THE ROLE OF COROTATION ENFORCEMENT CURRENTS IN DRIVING THE BEHAVIOR OF JUPITER'S ULTRAVIOLET MAIN EMISSION: INITIAL RESULTS

Matthew J. Rutala[1] & John T. Clarke[1]
[1]Center for Space Physics, Boston University
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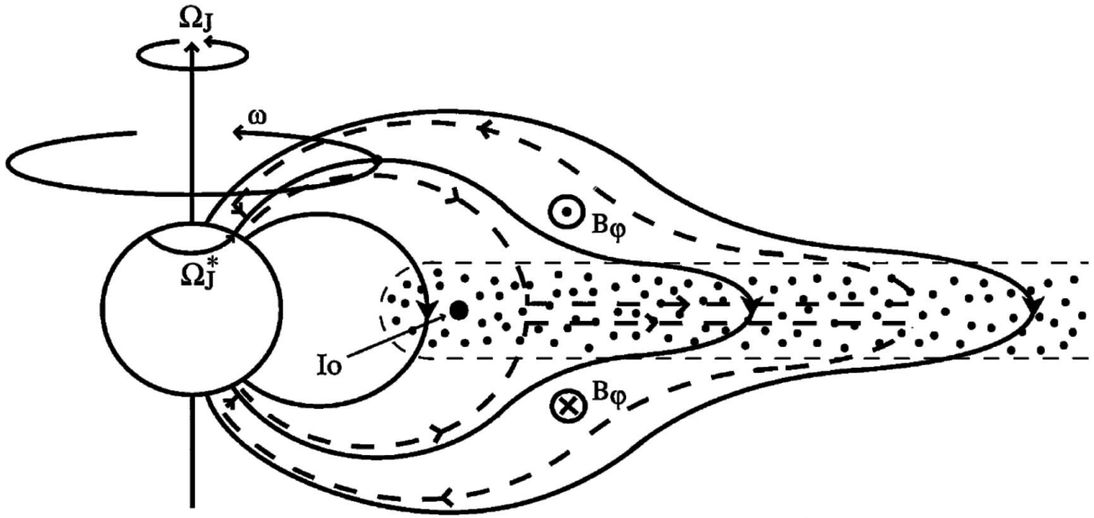
BACKGROUND + MOTIVATION

- Main emission classically driven by field-aligned corotation-enforcement currents (e.g. Hill 2001, Cowley + Bunce 2001, Southwood + Kivelson 2001)
  - Field-aligned currents enforce the corotation of magnetospheric plasma
  - Aurorae associated with downward electron flux from upward ionospheric currents
- Not apparent in *Juno* data to date
  - Bidirectional electron flux (Mauk + 2018)
  - Fragmented currents (Bonfond + 2020)
- Where are corotation-enforcement currents the dominant driver of the main emission?



From Cowley + Bunce 2001

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SCIENCE QUESTIONS

- Where do the properties of Jupiter's main emission correlate with the predictions of corotation-enforcement theory?
  - Can we measure auroral properties accurately enough to answer this?
  - What correlations are expected?
    - $I_{||} = 4\Sigma_P^*(\Omega_J - \omega)F_e$ (Cowley + Bunce 2001)
      - $I_{||} \propto (\Omega_J - \omega)$
        - » Auroral intensity ∝ - plasma velocity
      - $\frac{d}{dt} I_{||} \propto \frac{d}{dt}(\Omega_J - \omega)$
        - » Auroral velocity ∝ - plasma acceleration

