Isotropic Cosmic Birefringence

And SO LAT Calibration

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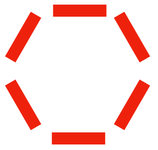
Axions ?

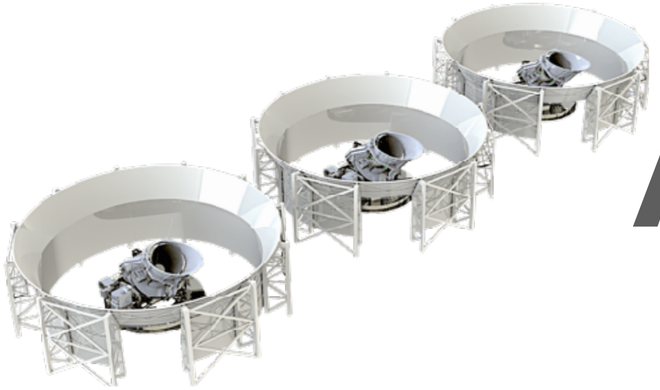
- Dark matter
- Dark energy

$$\mathscr{L} \supset -\frac{1}{2}\partial_\mu\phi\partial^\mu\phi - \frac{1}{4}F_{\mu\nu}F^{\mu\nu} + \frac{1}{4}g_{\gamma\phi}\phi F_{\mu\nu}\tilde{F}^{\mu\nu} - V(\phi)$$

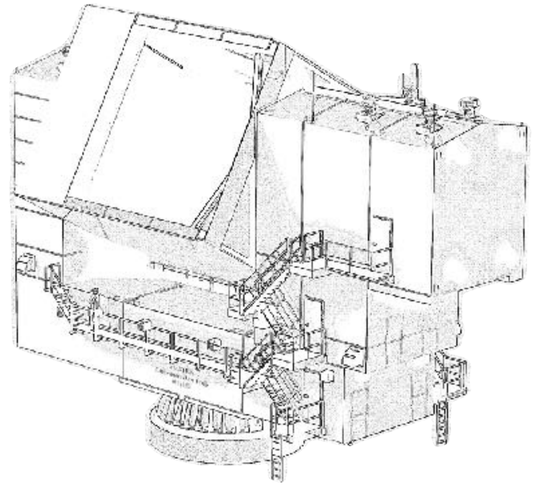
Chern-Simons coupling



Carroll, Field & Jackiw (1990)

