



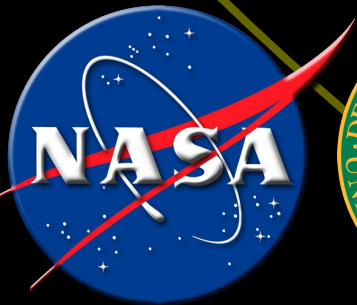
# Dark Photon Limits From Jupiter's Magnetic Field

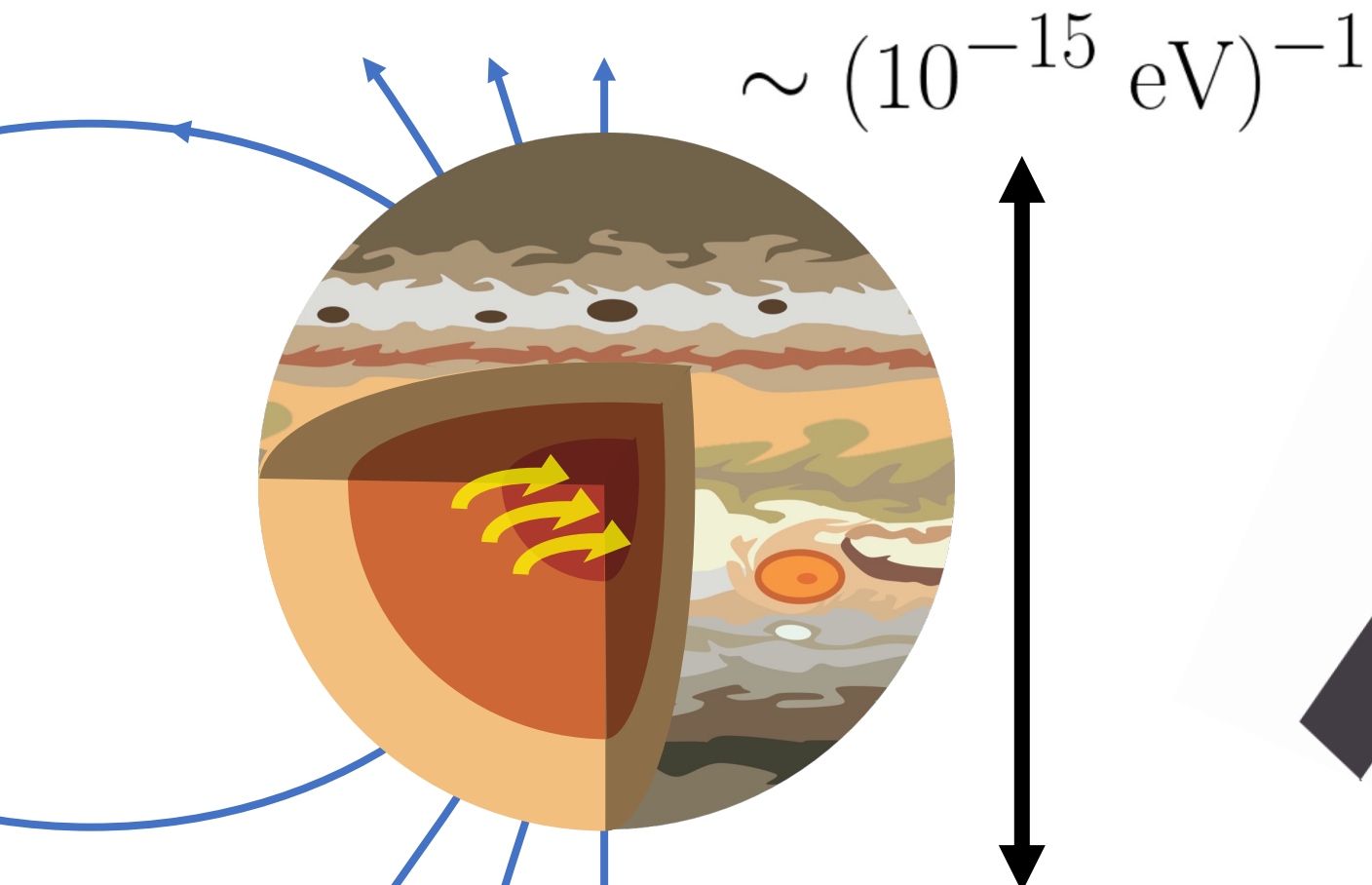
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June.28'st 2023

