SK/Tibet空気シャワーアレイによる 10 TeV宇宙線強度の恒星時日周変動の観測

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旅費（松本⇔柏）：５０千円（SK）/ 150千円（Tibet）

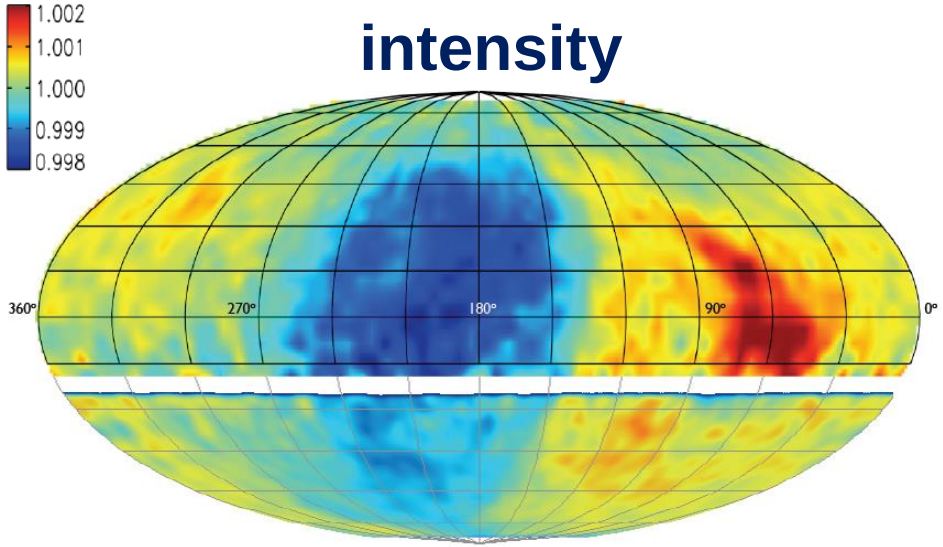
Two-hemisphere observations by Tibet & Ice Cube

Tibet ASγ

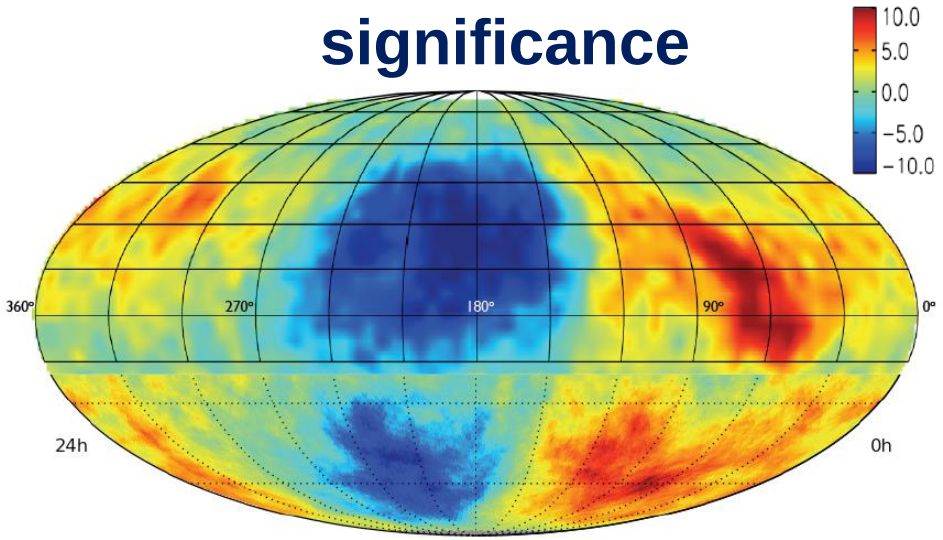
(Amenomori et al., Science, 314, 2006)

- AS measurement (**p+γ**)
- E_{mode} = **7** TeV (calibrated by using Moon shadow)
- 4.5×10^{10} events in 1999.11-2008.12 (270 Hz)

intensity



significance



Ice Cube

(Abbasi et al., arXiv:1005.2960v1, 2010)

- muon measurement (**p**)
- E_{mode} = **20** TeV
- 4.3×10^{9} events in 2007.6-2008.3 (220 Hz)

