Tracking bright points with shape-resolved observations

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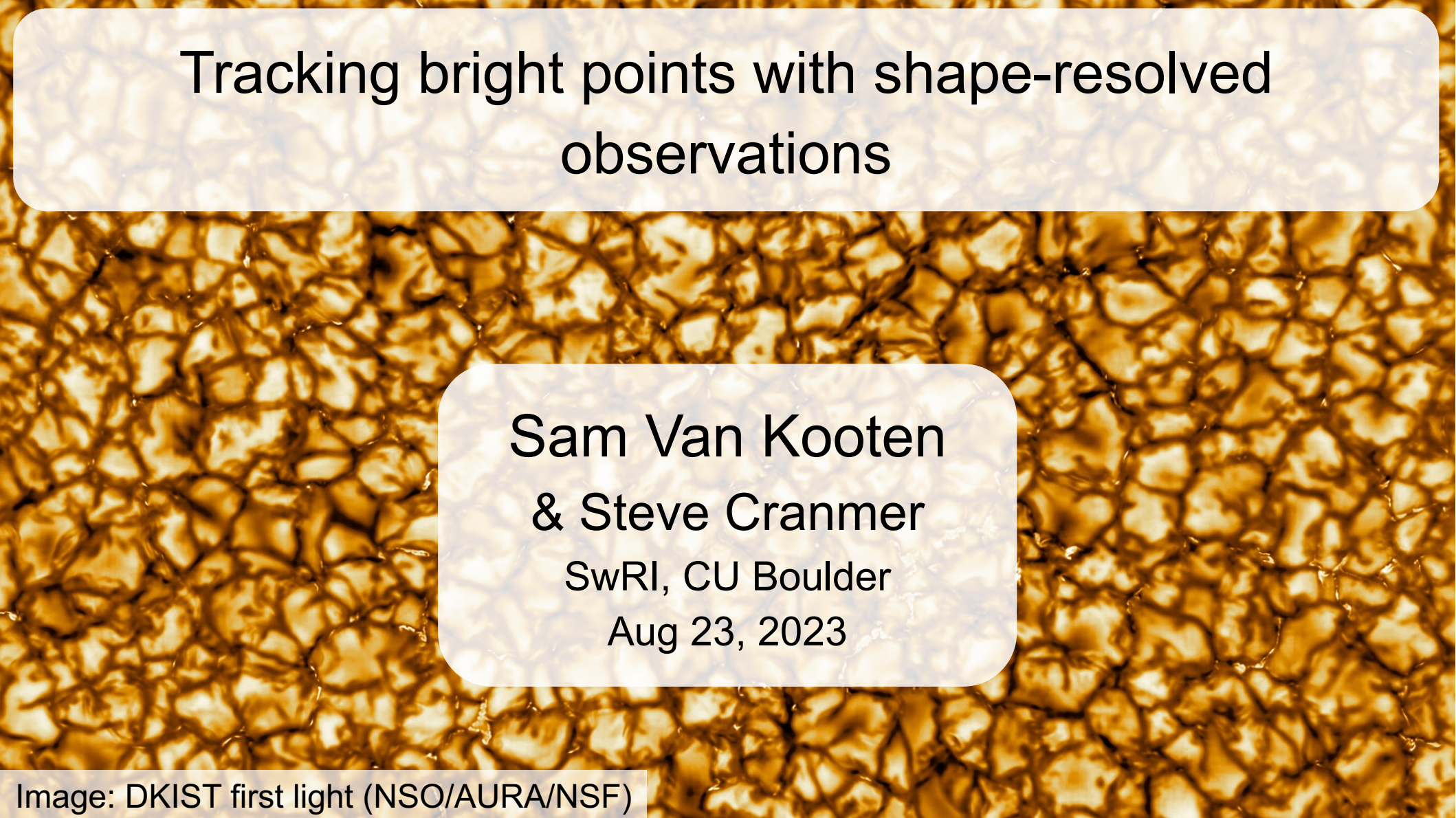
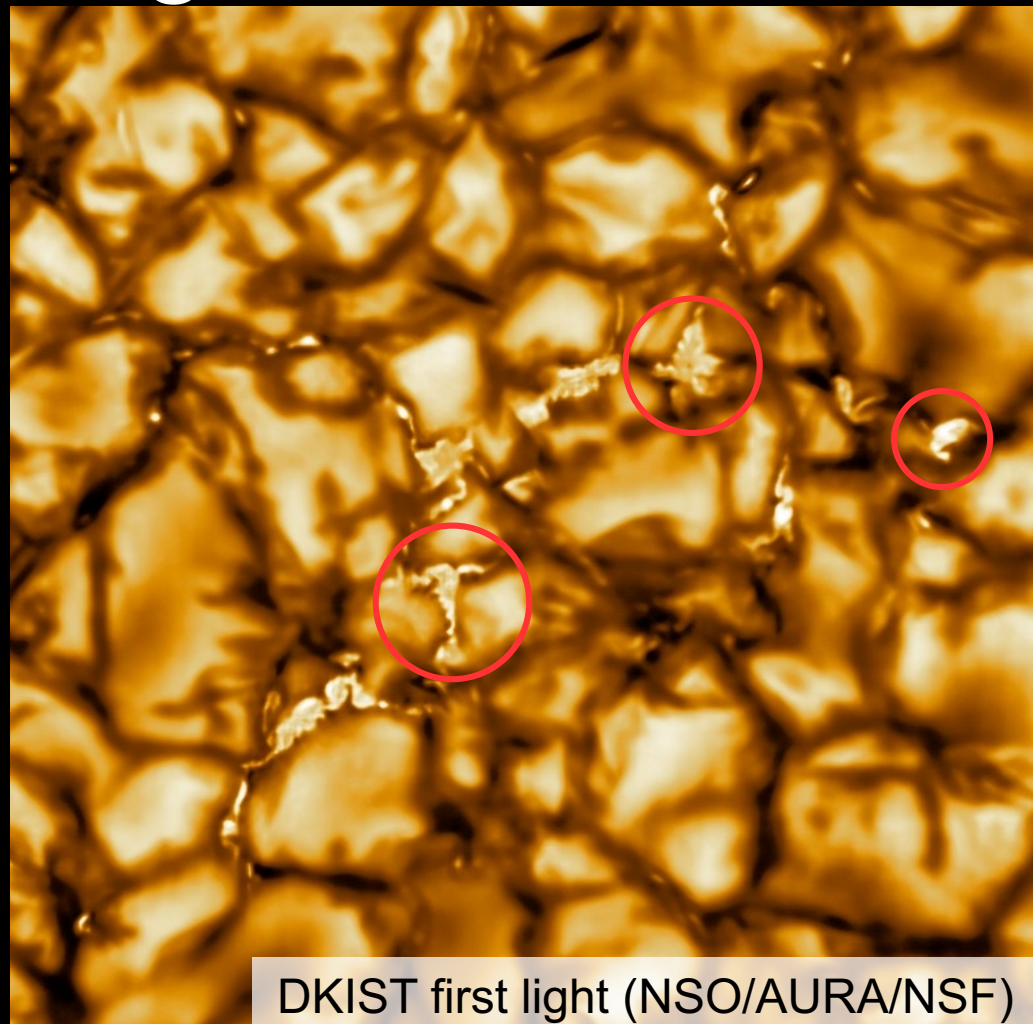


Image: DKIST first light (NSO/AURA/NSF)

Photospheric Bright Points

- ~ 100 km across
- Magnetic field: 1000 Gauss
  - ~1000 × average solar field
  - ~2000 × average Earth field
- Bases of magnetic flux tubes
  - Or observational proxy for those bases



DKIST first light (NSO/AURA/NSF)

