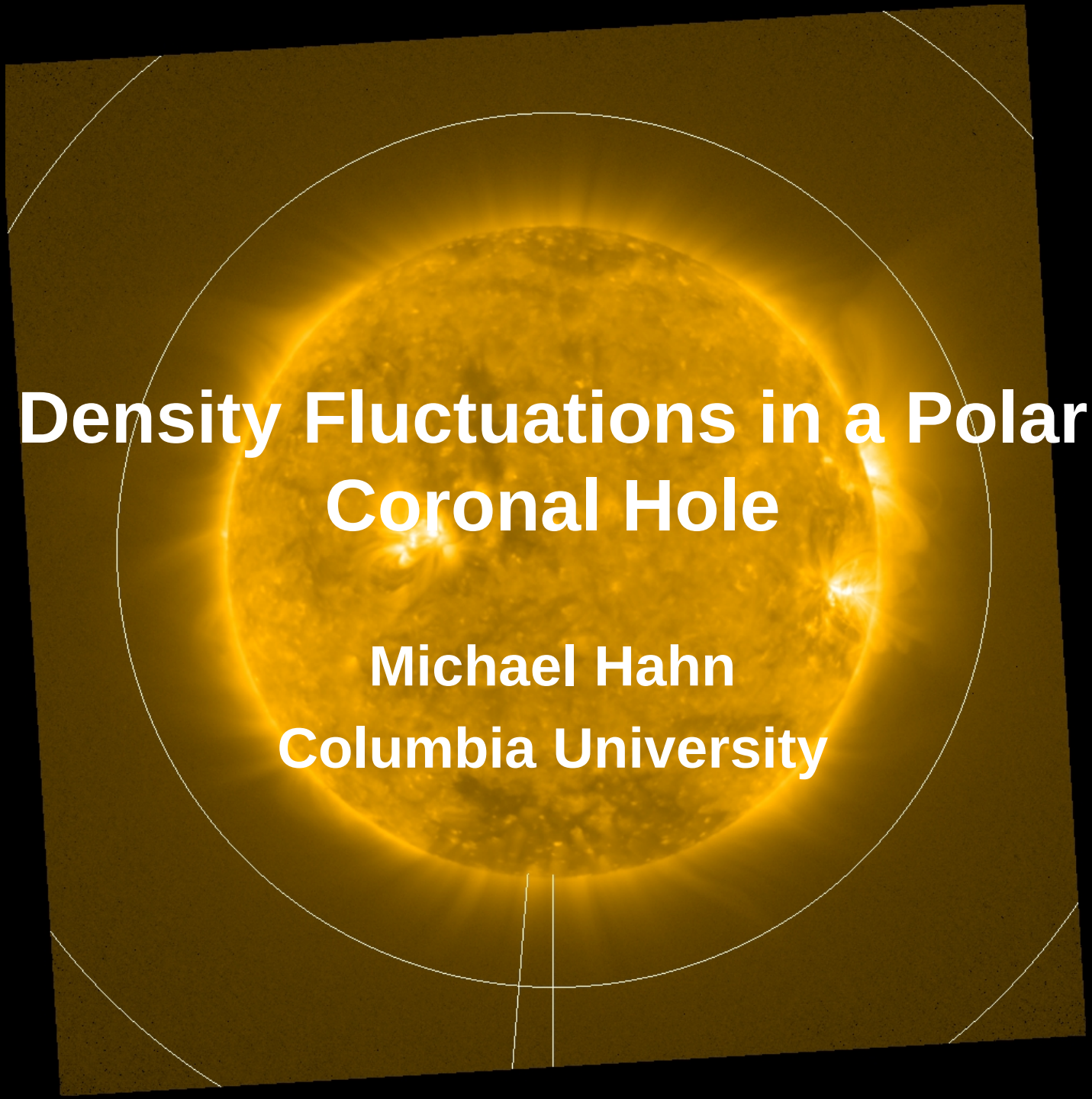


Density Fluctuations in a Polar Coronal Hole

Michael Hahn

Columbia University

What are the amplitudes of density fluctuations in the corona?