GA + MA model for Tibet data

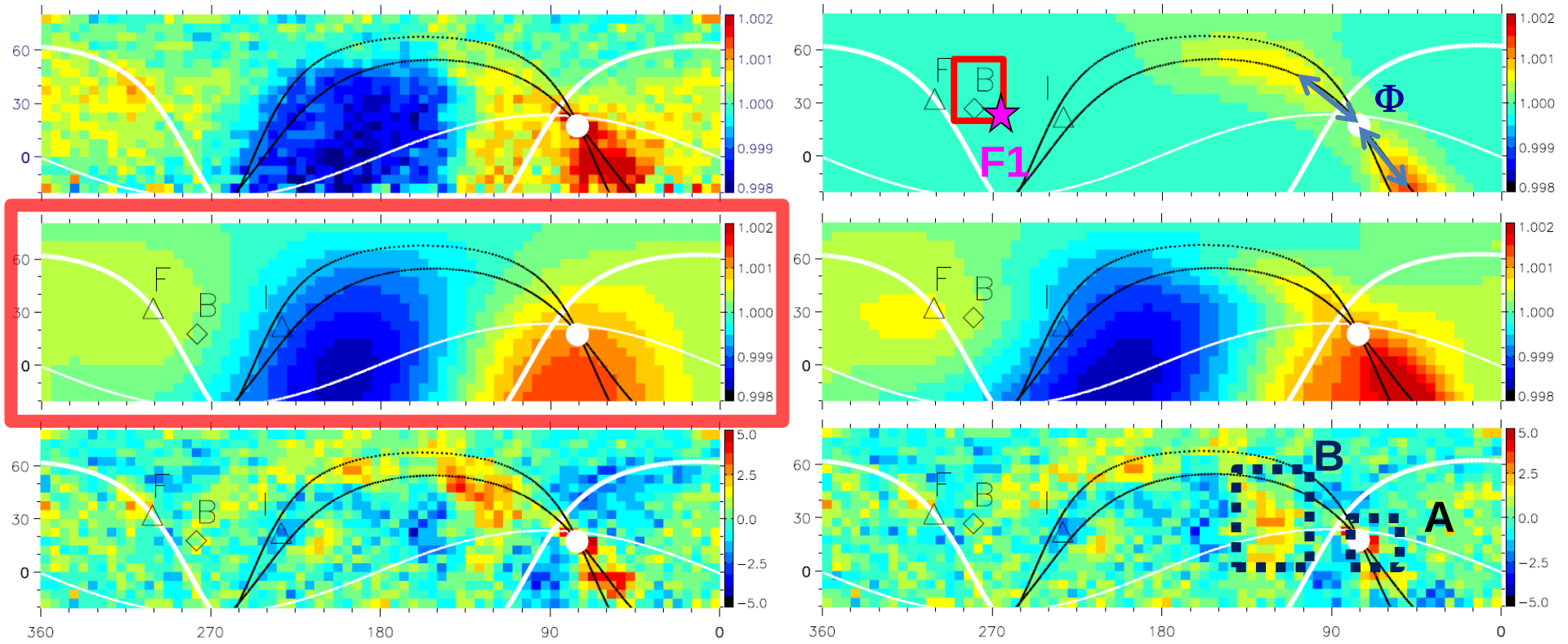
Predicted/observed ISMF (B) orientations

Global + Midscale anisotropy model: **B** (Amenomori et al., Astrophys. Space Sci. Trans, **6**, 49, 2010)

Faraday rotation measure: **F** (Frisch, Space Sci. Rev., **78**, 213, 1996)