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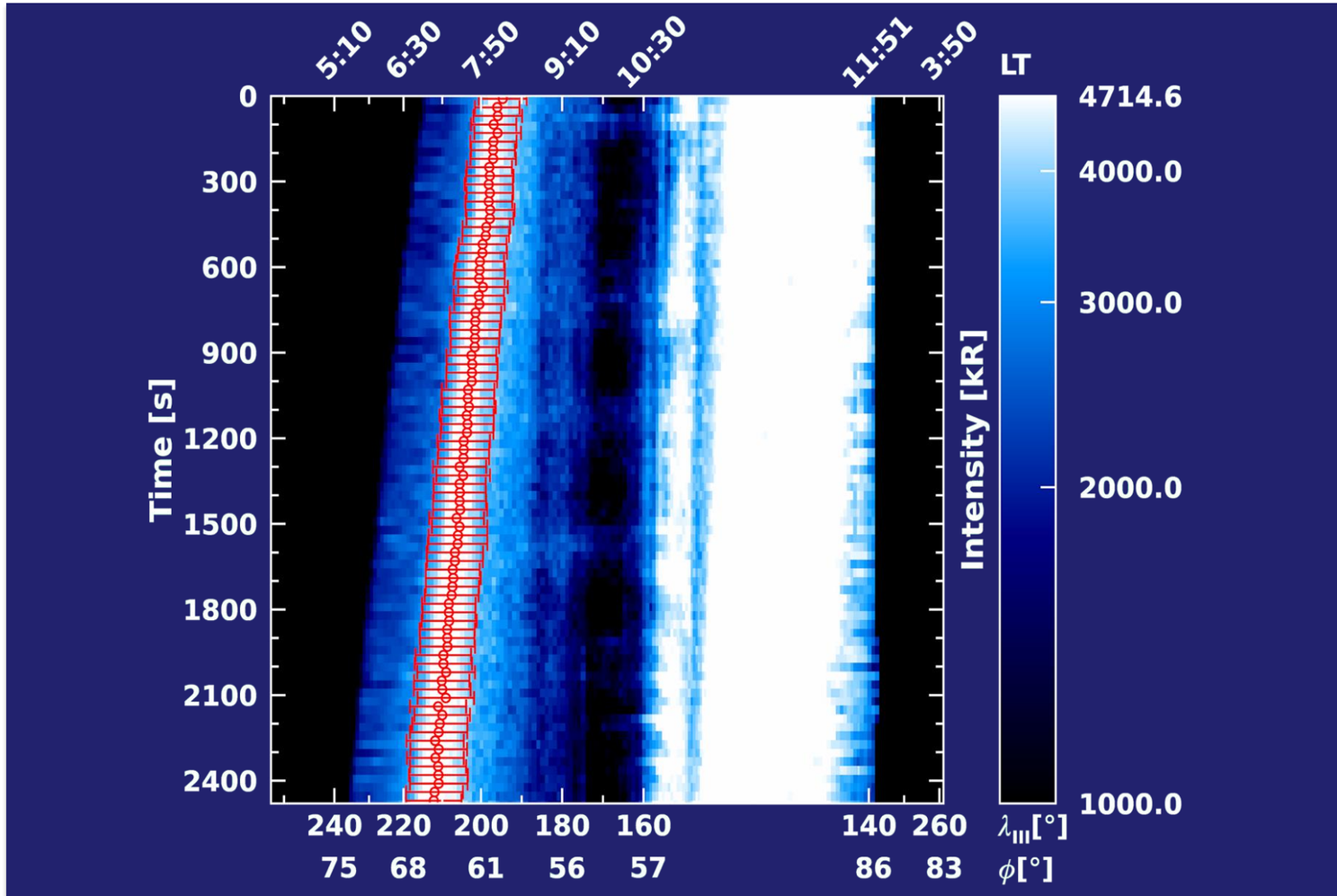
HST AURORAL SURVEY

- Gathered 200+ cumulative hours of HST exposure
- Auroral intensity and position have been used extensively
  - Auroral motion is less often measured
  - But, auroral motion is a useful metric
- Developed a way to measure auroral motion precisely and accurately