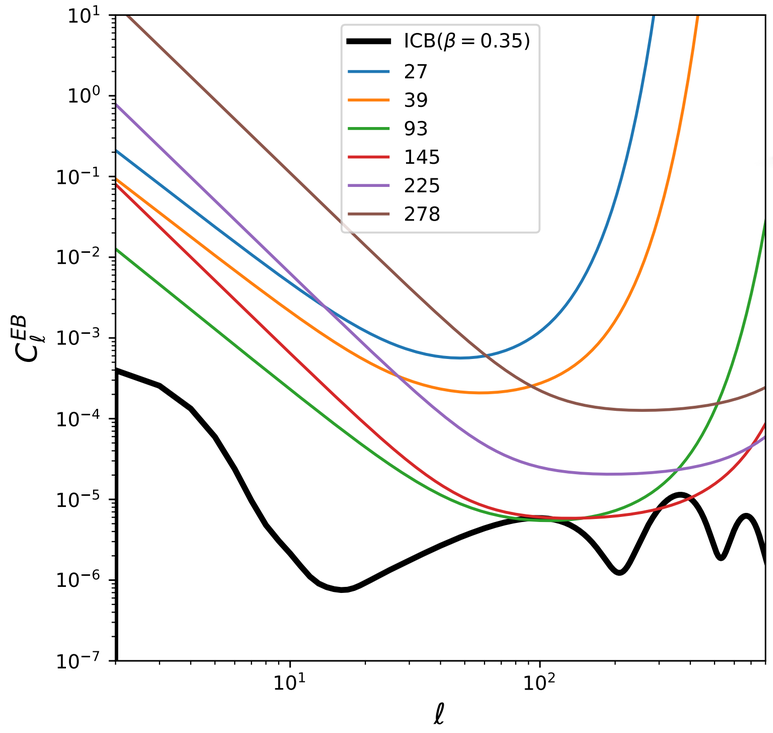


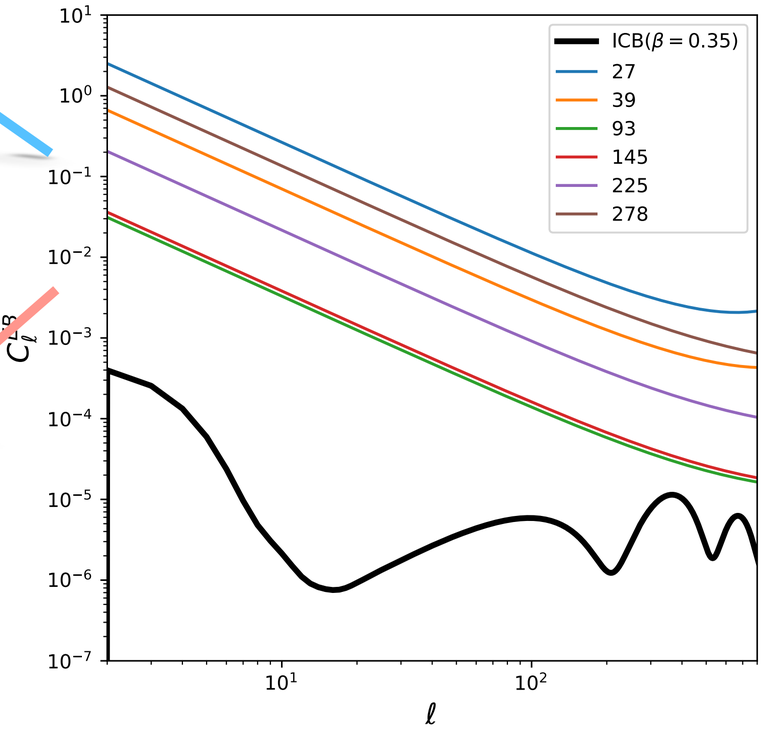
Analysis Pipelines



Method I

SAT Calib. LAT





Method II

Self Calibration

Minami-Komatsu

Simulation Suite

Isotropic CB angle $\beta = 0.35^{\circ}$

SO noise model 3.1.1
(5 years and 25% efficiency)

Dust(d10) and Synchrotron(s5)