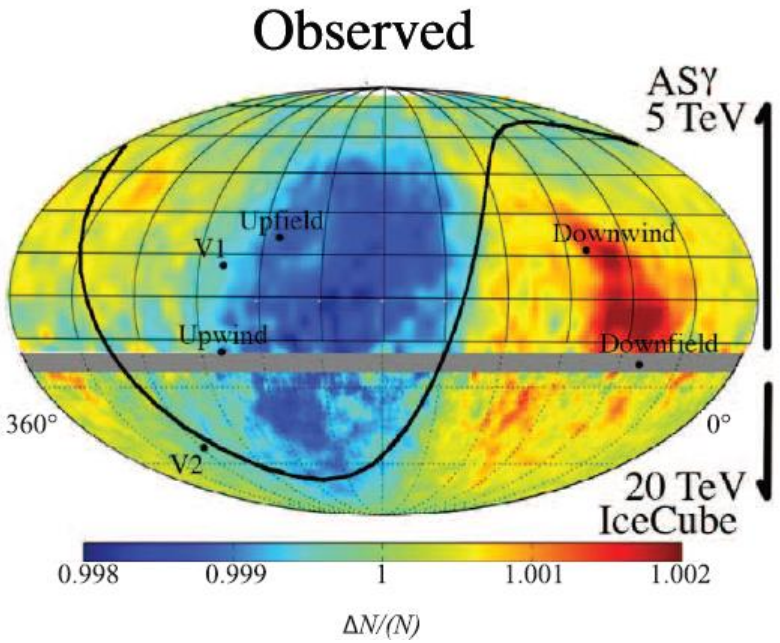
ENA ribbon by IBEX: **I** (Frisch, Space Sci. Rev., **78**, 213, 1996)

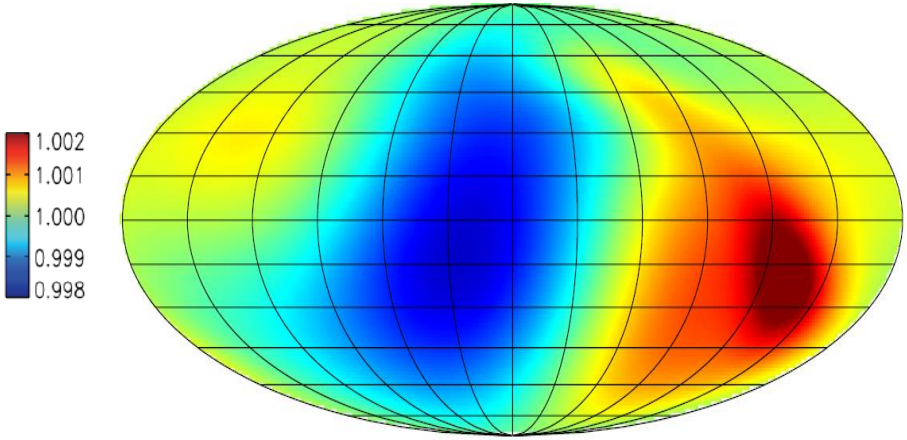
Starlight polarization by magnetized dust: **F1** (Astrophys. J., **760**, 106, 2012)



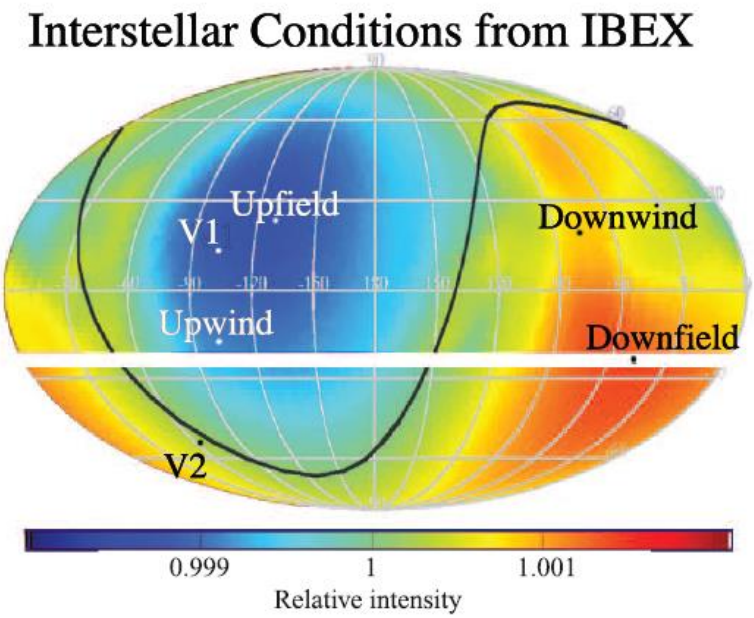
Miraglo “hot” regions (Abdo et al., PRL, 101, 2008)