Cosmology from Home

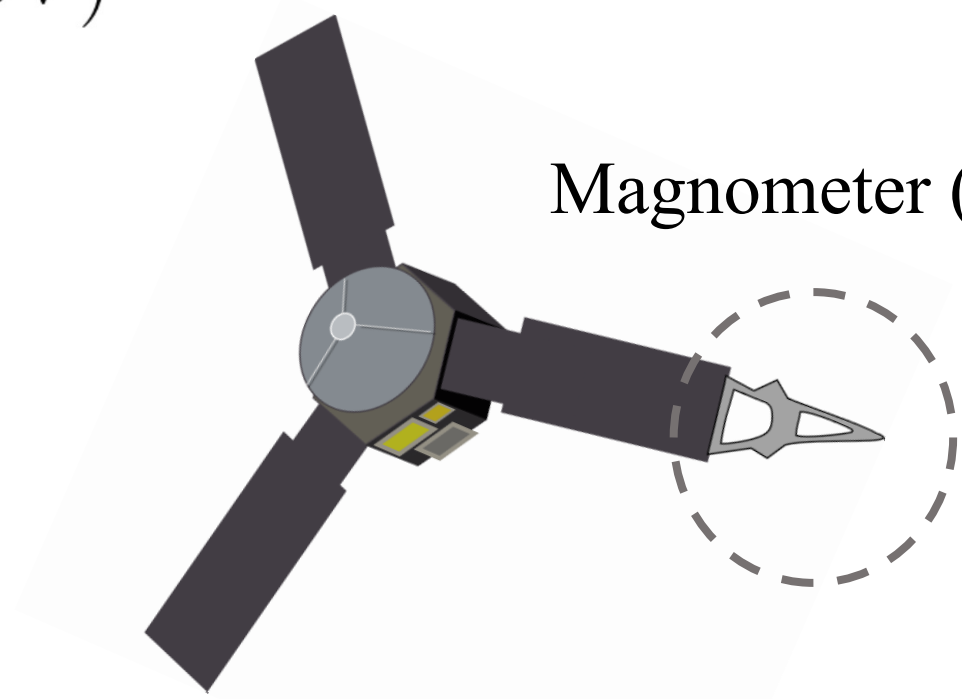
with Lingfeng Li and JiJi Fan





dynamo current  $\rightarrow$  (dark) B field

$$\Delta B_{dark} \propto \epsilon^2 e^{-mr}$$



Magnometer (MAG)

**Juno Mission**  
**(2011-)**

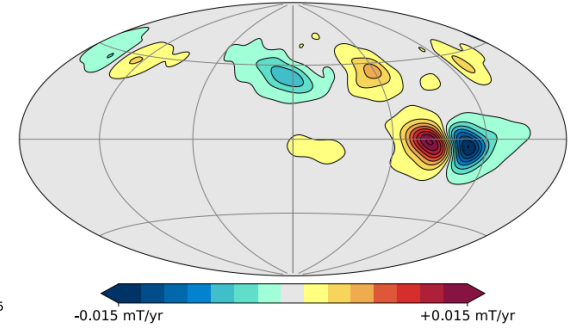
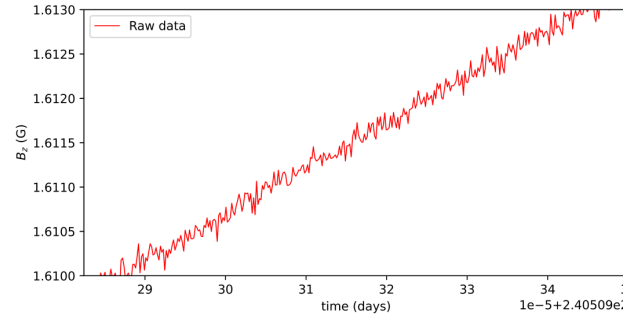


# Improvement 1 Quality of Data

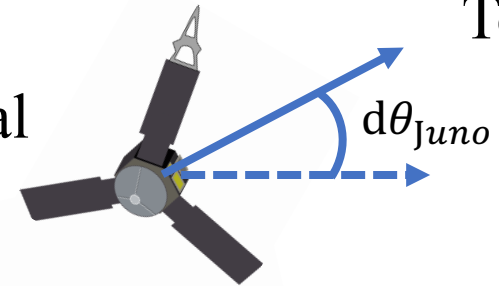
Pioneer 10  $\rightarrow$   $\sim 100$  One trajectory only