Bandpass Integration

Mis calibration angle per tube

Mask: CO + PS + GAL 60%

$f_{sky} = 0.09$

SAT

$f_{sky} = 0.24$

LAT

Method I

Joint Likelihood - SAT & LAT

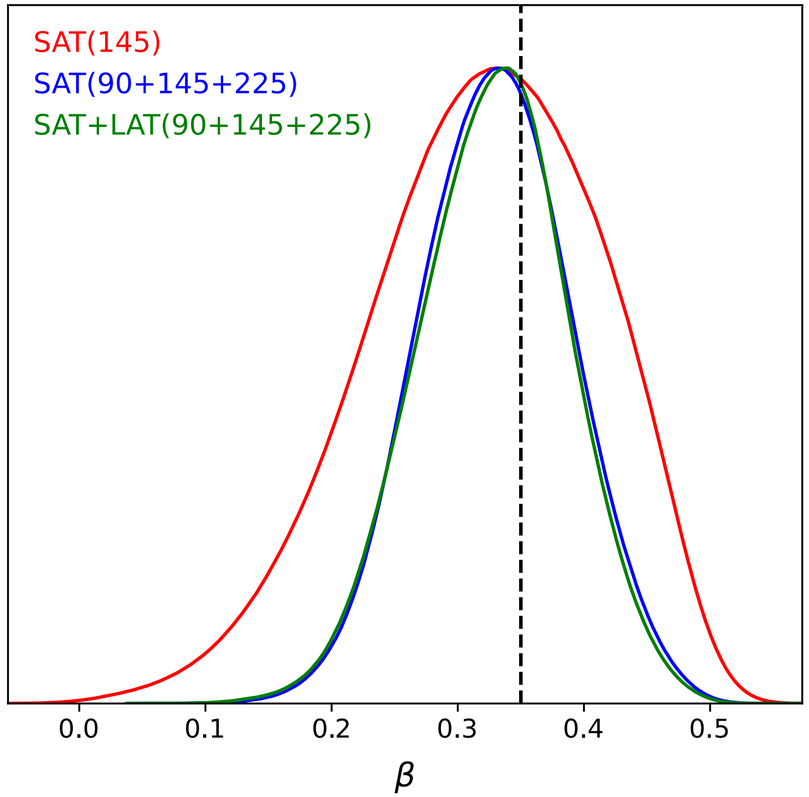
$$-2\ln\mathscr{L} = \chi^2_{\text{sat}} + \chi^2_{\text{lat}}$$

$$\chi^2_{\text{tele}} = \left(C_\ell^{EB,\text{obs}} - C_\ell^{EB,\text{theory}}\right)^T \Sigma^{-1}_{\text{tele}} \left(C_\ell^{EB,\text{obs}} - C_\ell^{EB,\text{theory}}\right)$$

$$\alpha_{\text{sat}} \sim \mathcal{N}\ [\mu, 0.1^\circ]$$

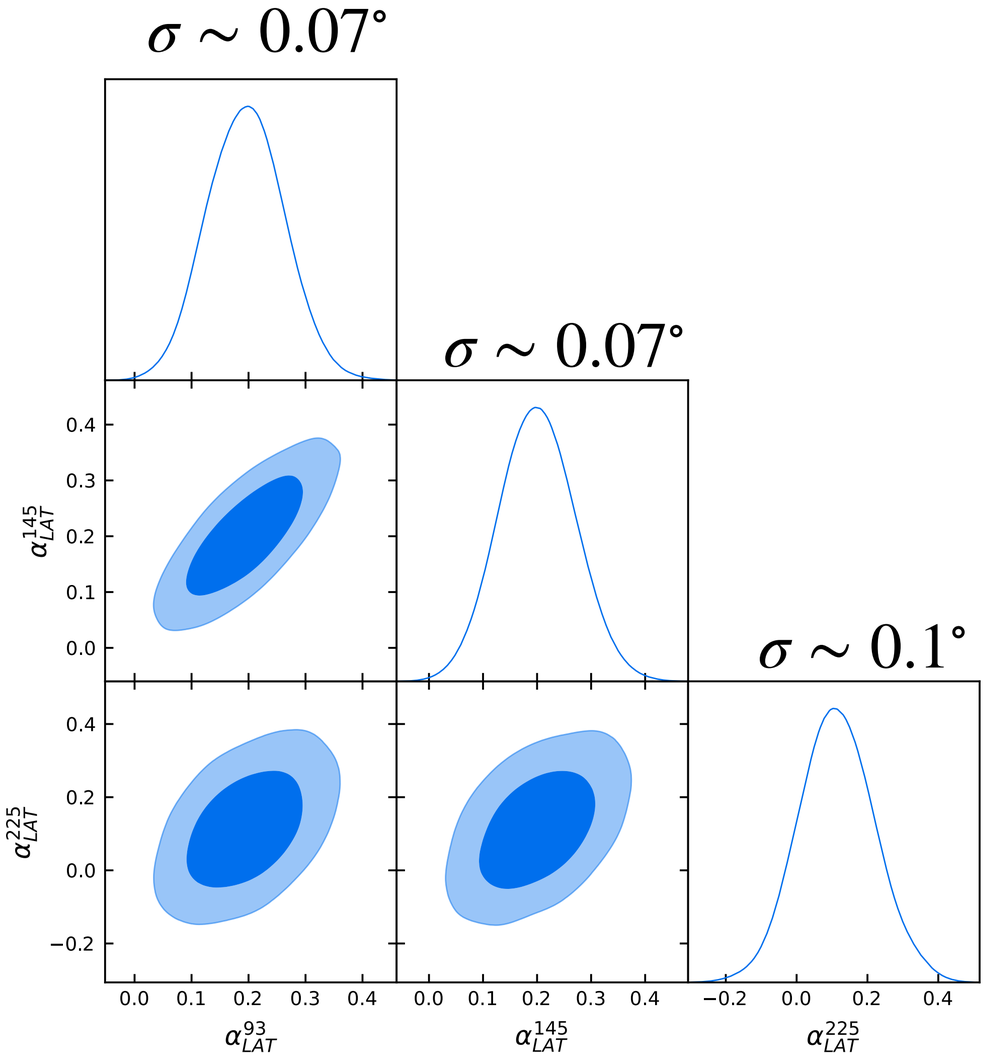
$$\alpha_{\text{lat}}, \beta \sim \mathcal{U}\ [-0.5^\circ, 0.5^\circ]$$