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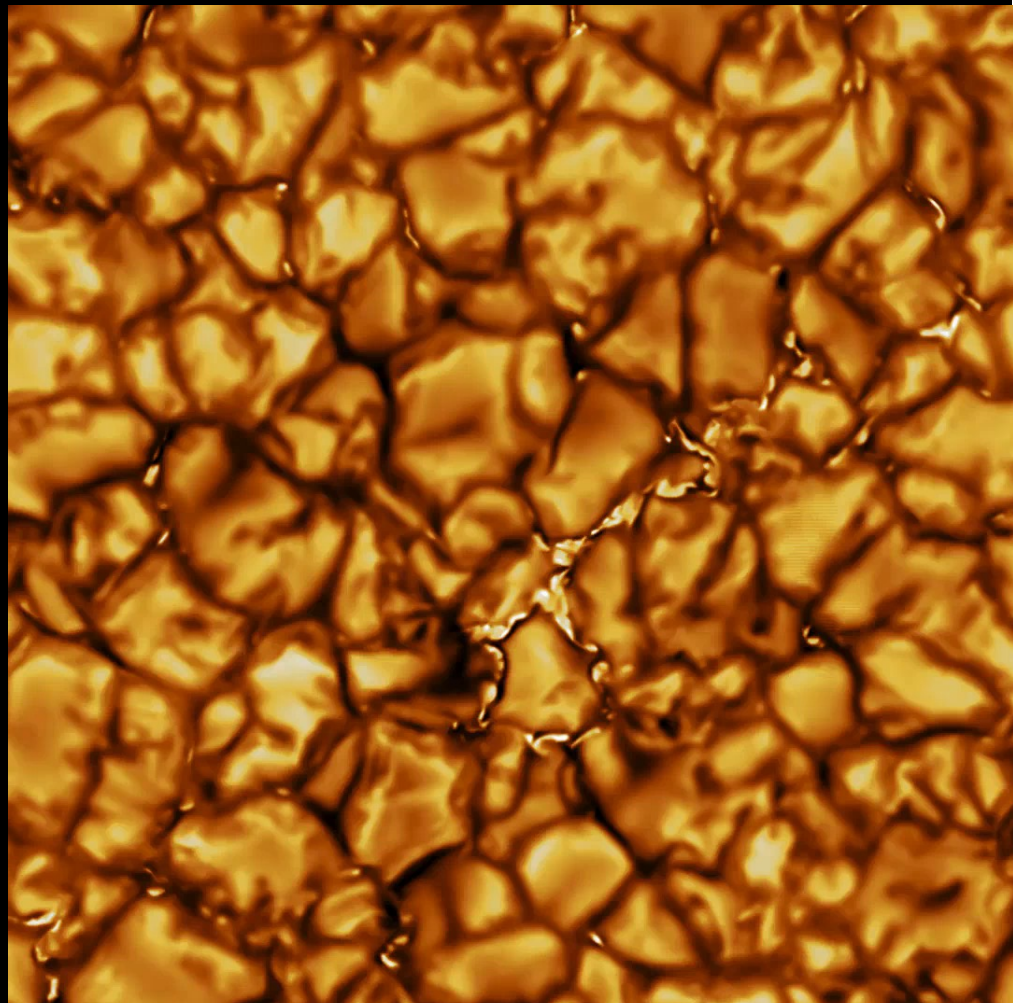
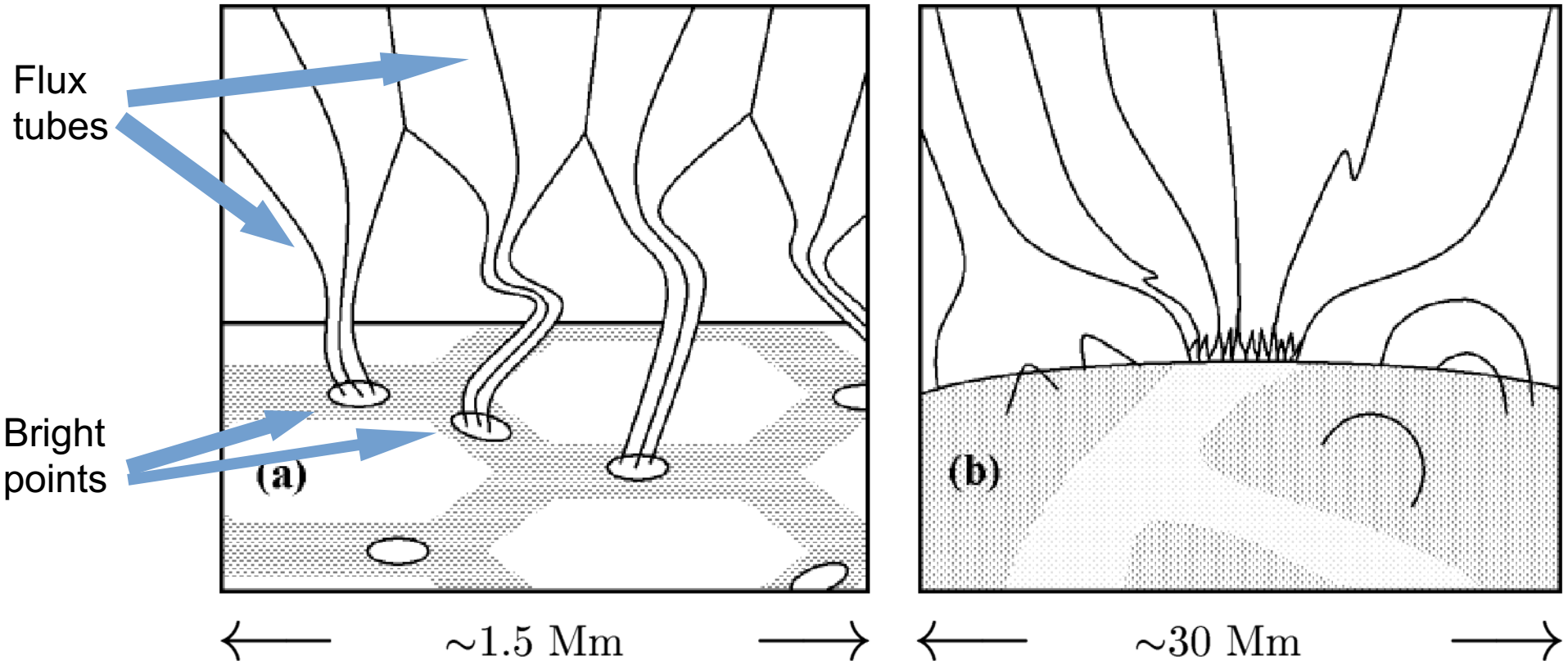