Two models

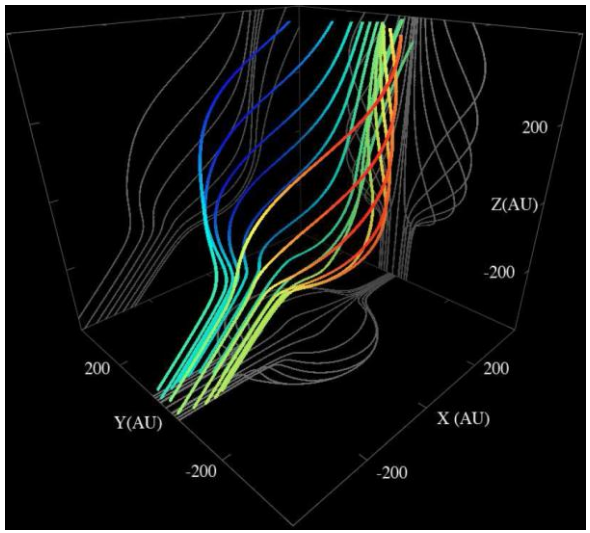




Amenomori+ (Astrophys. Space Sci. Trans. 6 2010)

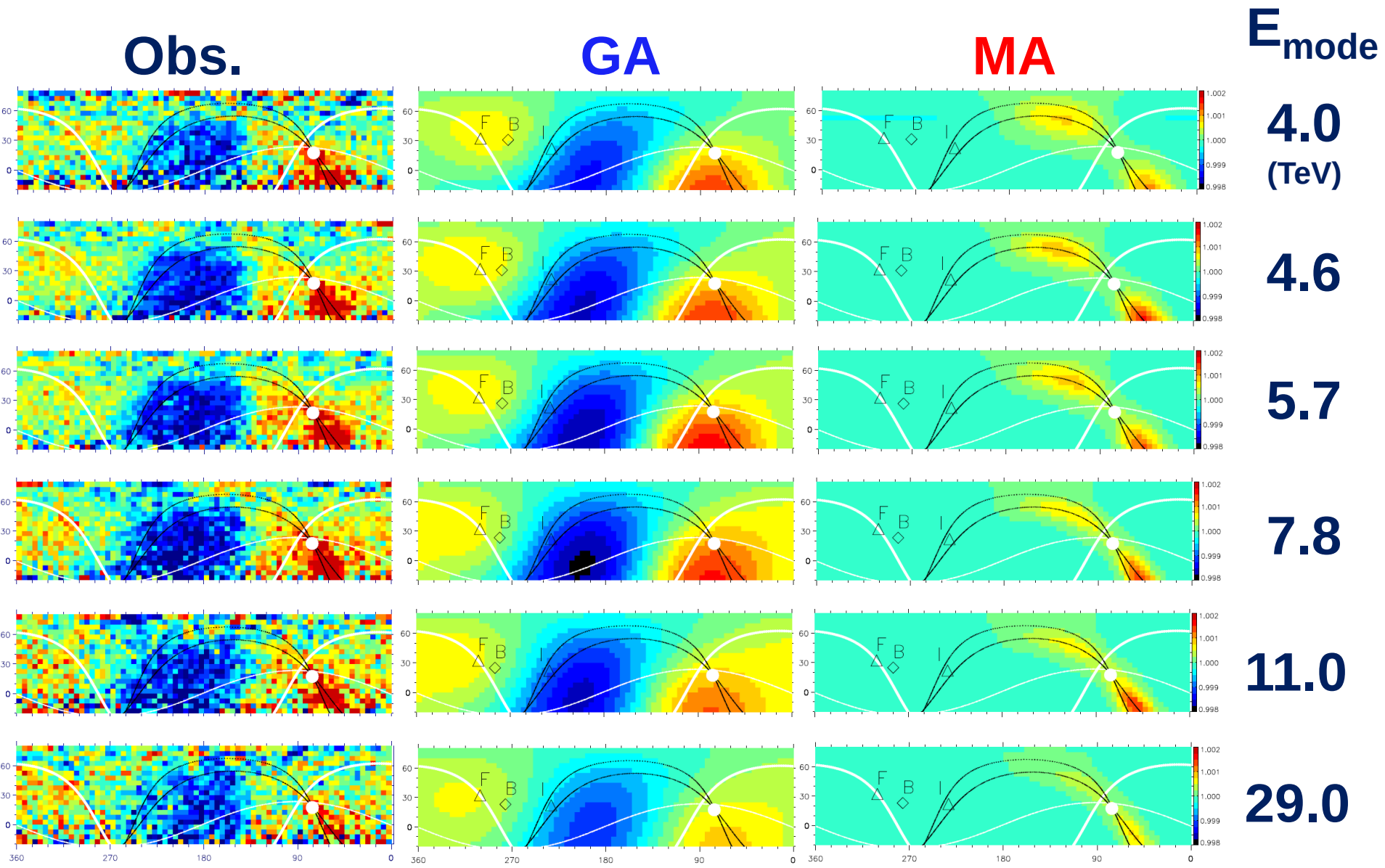


Schwadron+ (Science 343 2014)