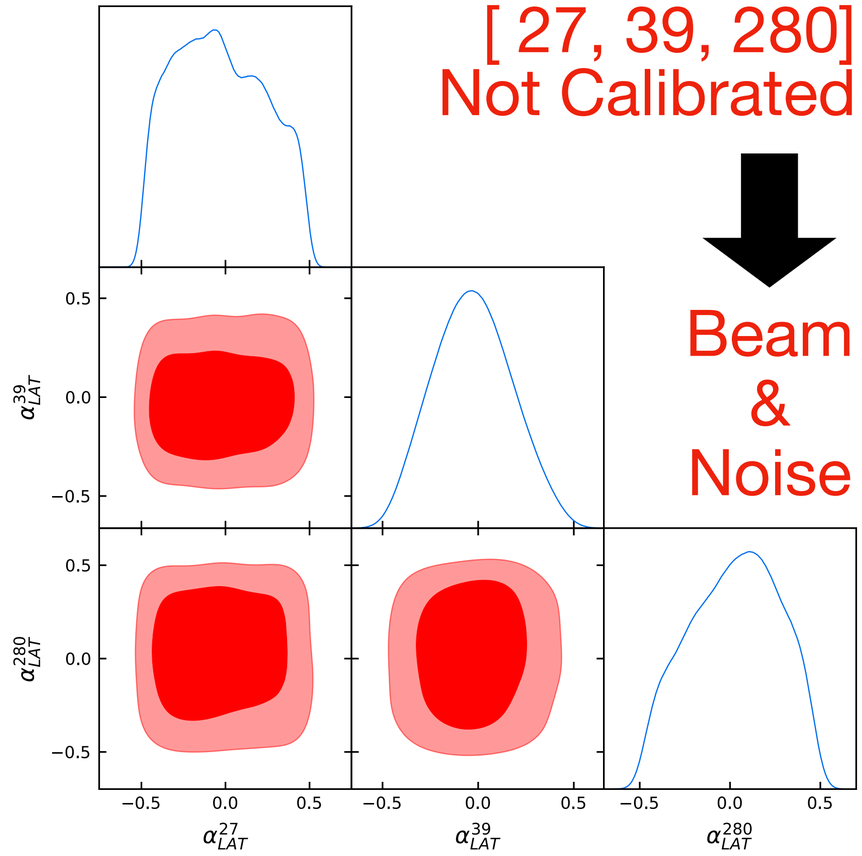
$0.33^{+0.1^\circ}_{-0.09^\circ}$ | $0.33 \pm 0.06^\circ$ | $0.34 \pm 0.06^\circ$