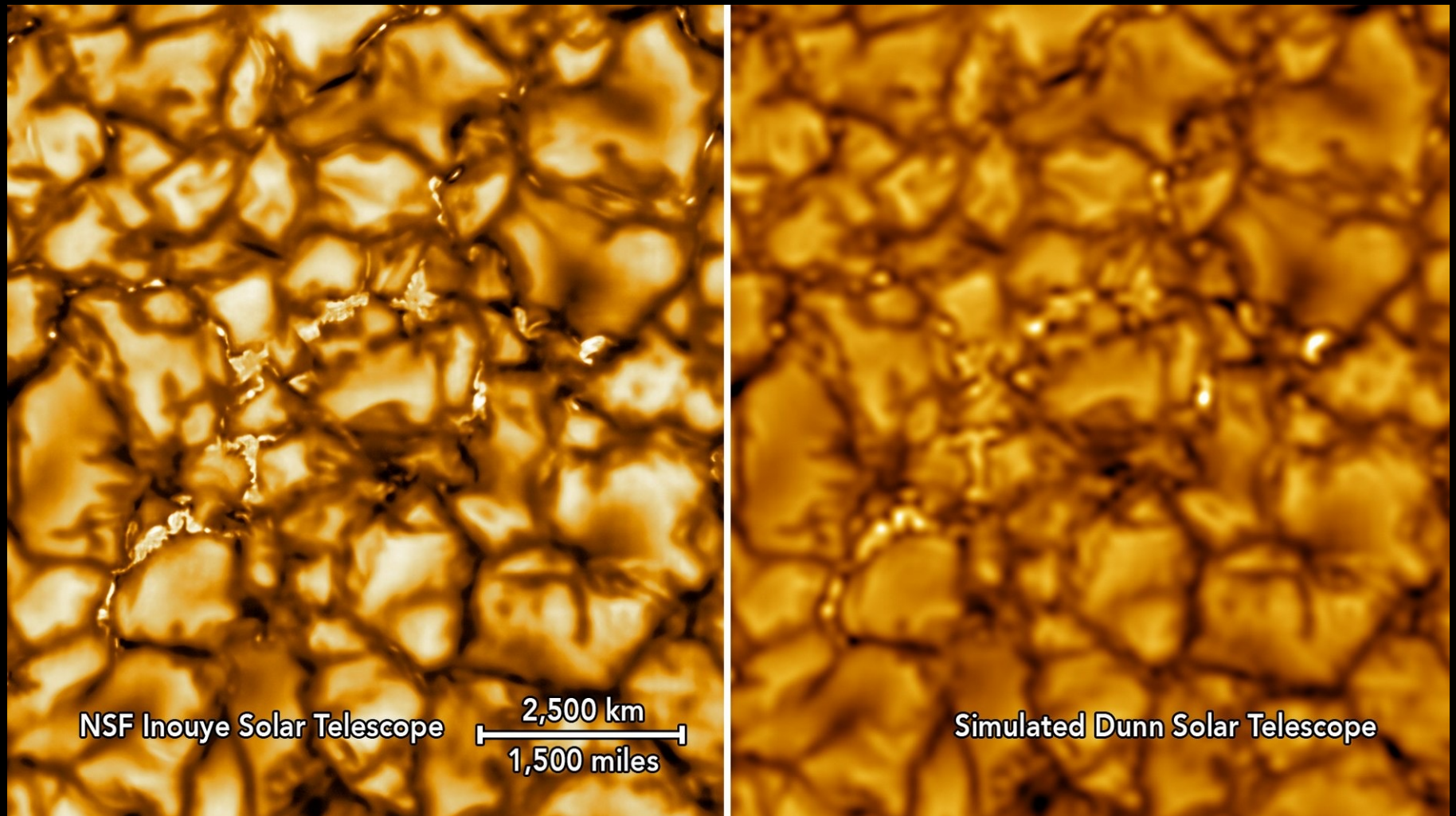
BPs are flux-tube footpoints



Cranmer & van Ballegooijen (2005)

The Promise of DKIST

DKIST will resolve BPs



NSO/A
URA/N
SF

My work: bright points & waves

- Goals:
  - Measure BP shape changes
  - Connect to wave driving
  - Connect to braiding/tangling models
  - Previous goal: Demonstrate & test on simulations
  - Next goal: Use data!

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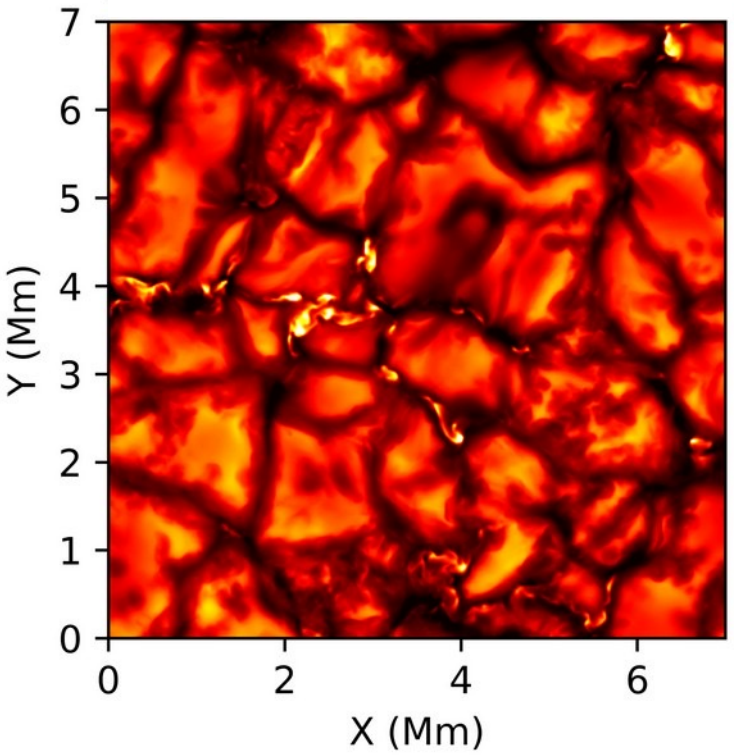
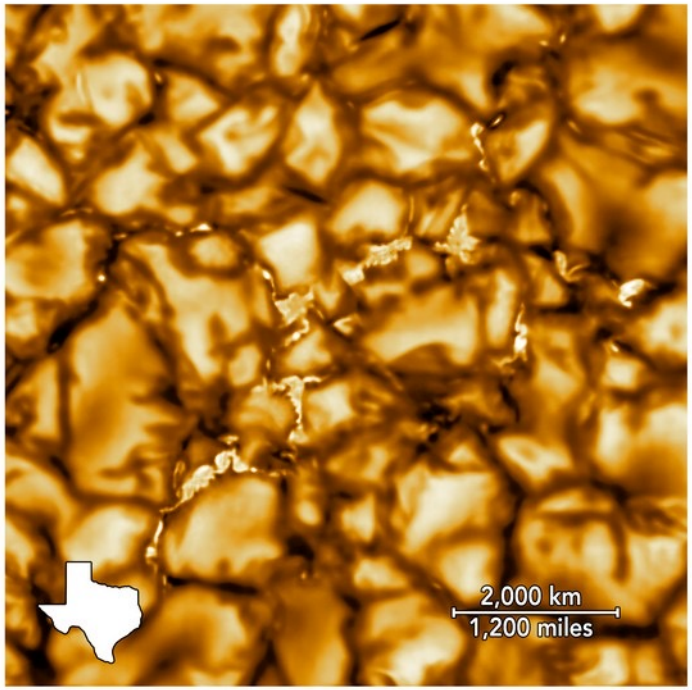
MURaM simulation as DKIST stand-in

- From Matthias Rempel
- 16 km grid spacing (c.f. ~15 km DKIST resolution)
- 20 s and 2 s cadence