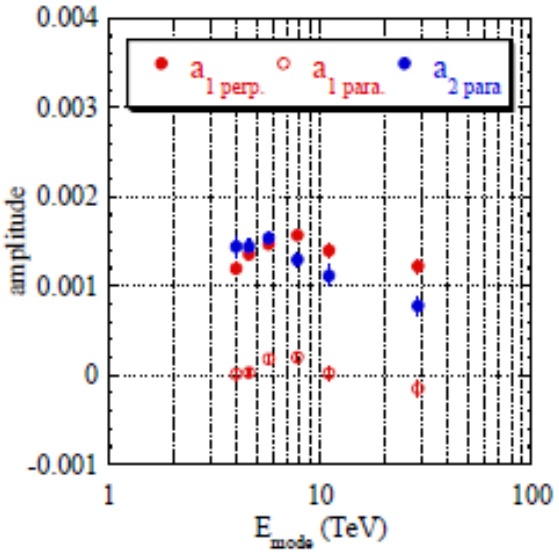
Energy dependence (1/3)

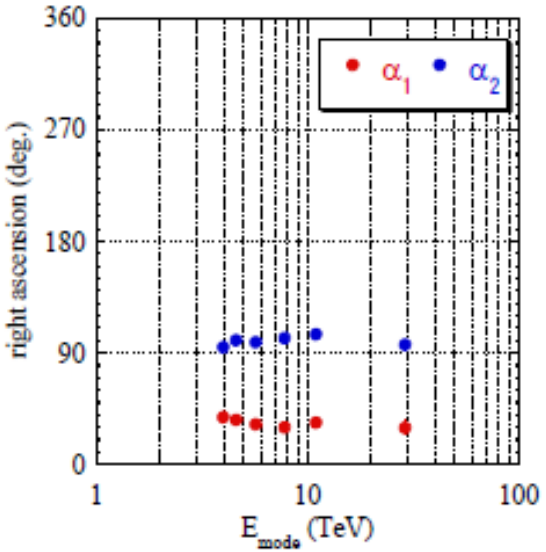
(Unfortunately, the energy resolution is poor as ~50 %)

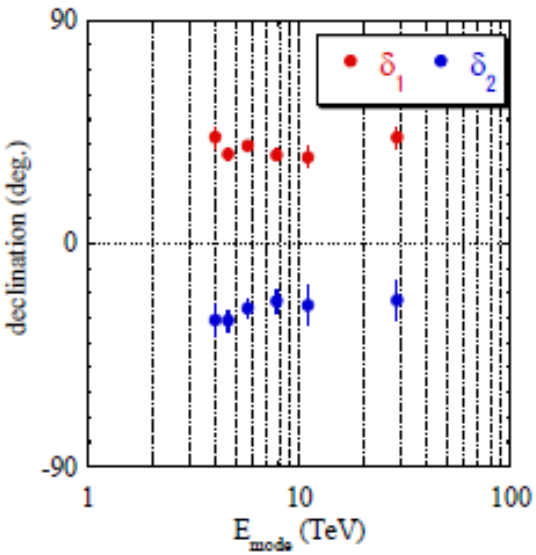


Energy dependence (2/3)