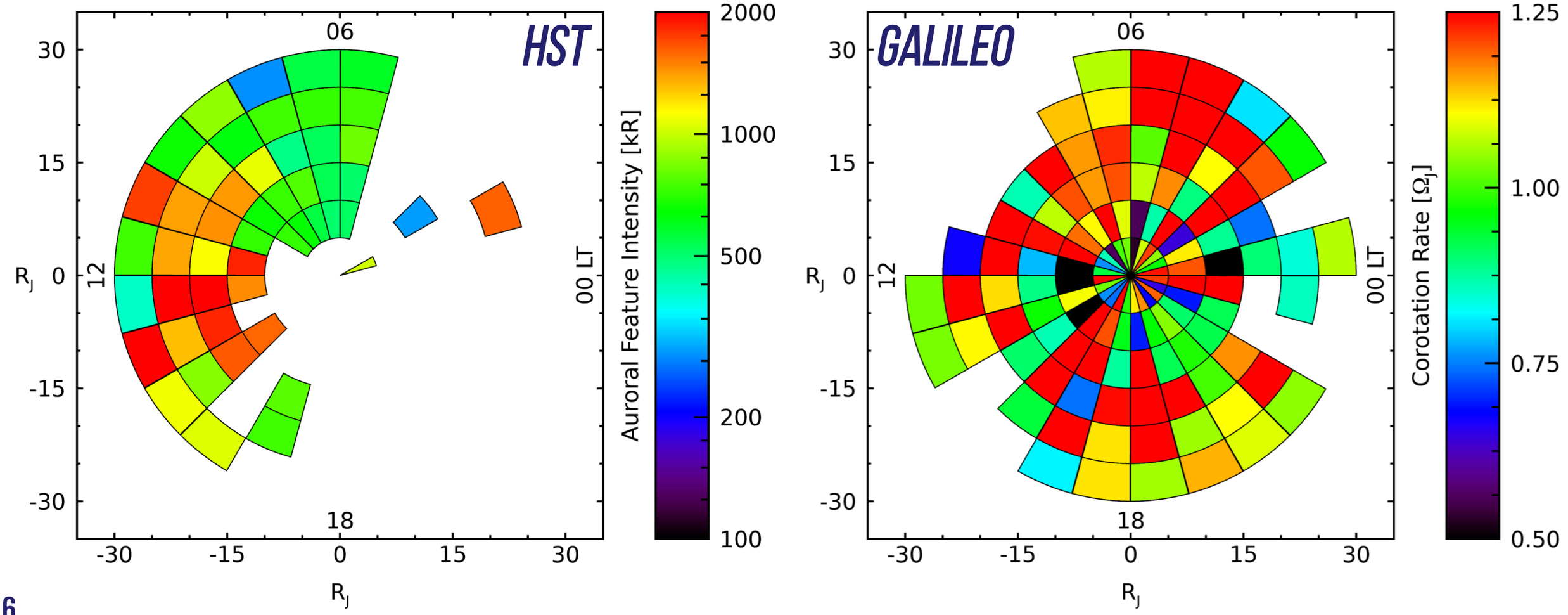
HST GO Program	Start	End	Cumulative Exposure [hours]
10862	Feb. 20, 2007	June 11, 2007	42
14105	May 16, 2016	July 18, 2016	35
14634	Nov. 30, 2016	May 23, 2018	101
15638	Feb. 9, 2019	Sep. 13, 2019	36
Totals			204

FEATURE IDENTIFICATION

- ~800 discrete auroral features detected
- Discrete features identified as:
  - Local brightness maxima 10+% brighter than neighboring points within the same exposure
  - Maxima clustered based on hierarchical density clustering (DBSCAN)
  - Resulting clusters required to span at least 50% of the exposure