MURaM



DKIST first light

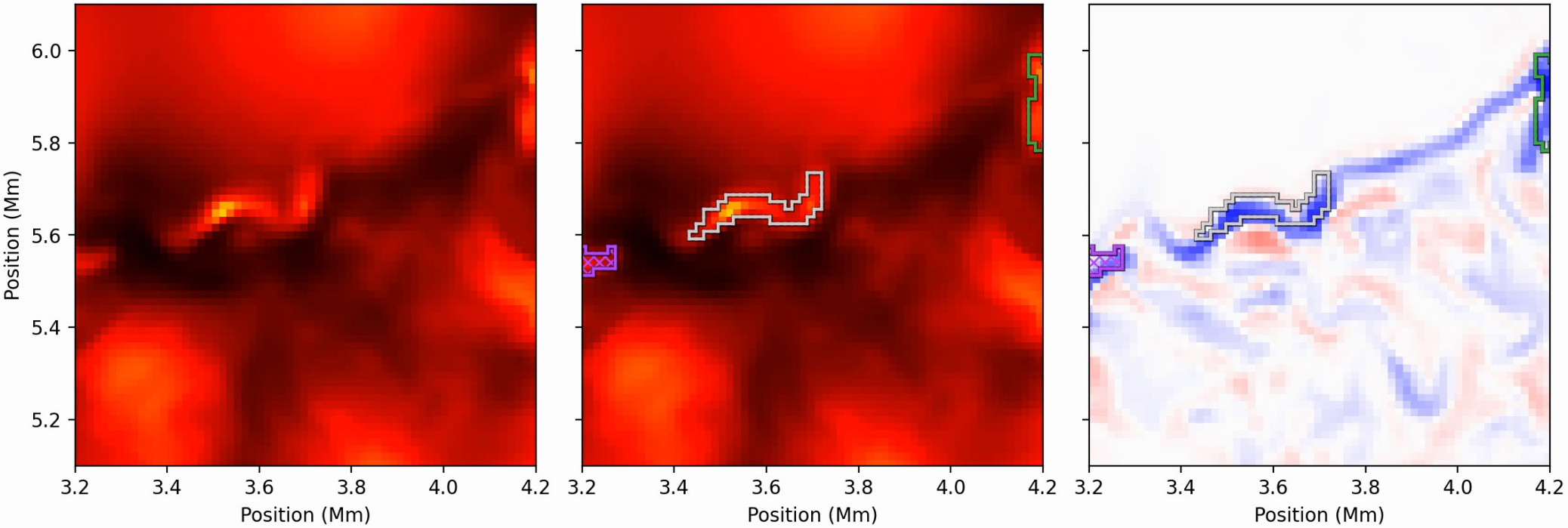


Automatic tracking of BPs

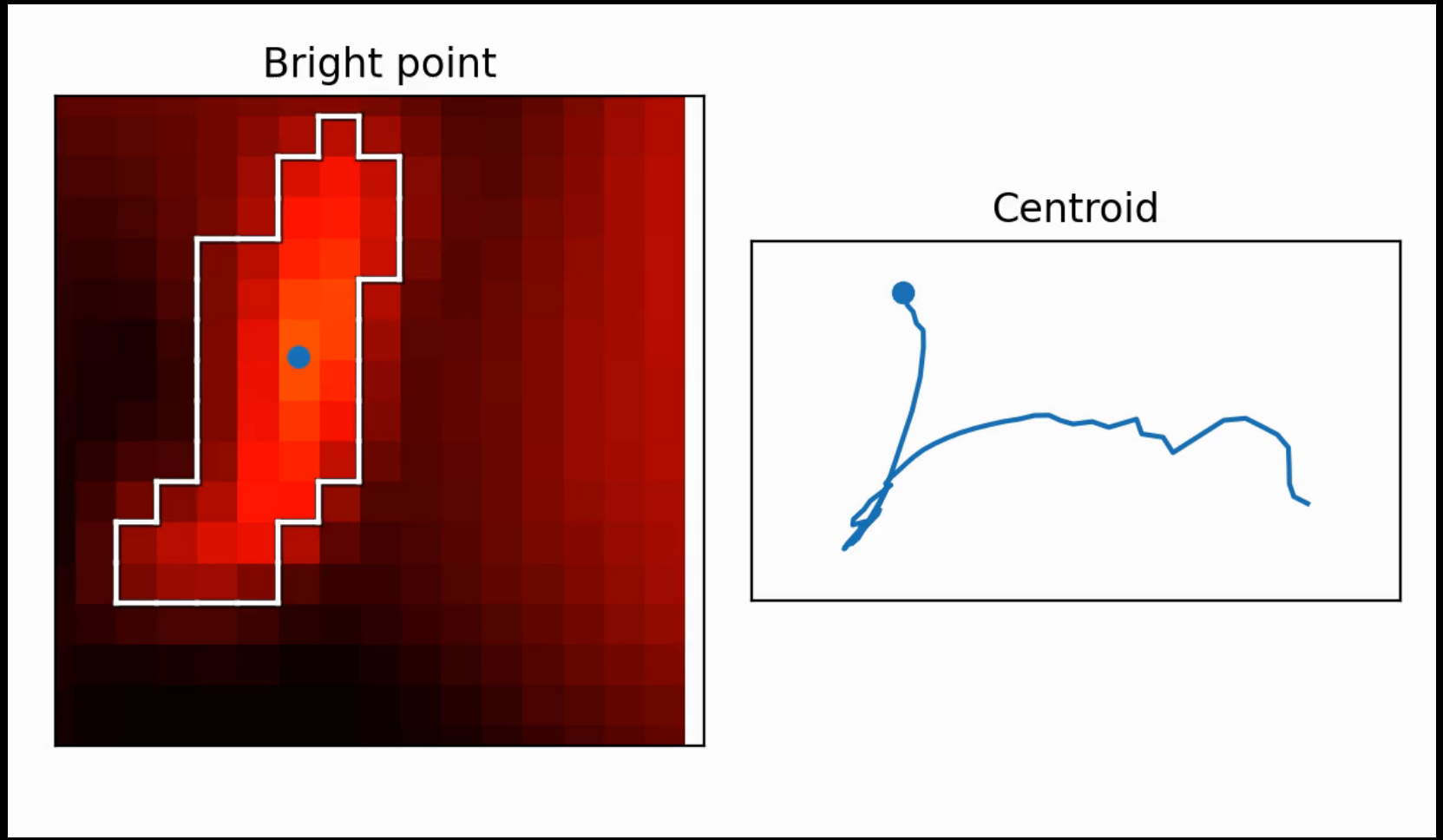
Intensity

Intensity

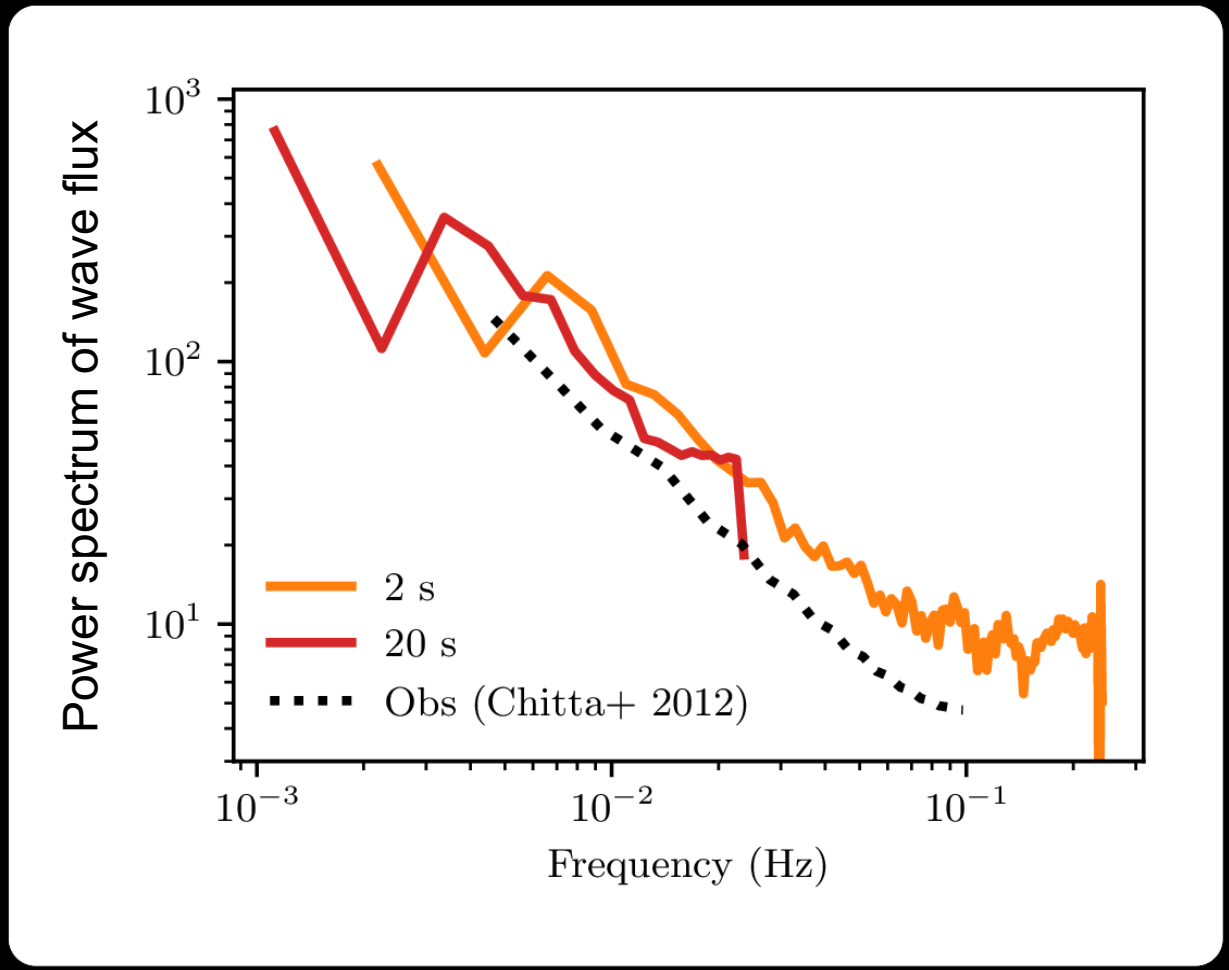
Vertical magnetic field



An appetizer: centroid tracking



Higher resolution resolves more motion



Van Kooten & Cranmer (2017)

Bright-point shape changes

- Plan:
  - Fit BP boundaries w/ sum of sinusoids
  - Depend only on shape outlines
    - Little information is available inside BPs

