begin{pmatrix} \nu_1 \\ \nu_2 \\ \nu_3 \end{pmatrix}$$

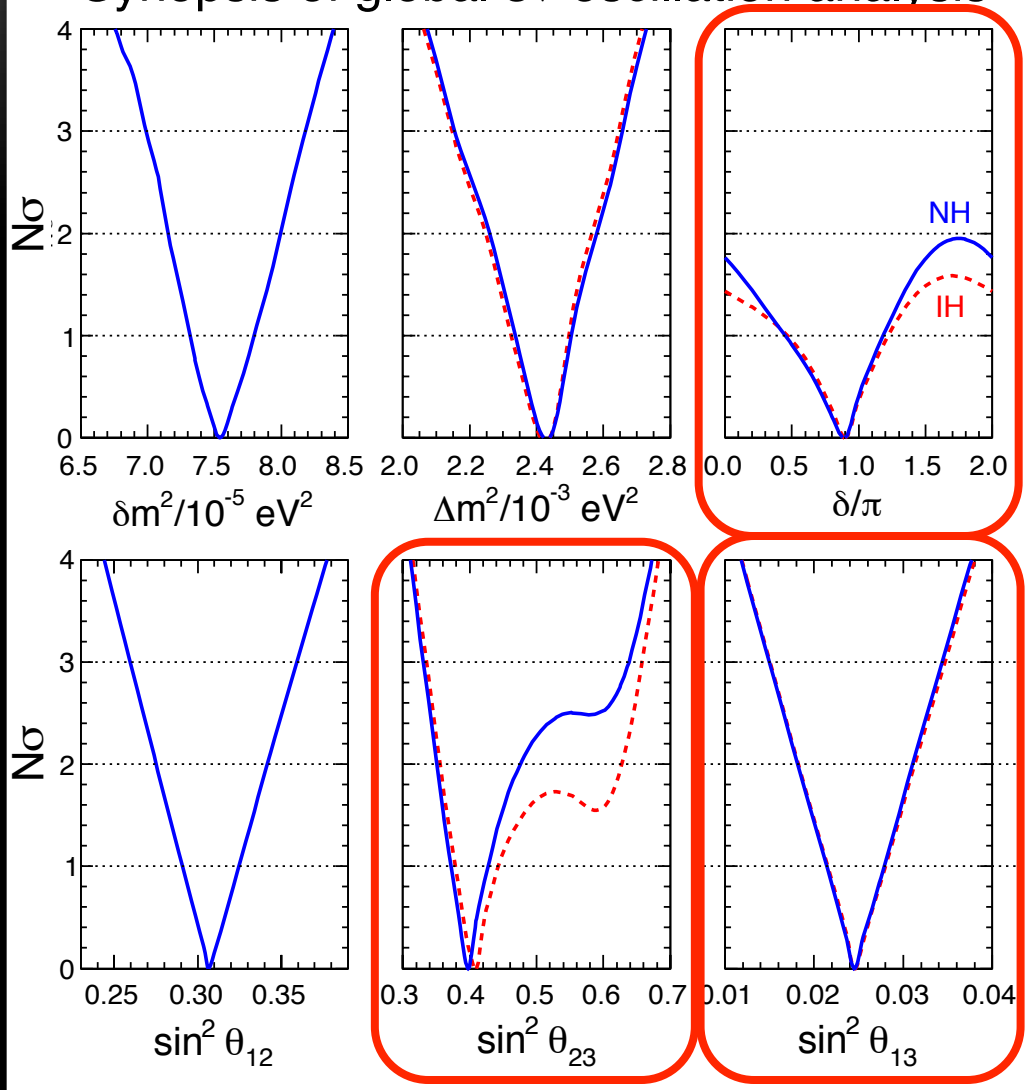
$$\mathbf{U} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos\theta_{23} & \sin\theta_{23} \\ 0 & -\sin\theta_{23} & \cos\theta_{23} \end{pmatrix} \cdot \begin{pmatrix} \cos\theta_{13} & 0 & e^{-i\delta}\sin\theta_{13} \\ 0 & 1 & 0 \\ -e^{i\delta}\sin\theta_{13} & 0 & \cos\theta_{13} \end{pmatrix} \cdot \begin{pmatrix} \cos\theta_{12} & \sin\theta_{12} & 0 \\ -\sin\theta_{12} & \cos\theta_{12} & 0 \\ 0 & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} 1 & & \\ & e^{i\varphi_2} & \\ & & e^{i\varphi_3} \end{pmatrix}$$


LBL + Solar + KamLAND
+ SBL Reactors
+ SK Atm
NH
IH
normal hierarchy
inverted hierarchy
$\sin^2\theta_{13}$
$\sin^2\theta_{23}$
0.06
0.04
0.02
0.2
0.4
0.6
0.8
1σ
2σ
3σ



We find a ~ 1σ preference for θ ~ π as in the early analysis of hep-ph/0506083.

Synopsis of global 3ν oscillation analysis



- Previous hints of $\theta_{13} > 0$ are now measurements! (and basically independent of old/new reactor fluxes)
- Some hints of $\theta_{23} < \pi/4$ are emerging at ~ 2σ, worth exploring by means of atm. and LBL+reac. data
- A possible hint of $\delta_{CP} \sim \pi$ emerging from atm. data [Is the PMNS matrix real?]
- So far, no hints for NH ⟷ IH

Thank you !