Method I

Calibrating LAT using SAT



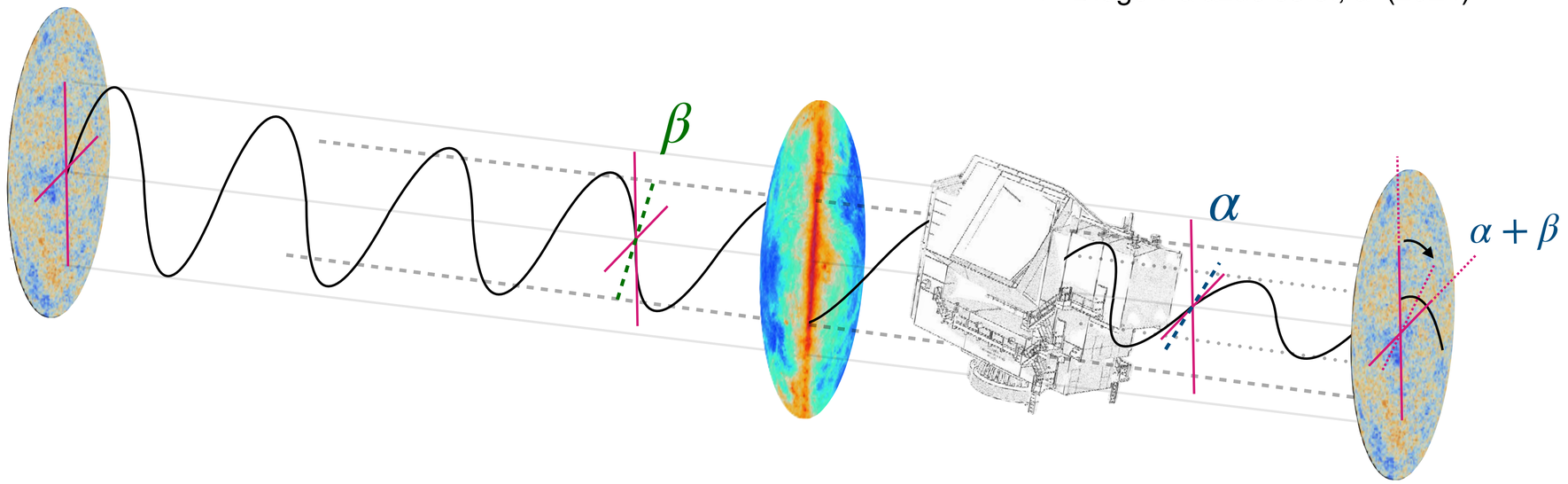


Method II

Self calibration - Minami Komatsu

$$C_\ell^{E_iB_j,\mathrm{obs}} \approx 2\alpha_j C_\ell^{E_iE_j,\mathrm{obs}} - 2\alpha_i C_\ell^{B_iB_j,\mathrm{obs}} + 2\beta\left(C_\ell^{E_iE_j,\mathrm{CMB}} - C_\ell^{B_iB_j,\mathrm{CMB}}\right)$$
$$+ \mathcal{A}_\mathrm{s} C_\ell^{E_iB_j,\mathrm{sync}} + \mathcal{A}_\mathrm{sd}\left(C_\ell^{E_i^\mathrm{sync}B_j^\mathrm{dust}} + C_\ell^{E_i^\mathrm{dust}B_j^\mathrm{sync}}\right) + \mathcal{A}_\mathrm{d} C_\ell^{E_iB_j,\mathrm{dust}}$$