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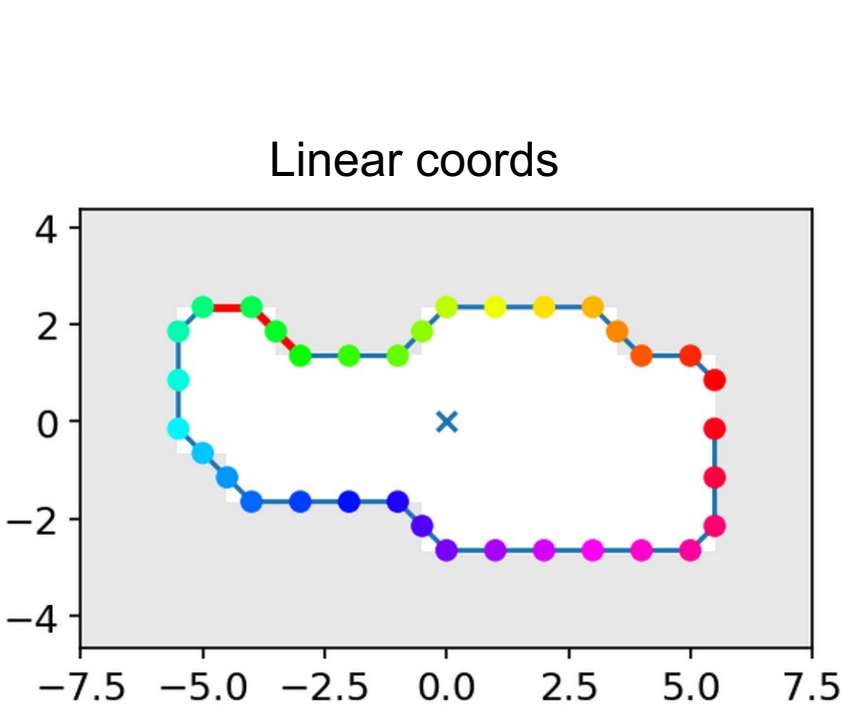
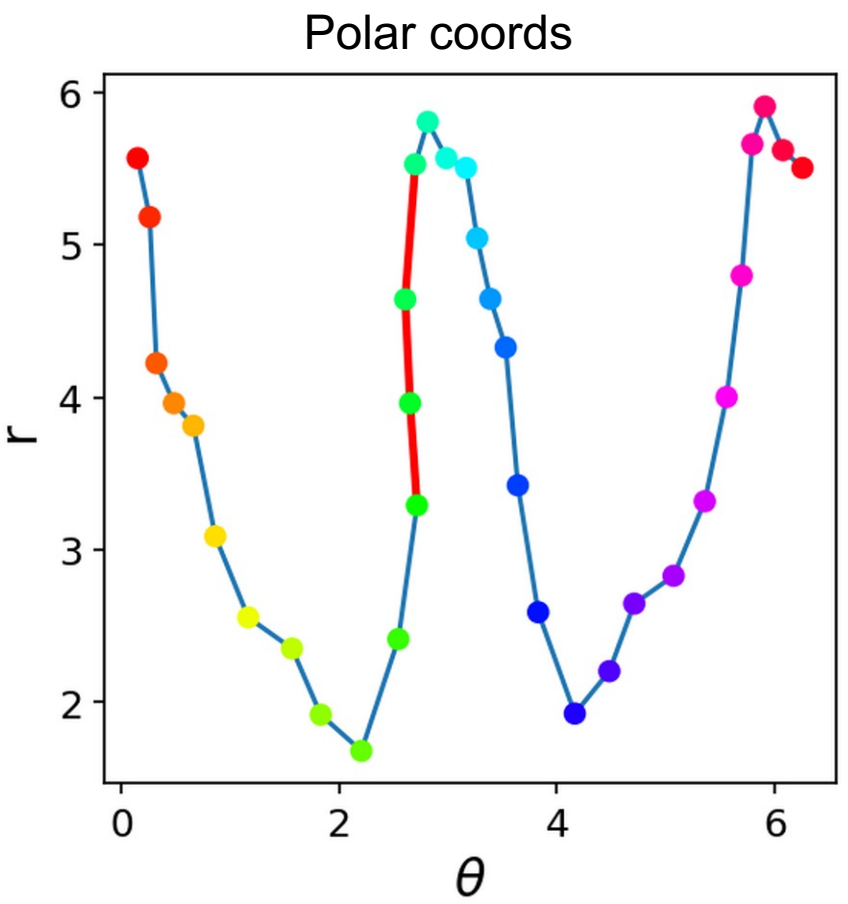
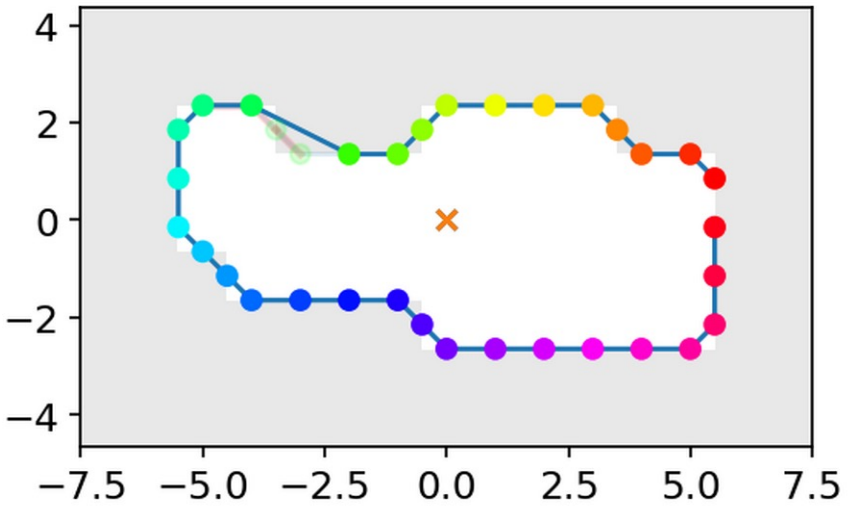
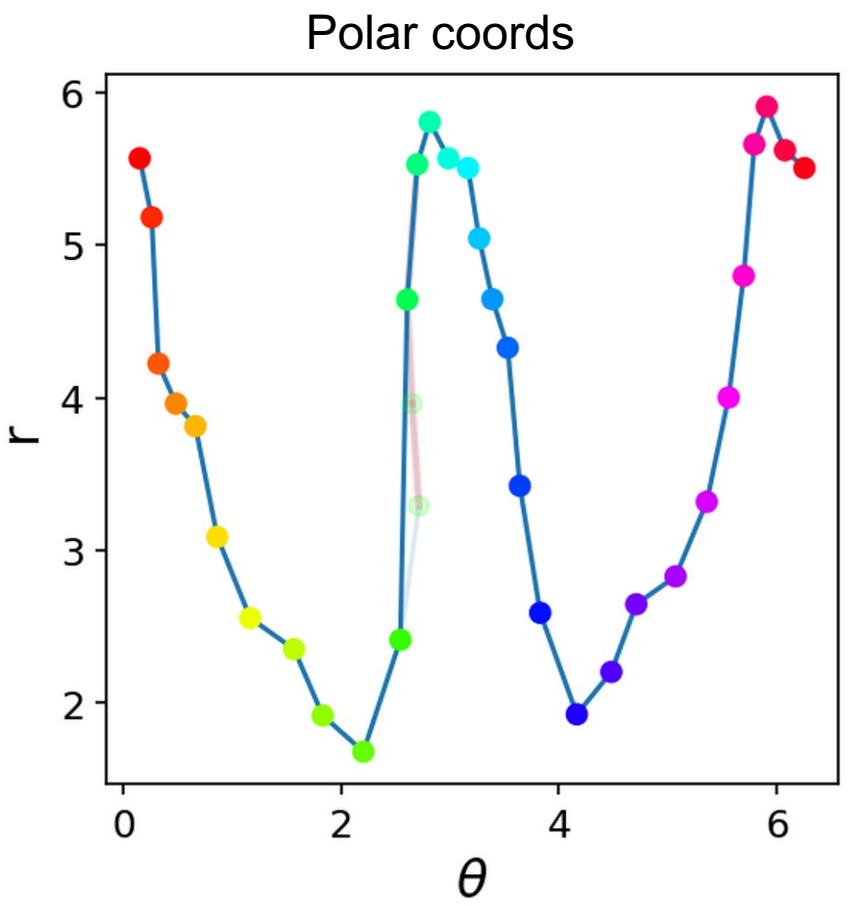
BP outlines “unrolled” into r–θ