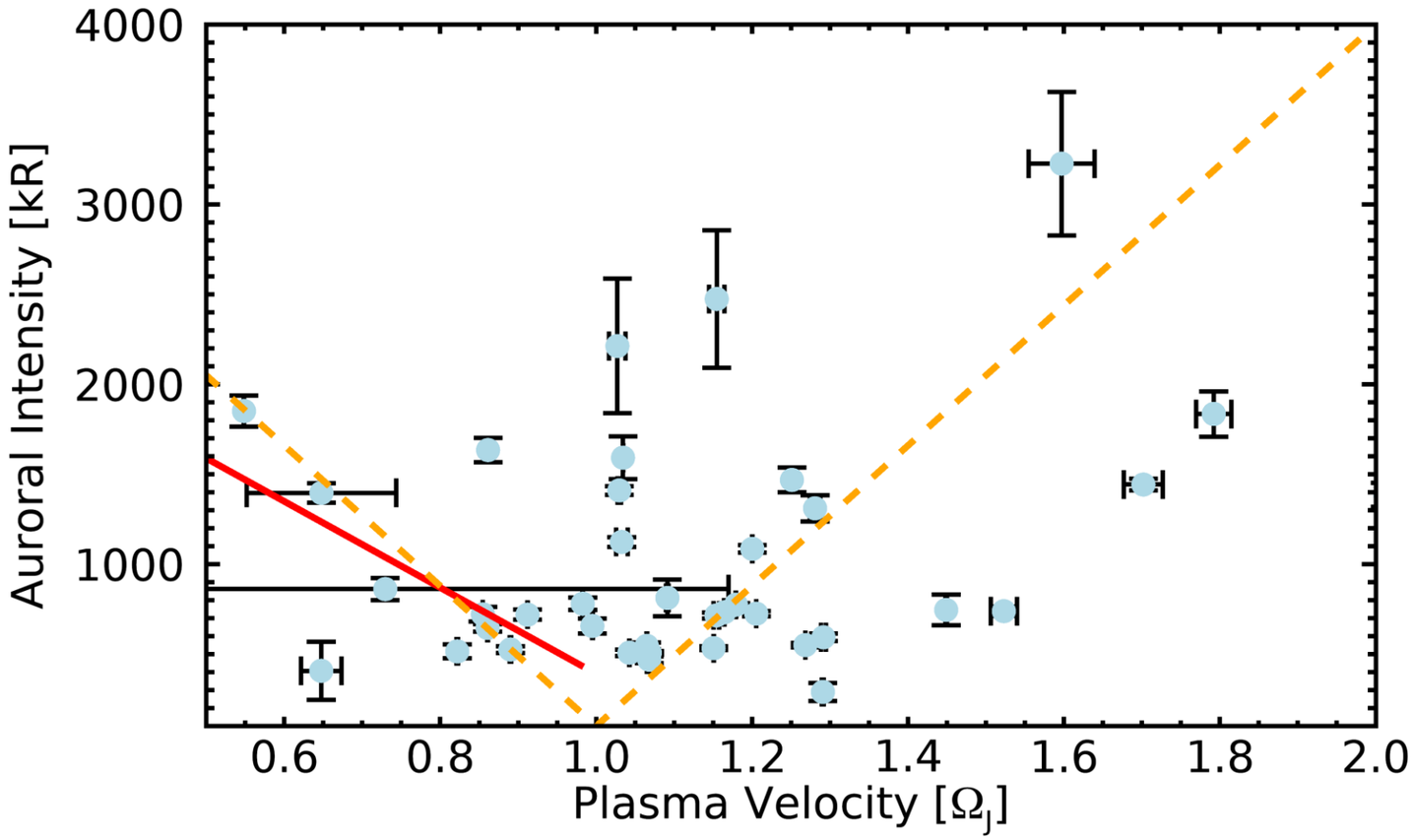


AURORAL INTENSITY VS. PLASMA VELOCITY

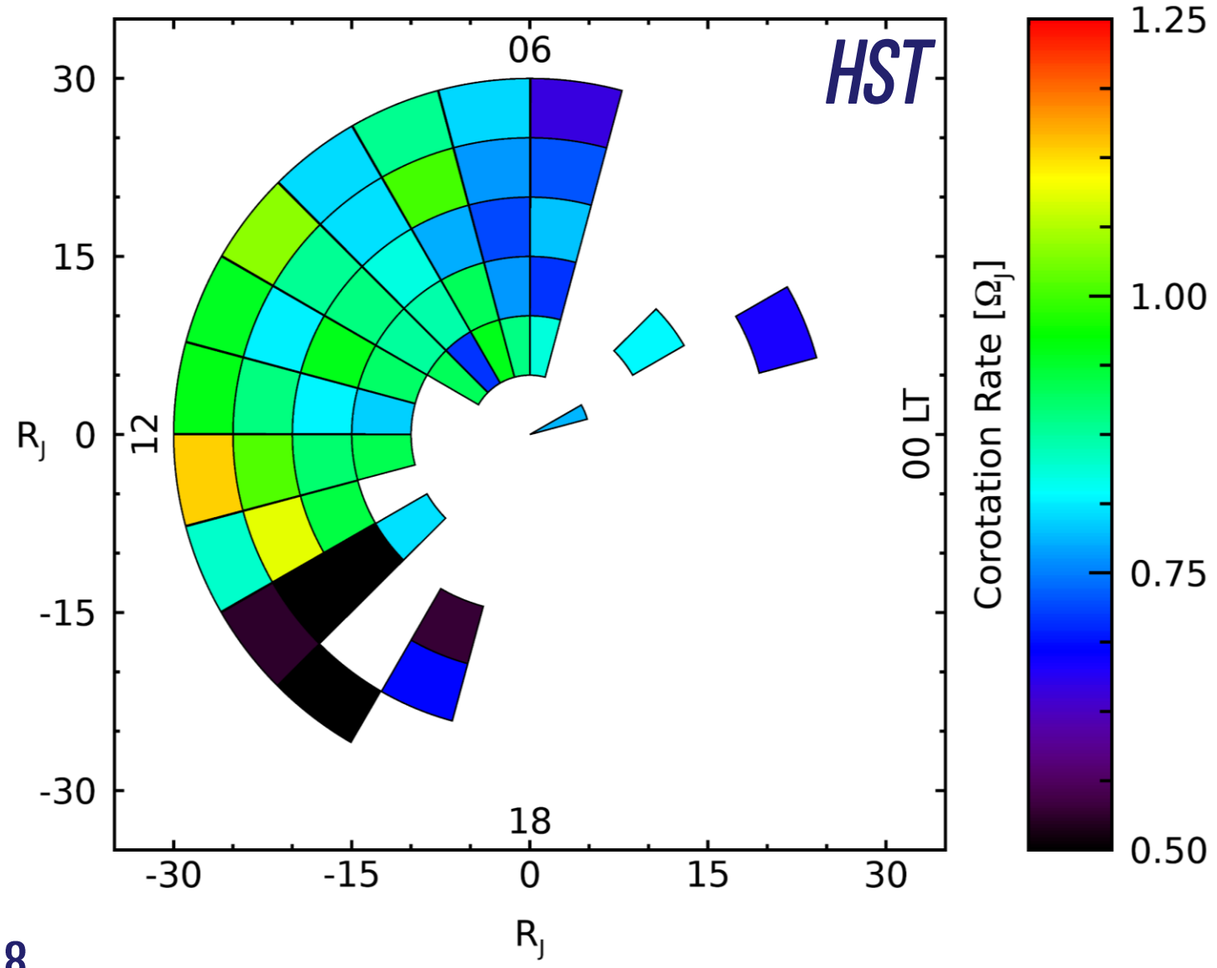


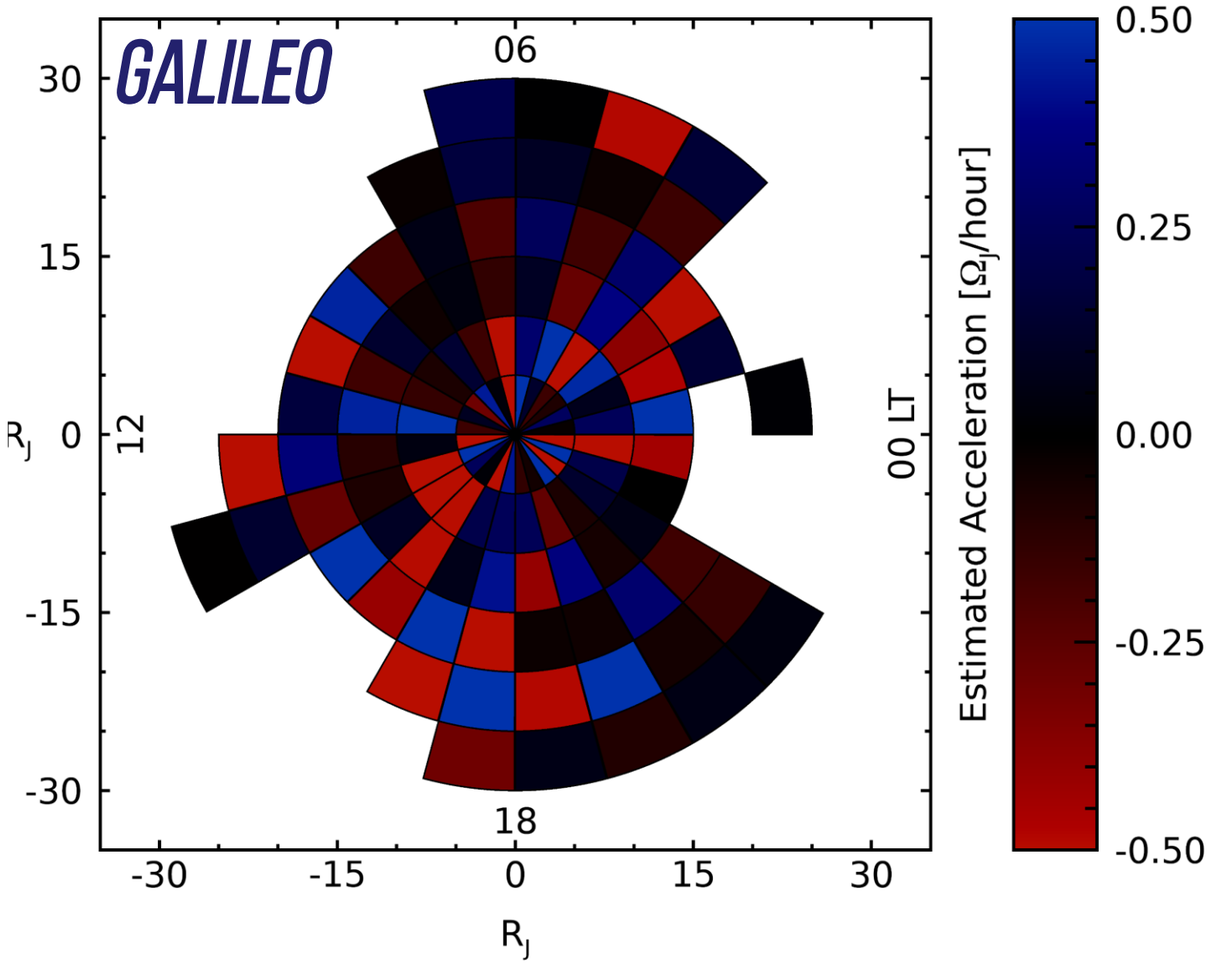
HST AURORAL INTENSITY VS. GALILEO PLASMA VELOCITY

- Auroral intensity ∝ negative plasma velocity
  - $I_{||} \propto (|\Omega_J - \omega|)$ 1:1 in orange
  - Measured fit in red
- Measurements generally consistent with expectations
  - Spread may be due to Σ_P^* or F_e, or non-FAC effects