Juno  $> 10000$  from  $\sim 40$  trajectories

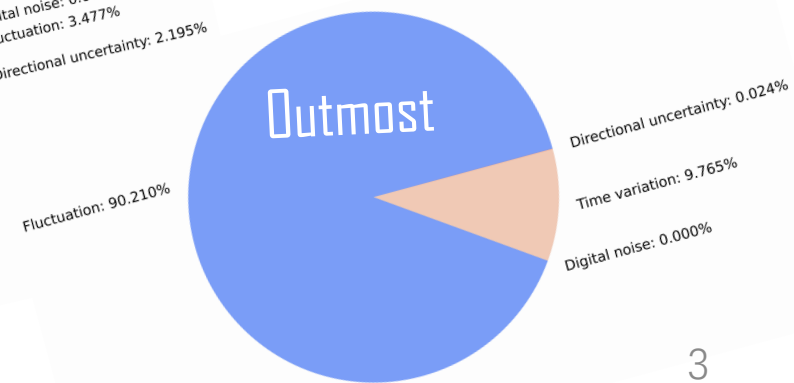
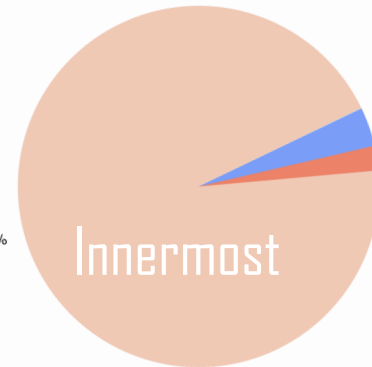
## Proper Statistic Components of Errors:



Directional



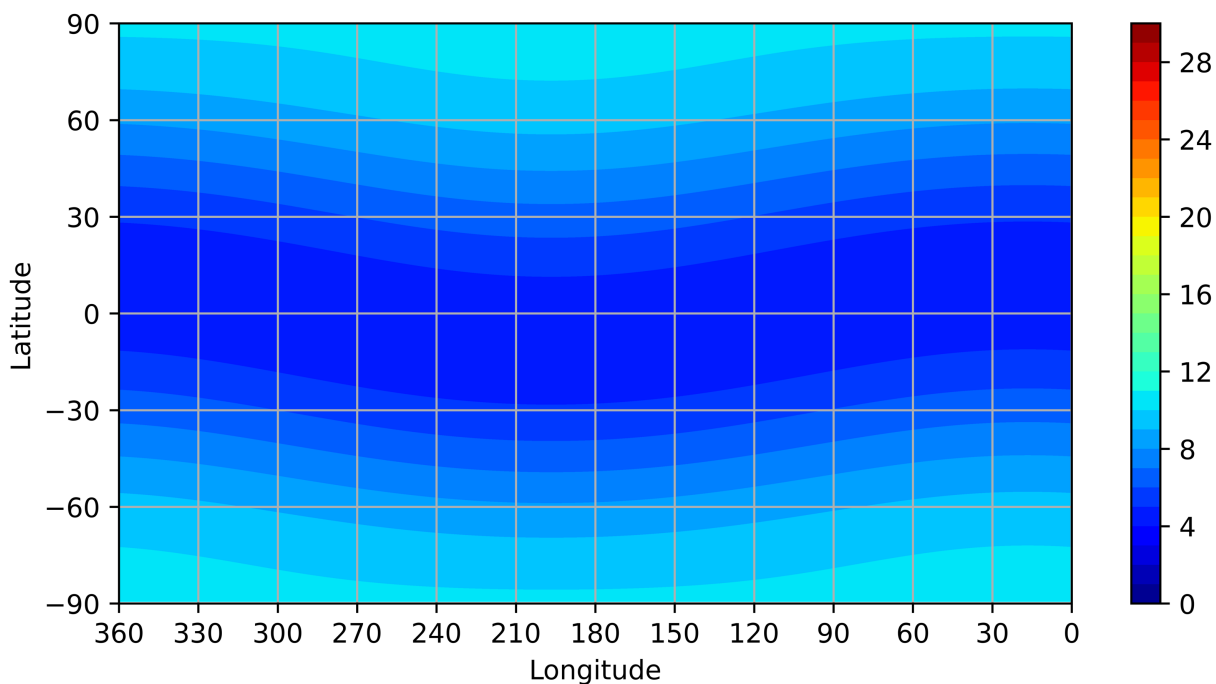
Temporial



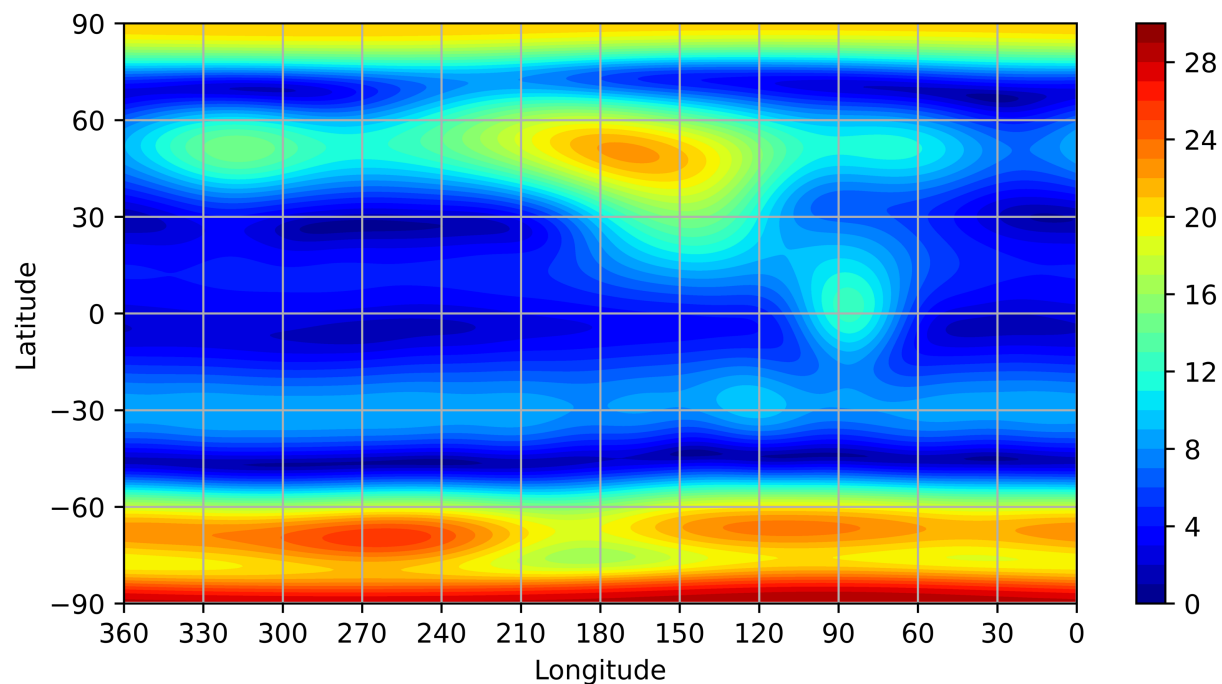
# Improvement 2

## Higher order multipoles:

Dipole with  $l_{max} = 1$

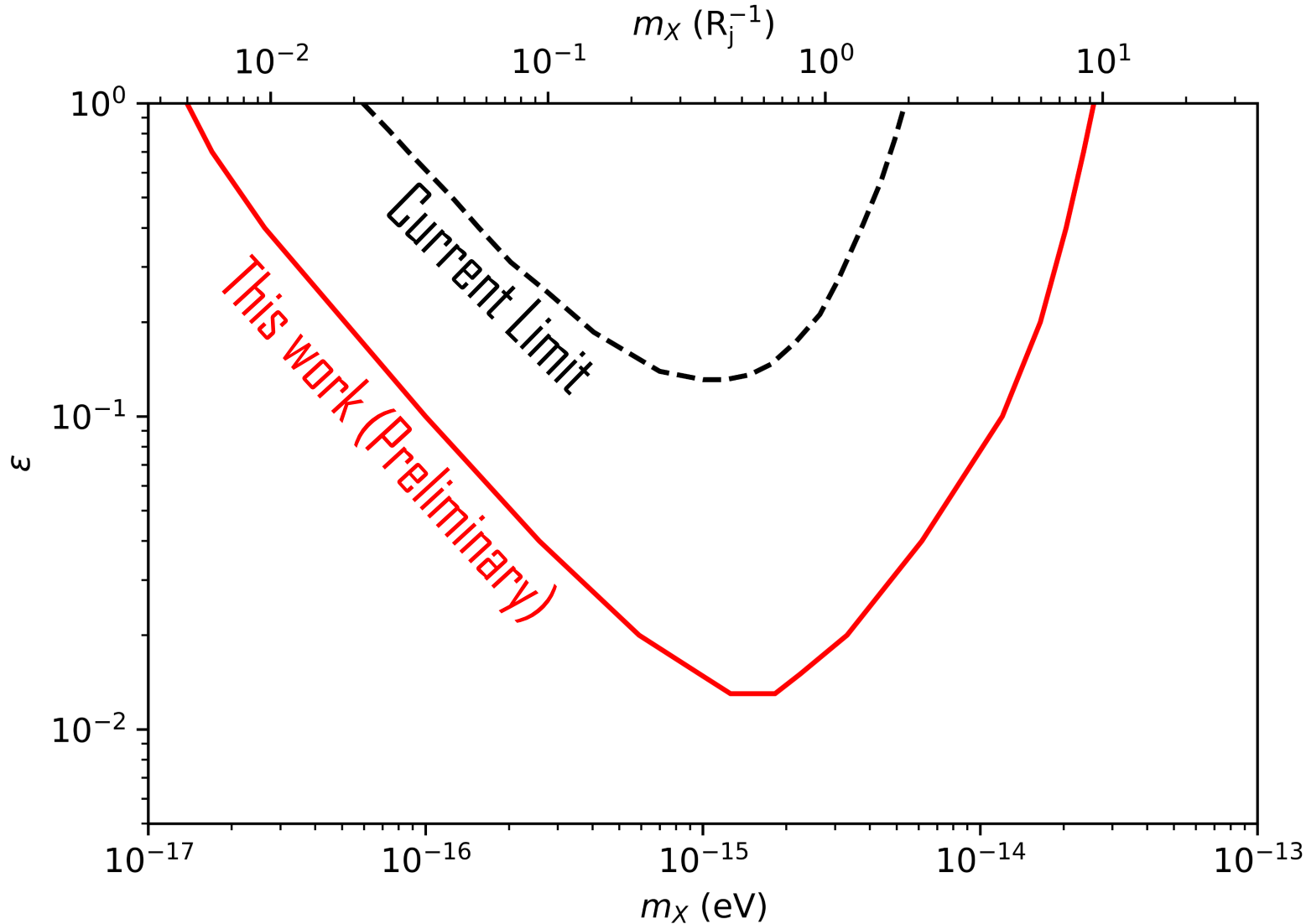


Multipole with  $l_{max} = 24$



### Magnetic Field on the Jupiter's Surface

# Preliminary Constraint



Also puts a photon mass constraint:

Pioneer 1975:

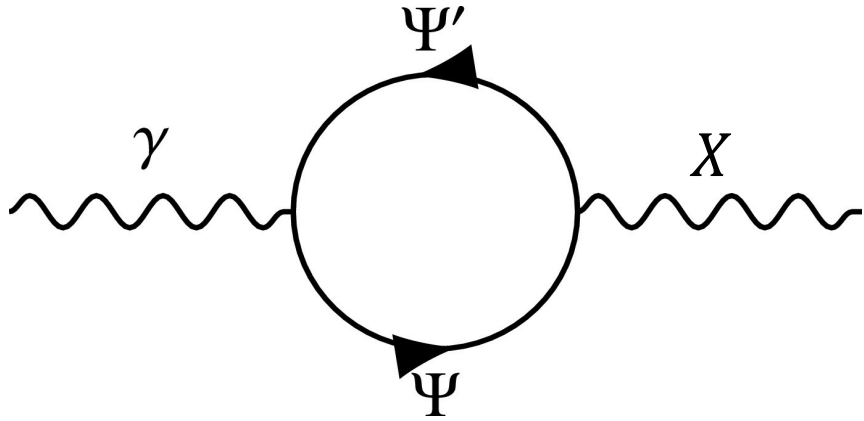
$$m_\gamma \leq 10^{-15.2} \text{ eV}$$

**Our Preliminary Result:**

$$m_\gamma \leq 10^{-17} \text{ eV}$$

# Back Up Slides

# How Dark Photon Interacting with SM



The kinetic mixing of the SM photon with a dark photon  $X$  at the one-loop level.

For a review, [Filippi, A., & De N, M. \(2020\). 2006.04640](#)

The low-energy effective Lagrangian due to the presence of dark photon

$$\mathcal{L} \supset -\frac{1}{4} F^{\mu\nu} F_{\mu\nu} - \frac{1}{4} X^{\mu\nu} X_{\mu\nu} + \frac{\varepsilon}{2} F^{\mu\nu} X_{\mu\nu} + \frac{m_X^2 \sqrt{1 - \varepsilon^2}}{2} X^\mu X_\mu$$

# Error Proportions