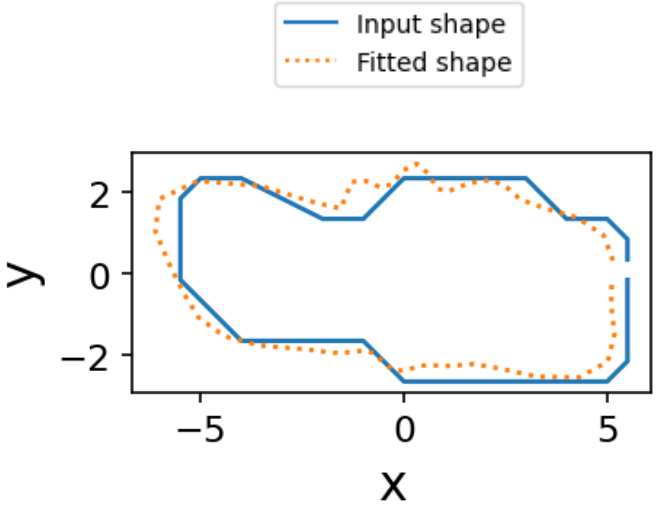


“Back-tracking” points adjusted

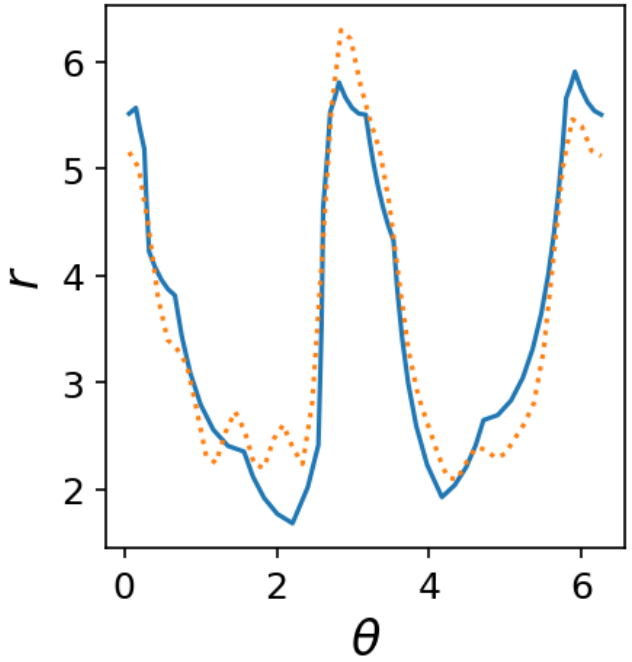


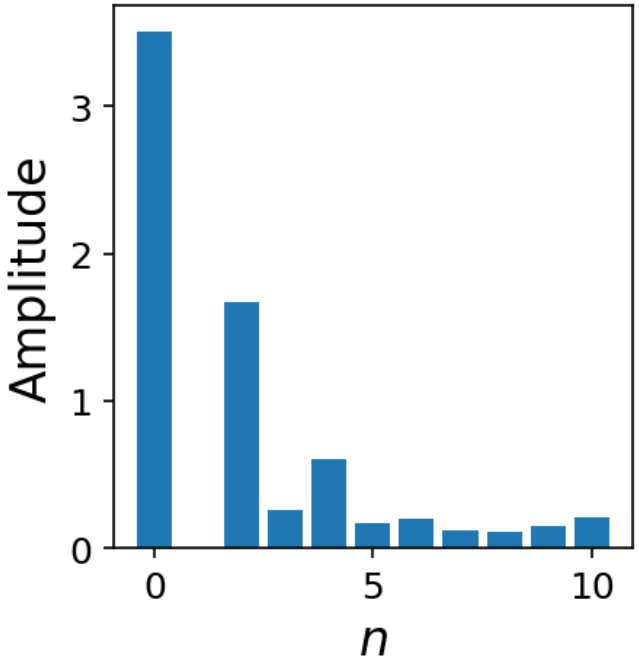


Outlines are fit w/ sum of sinusoids