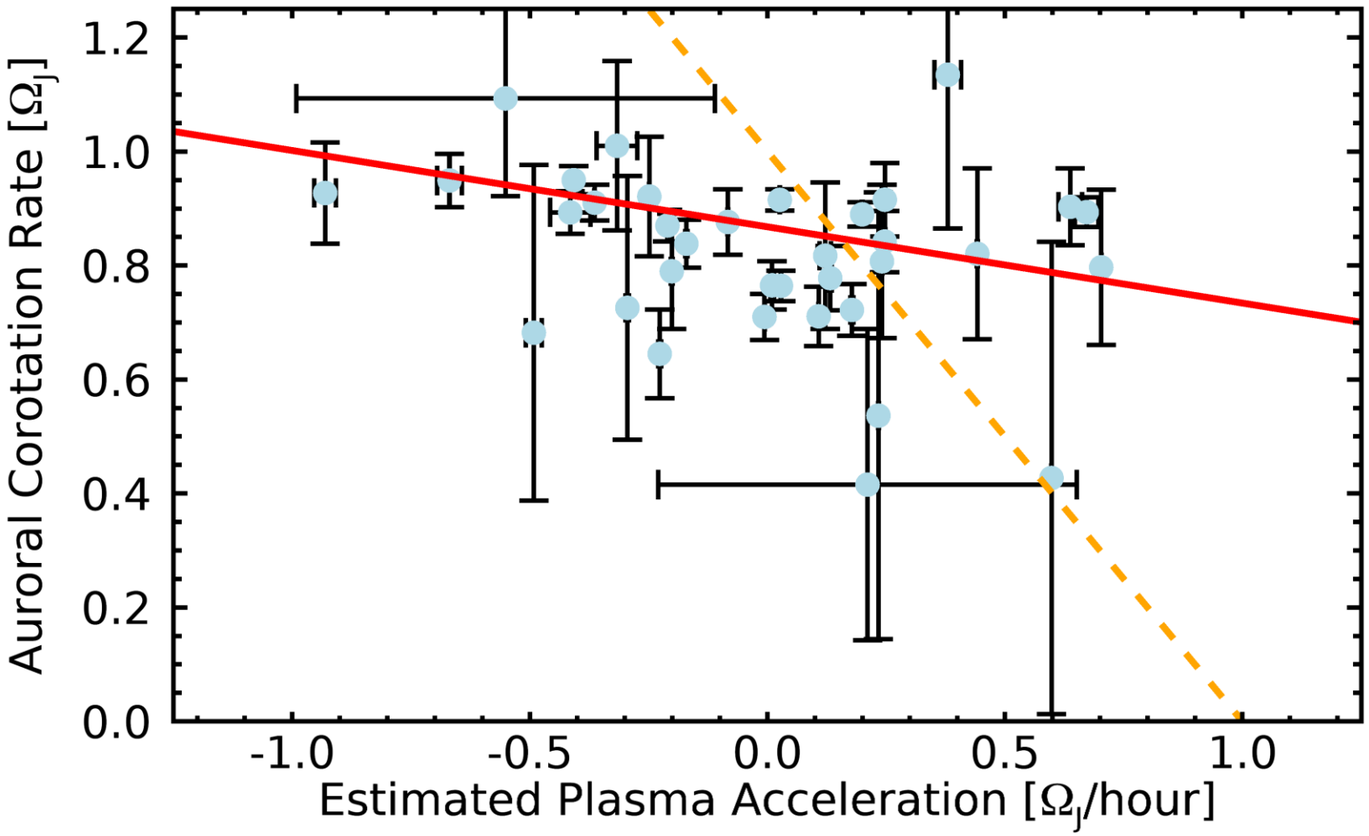
AURORAL MOTION VS. PLASMA ACCELERATION





HST AURORAL MOTION VS. GALILEO PLASMA ACCELERATION

- Auroral motion ∝ negative plasma acceleration
  - $\frac{d}{dt} I_{||} \propto \frac{d}{dt}(\Omega_J - \omega)$ 1:1 in orange
  - Measured fit in red
- Recover the negative proportionality



CONCLUSIONS

- Measurement of auroral velocities to better precision and for more features allows useful new statistics to be looked at
- Initial results comparing HST aurorae statistics and Galileo in-situ statistics are generally consistent with corotation-enforcement theory
  - Auroral intensity ∝ - plasma velocity $\left(I_{||} \propto (\Omega_J - \omega)\right)$
  - Auroral velocity ∝ - plasma acceleration $\left(\frac{d}{dt} I_{||} \propto \frac{d}{dt}(\Omega_J - \omega)\right)$
  - Many outliers
- Planned addition of *Juno* JADE data will drastically enhance plasma statistics in the dawn-midnight sectors
  - Aim is to increase resolution enough to find where the data matches corotation-enforcement theory and where other drivers dominate

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THANK YOU

Contact the author at:

mrutala@bu.edu
mjrutala@github.io

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