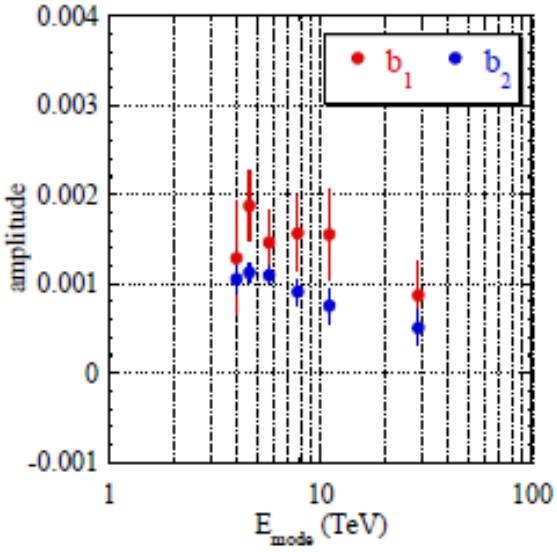
GA

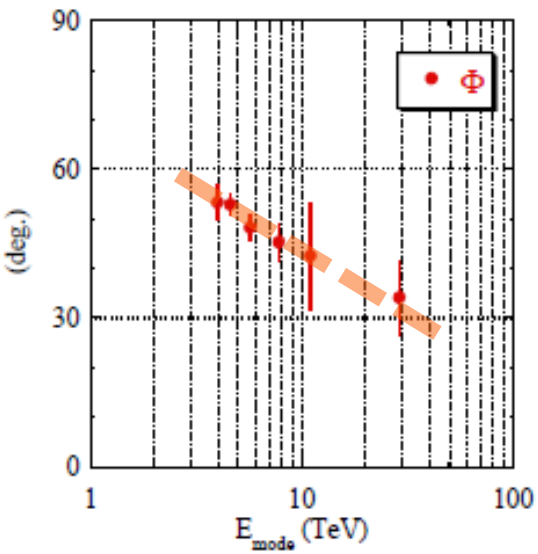






MA





Energy dependence of the large-scale anisotropy observed with Tibet ASγ and IceCube

ABSTRACT

(Abbasi+, ApJL, 746, 2012)

The same large-scale anisotropy observed at median energies around 20 TeV is not present at 400 TeV. Instead, the high-energy sky map shows a different anisotropy structure including a deficit with a post-trial significance of -6.3σ. This anisotropy reveals a new feature of the Galactic cosmic-ray distribution, which must be incorporated into theories of the origin and propagation of cosmic rays.

Harmonic Fit Values Per Declination Band for the Energy Band Centered at 400 TeV

Decl. Mean	$A_1 \pm$ (stat.) (10^{-4})	$\phi_1 \pm$ (stat.) (°)	$A_2 \pm$ (stat.) (10^{-4})	$\phi_2 \pm$ (stat.) (°)
−24	9.6 ± 3.1	248.1 ± 18.6	5.4 ± 3.1	143.6 ± 16.6
−27	1.1 ± 3.0	245.7 ± 15.8	6.5 ± 3.0	$158.1 \pm$
−30	5.1 ± 2.6	238.9 ± 29.6	3.0 ± 2.6	± 25.2
−33	3.9 ± 2.7	255.9 ± 37.8	2.0 ± 2.6	205.3 ± 37.6
−36	9.6 ± 2.4	217.0 ± 14.2	± 2.4	171.5 ± 10.9
−39	9.5 ± 2.4	246.9 ± 14.3	6.5 ± 2.4	144.2 ± 10.5
~~−39~~	~~9.5 ± 2.4~~	~~246.9 ± 14.3~~	~~6.5 ± 2.4~~	~~234.2 ± 10.5~~
−42	4.2 ± 2.2	± 30.1	2.5 ± 2.2	231.3 ± 25.4
−45	$1.2 \pm$	311.4 ± 115.6	2.8 ± 2.5	110.4 ± 25.1
−48	± 2.3	181.0 ± 95.6	3.6 ± 2.3	154.2 ± 18.2
	3.7 ± 2.4	236.7 ± 38.2	2.0 ± 2.4	156.8 ± 35.6
−54	5.5 ± 2.4	220.8 ± 25.8	1.5 ± 2.5	142.5 ± 46.8
−57	1.4 ± 2.6	228.8 ± 112.1	3.7 ± 2.6	165.0 ± 21.9
−60	3.9 ± 2.6	359.8 ± 38.5	7.4 ± 2.6	161.0 ± 10.2
−63	2.6 ± 3.4	13.0 ± 72.8	3.2 ± 3.3	148.6 ± 29.6
−66	1.3 ± 2.9	143.4 ± 127.8	5.3 ± 3.0	107.5 ± 15.9
−69	1.0 ± 3.4	304.5 ± 188.2	4.2 ± 3.4	227.9 ± 23.2
−72	6.8 ± 3.4	174.8 ± 28.4	6.7 ± 3.4	152.5 ± 14.5