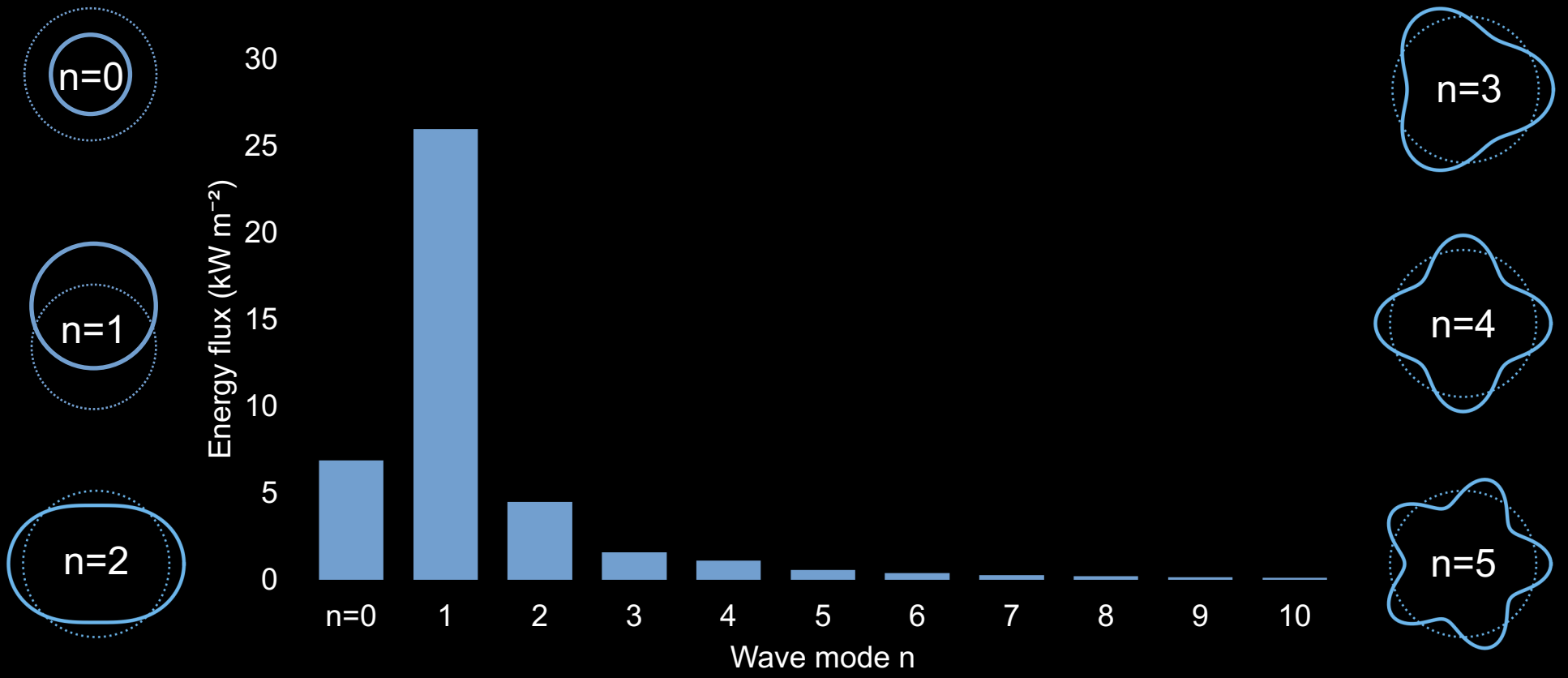


$r_{fit}(\theta)$
$= r_0$

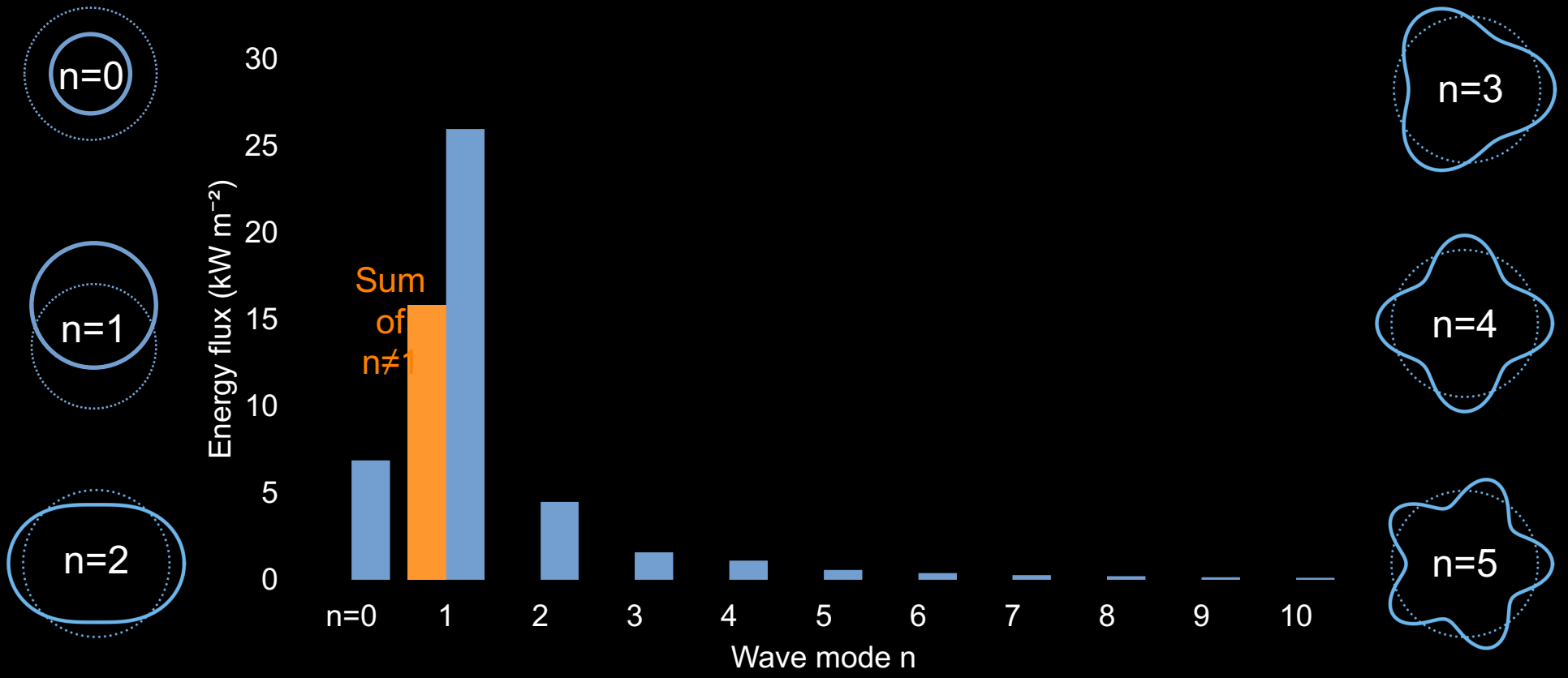




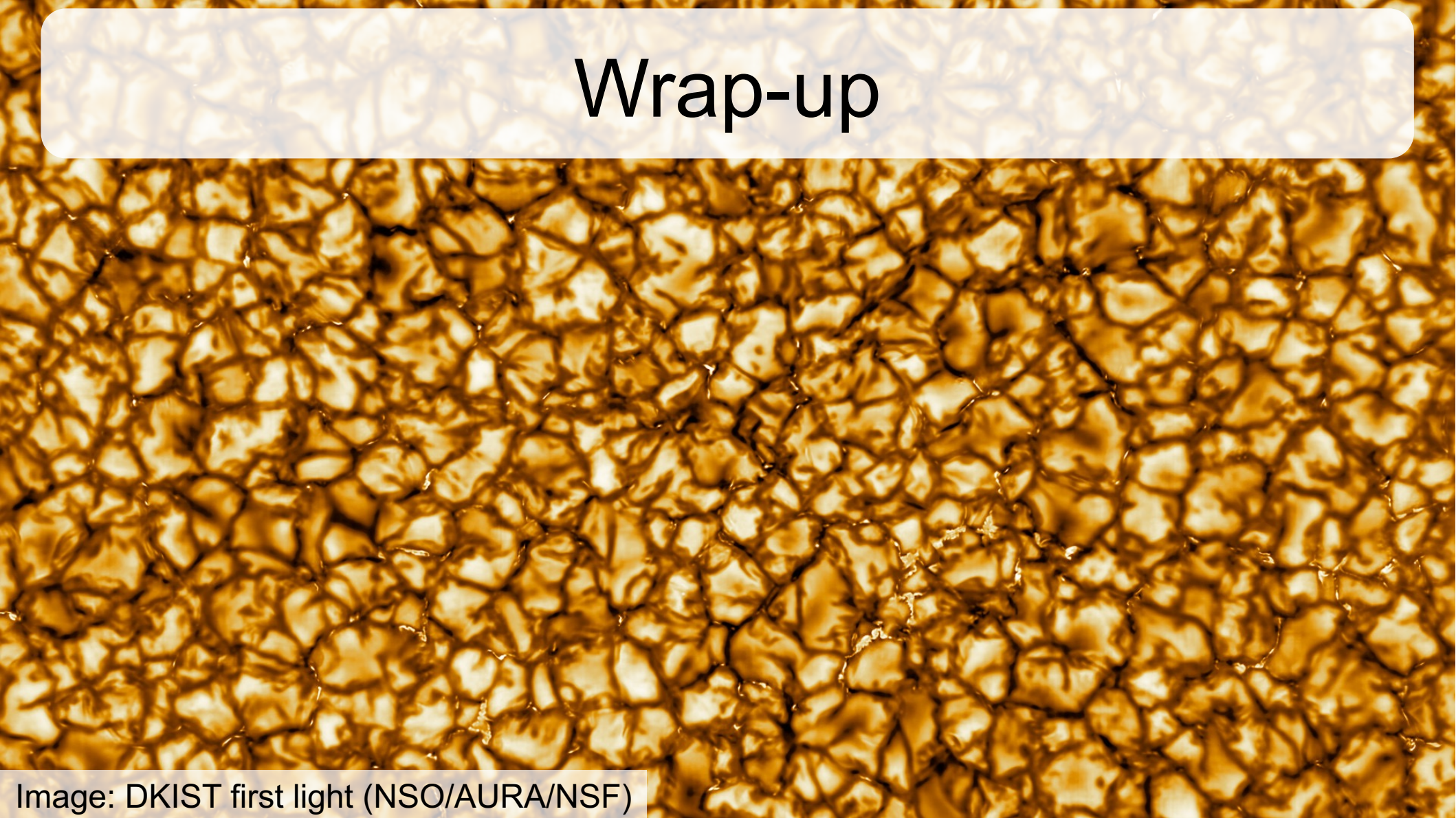
n>2 modes drop off rapidly



Sum of n≠1 is significant!