P. Diego-Palazuelos et, al (2024)



Method II

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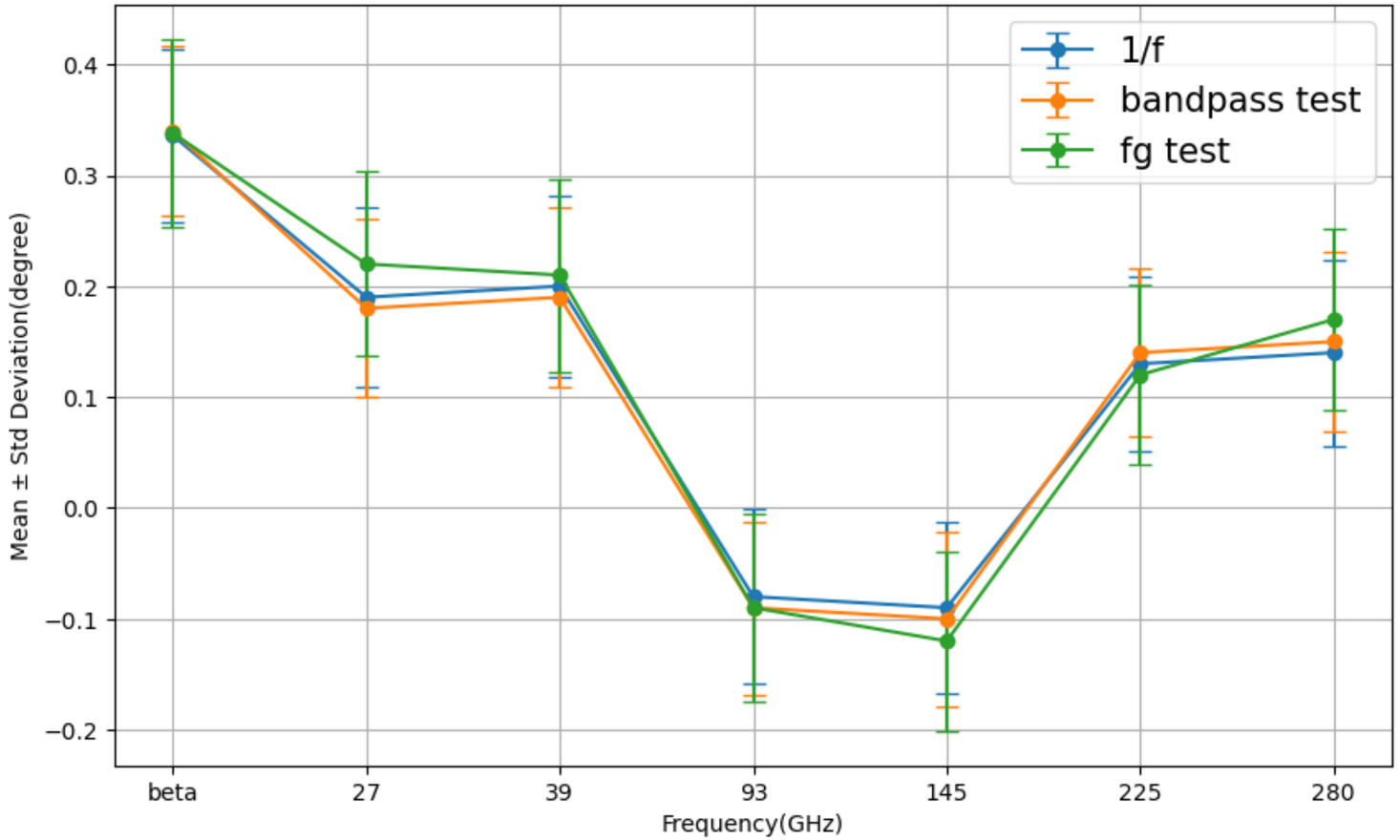

$$\sigma(\alpha) = \sigma(\beta) = 0.08^{\circ}$$

Summary and Future updates

	$\sigma(\beta)$	$\sigma(\alpha)$
Method I	0.06	0.07
Method II	0.08	0.08

Developing stage:

- SO simulation product - Noise
- Angle distribution - Mis calibration
- Include Non-null EB
- Tau A and Drone based calibration

30% - 40% increase in sensitivity compared to Planck