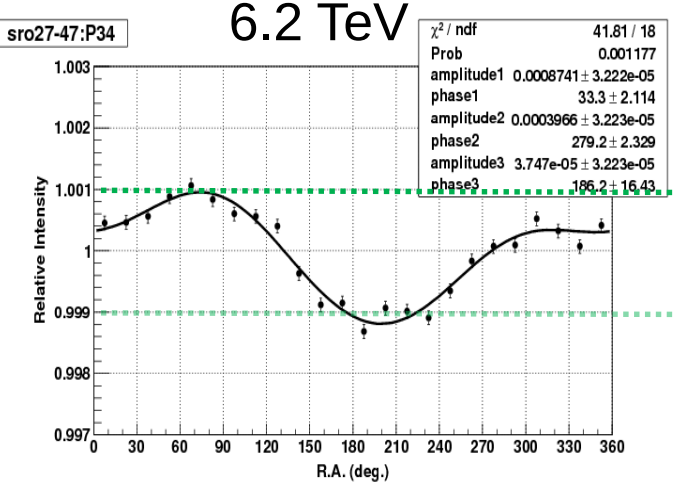
Analysis of two hemisphere data is now possible.

RA distributions by Tibet & IceCube

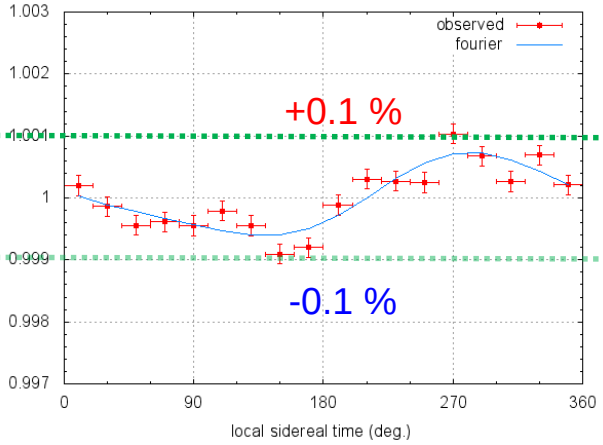
TibetAS

● : observed intensity
— : harmonics (n≤2)