Wrap-up



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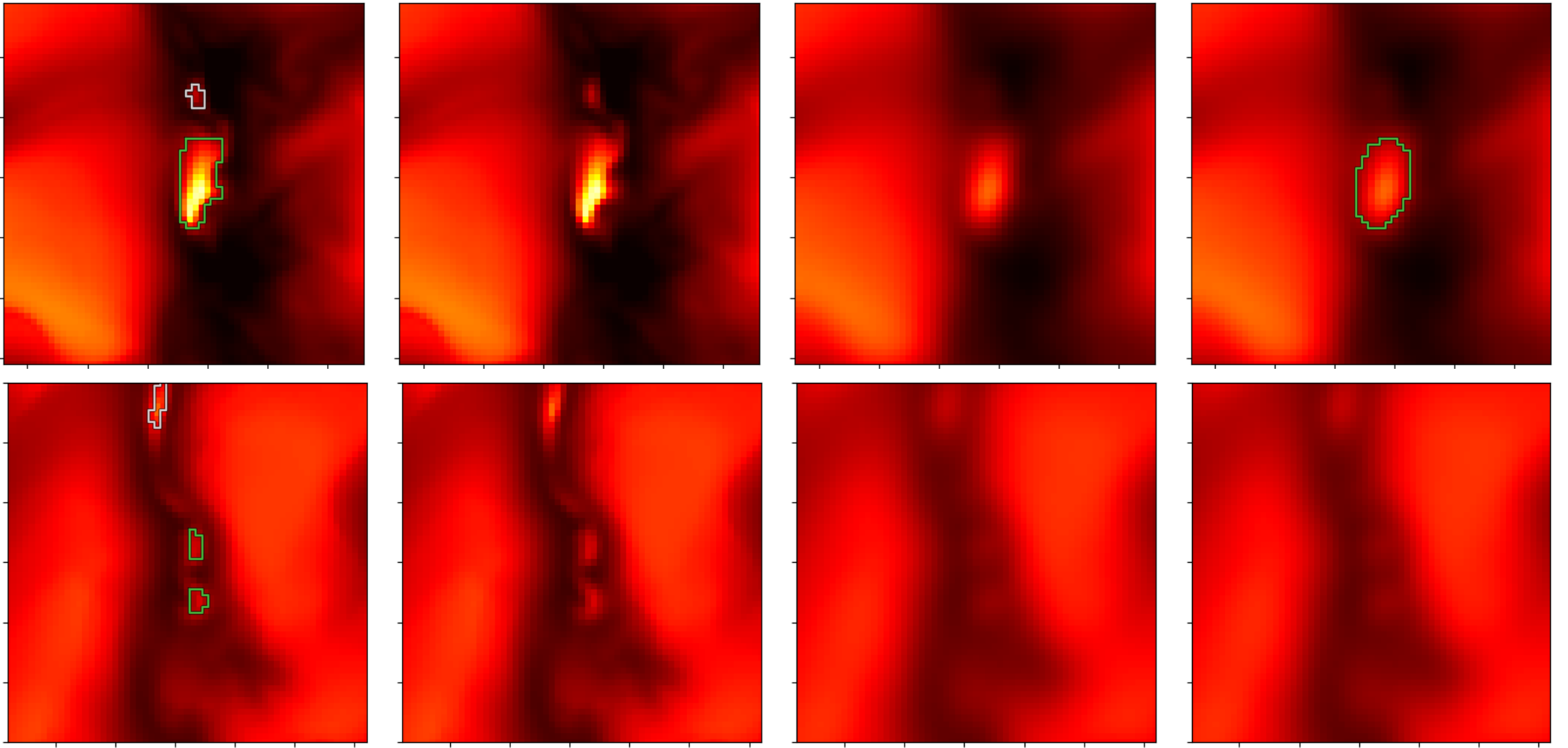
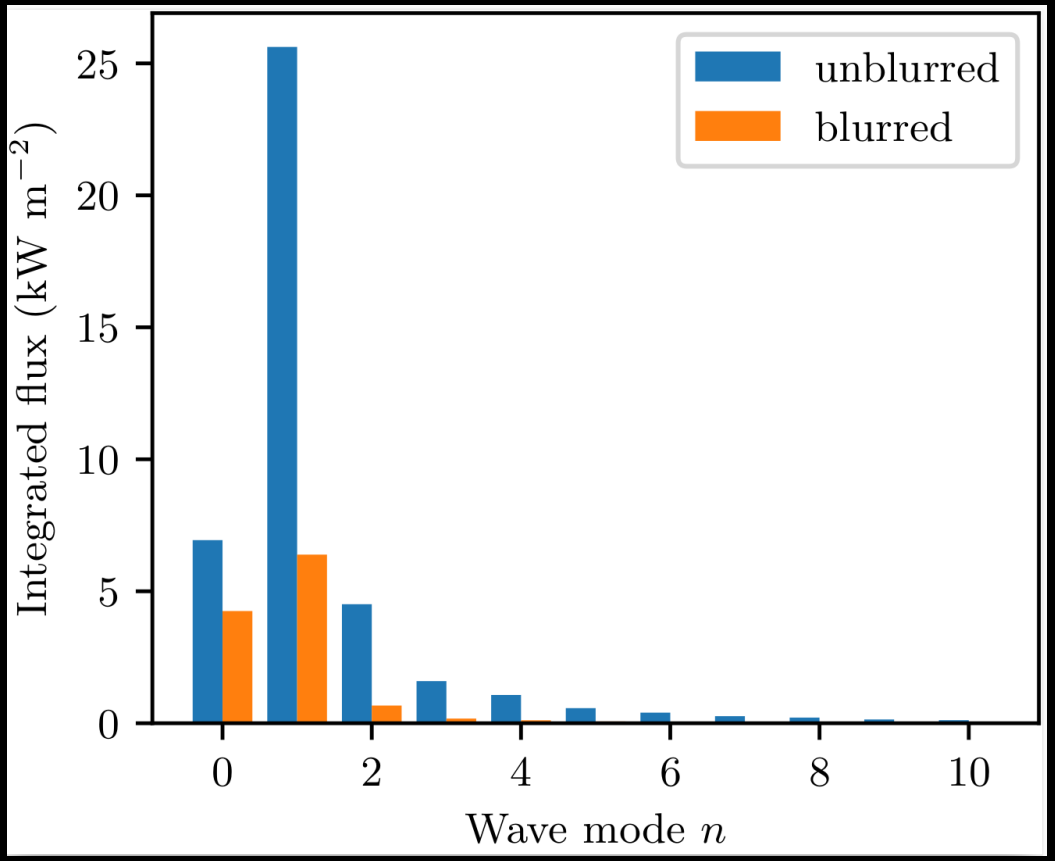
Importance of resolution

MURaM res

~Pre-DKIST obs res (100 km)



Pre-DKIST resolution significantly reduces fluxes

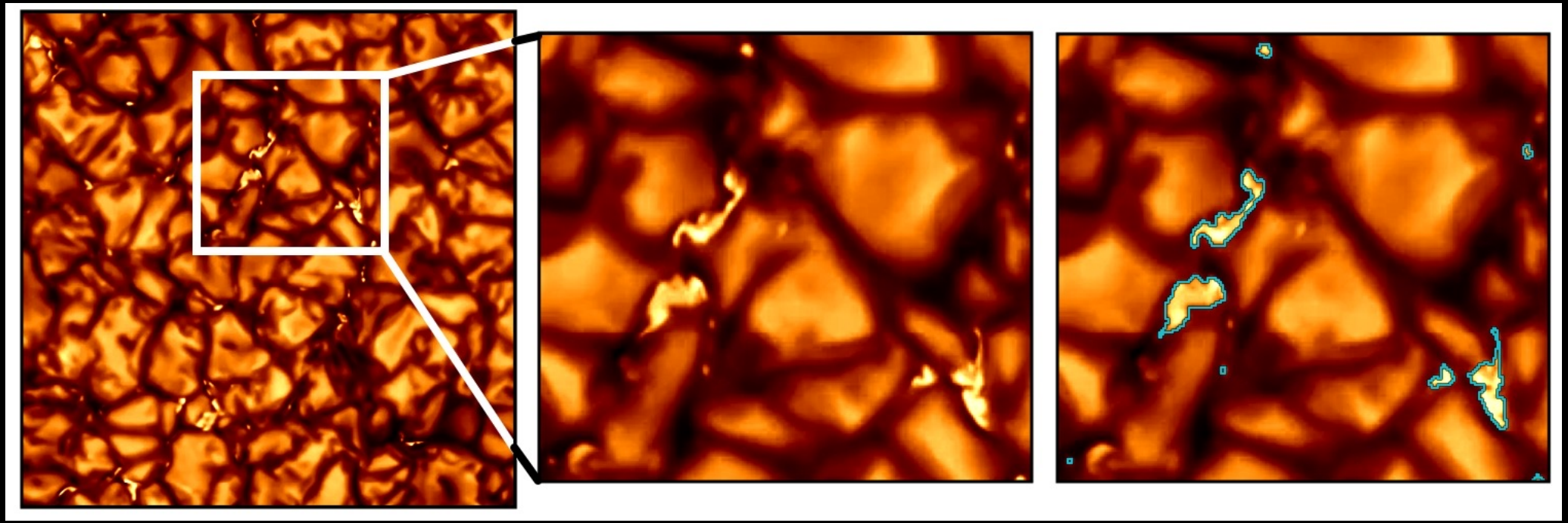


Tracking bright points versus flux elements

- i.e. white light or magnetograms
- MURaM data practicality—currently no LOS magnetograms
- With DKIST instruments, magnetograms still require small trade-offs in resolution, FOV, or cadence

BP tracking with DKIST

- It works!

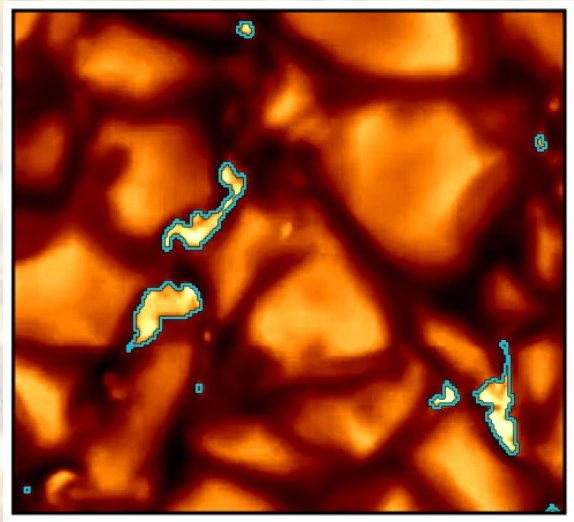


Next steps

- Use DKIST data!
- n≠1 wave propagation & dissipation should be modeled
- Further investigate FE–BP comparison
- Are there other places to apply this tracking?
  - Field line braiding!

Summary

- Laid initial groundwork for wave-driving analysis of resolved bright points
- Preliminary results suggest it will be a fruitful line of inquiry (50% increase in energy budget for wave/turbulence!)
- I want to extend my tracking to twisting/tangling models as well!



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