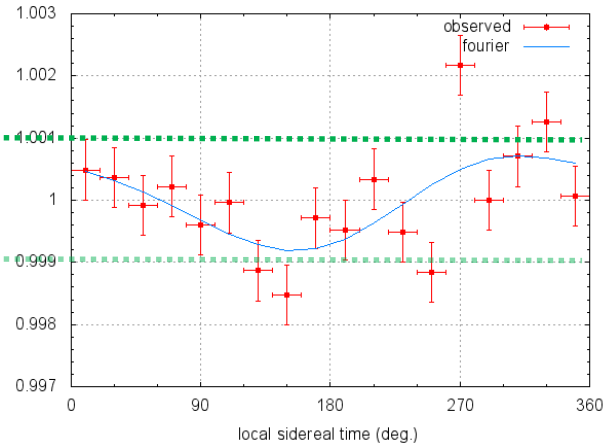
6.2 TeV



50 TeV

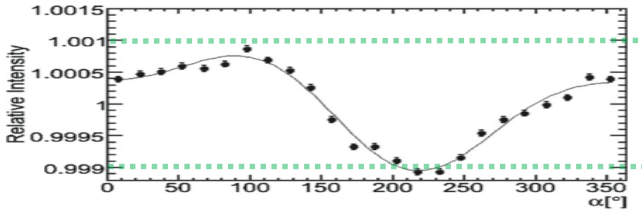


200 TeV



Ice Cube

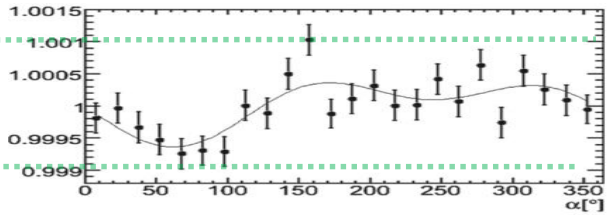
20 TeV



+0.1 %

-0.1 %

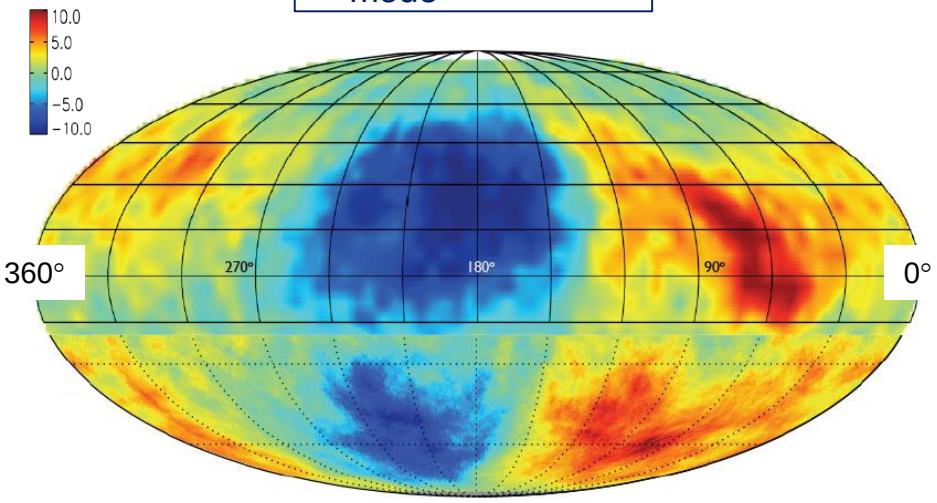
400 TeV



Energy dependence (3/3)

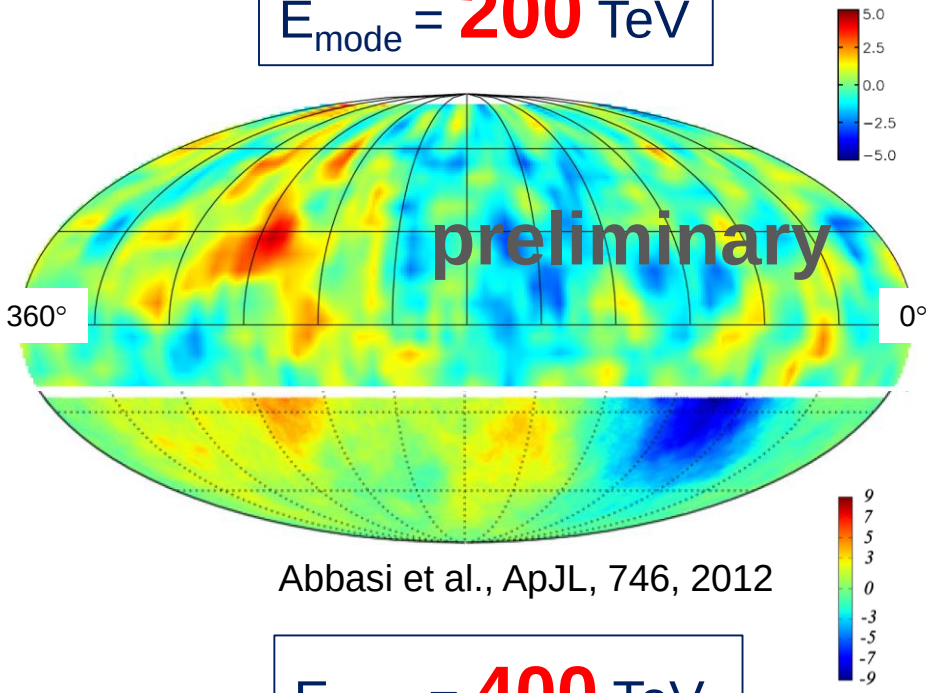
Tibet ASγ

E_{mode} = **7** TeV



E_{mode} = **20** TeV

E_{mode} = **200** TeV



Abbasi et al., ApJL, 746, 2012

E_{mode} = **400** TeV

Ice Cube

Summary

- GAs by Tibet & IceCube are consistent with each other in 5-20 TeV.
- IceCube recently reported GA at 400 TeV different from GA at 20 TeV.
- RA distribution (RAD) by Tibet at 200 TeV also looks different from RAD in 5-20 TeV (with 50 TeV data in between).
- RAD by Tibet at 200 TeV looks different from RAD by IceCube at 400 TeV.
- Analysis of two hemisphere data are now ongoing.

本共同研究へのご支援に感謝します。