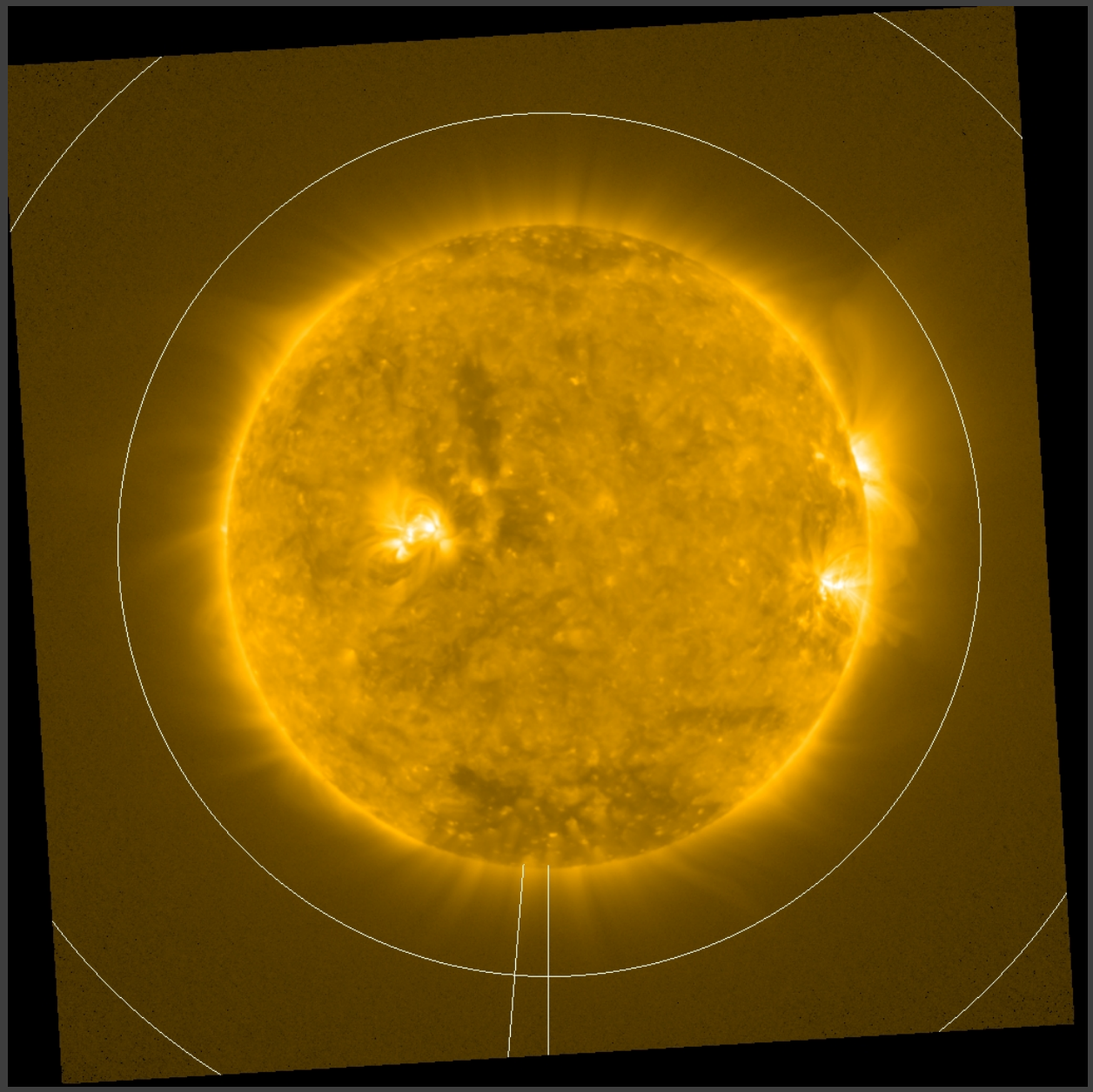
Plasma waves are important for coronal heating

Alfven waves carry most of the energy flux in the corona and are ubiquitous.

Compressive modes (density fluctuations) can promote dissipation of Alfven waves.

However, there are few measurements of density fluctuations in the corona, except close to the limb.

SWAP observation 2017 April 6-7



Fluctuations and Noise Sources

$$\Delta I^2_{\text{meas}} = \Delta I^2 + \Delta I^2_{\text{phot}} + \Delta I^2_{\text{detector}} + \Delta I^2_{\text{scattered}}$$

The measured RMS amplitude from all causes

Real fluctuations in the corona

Counting statistics

Detector noise

Real fluctuations from the solar disk that appear to be from the corona due to scattered light

Fluctuations and Noise Sources

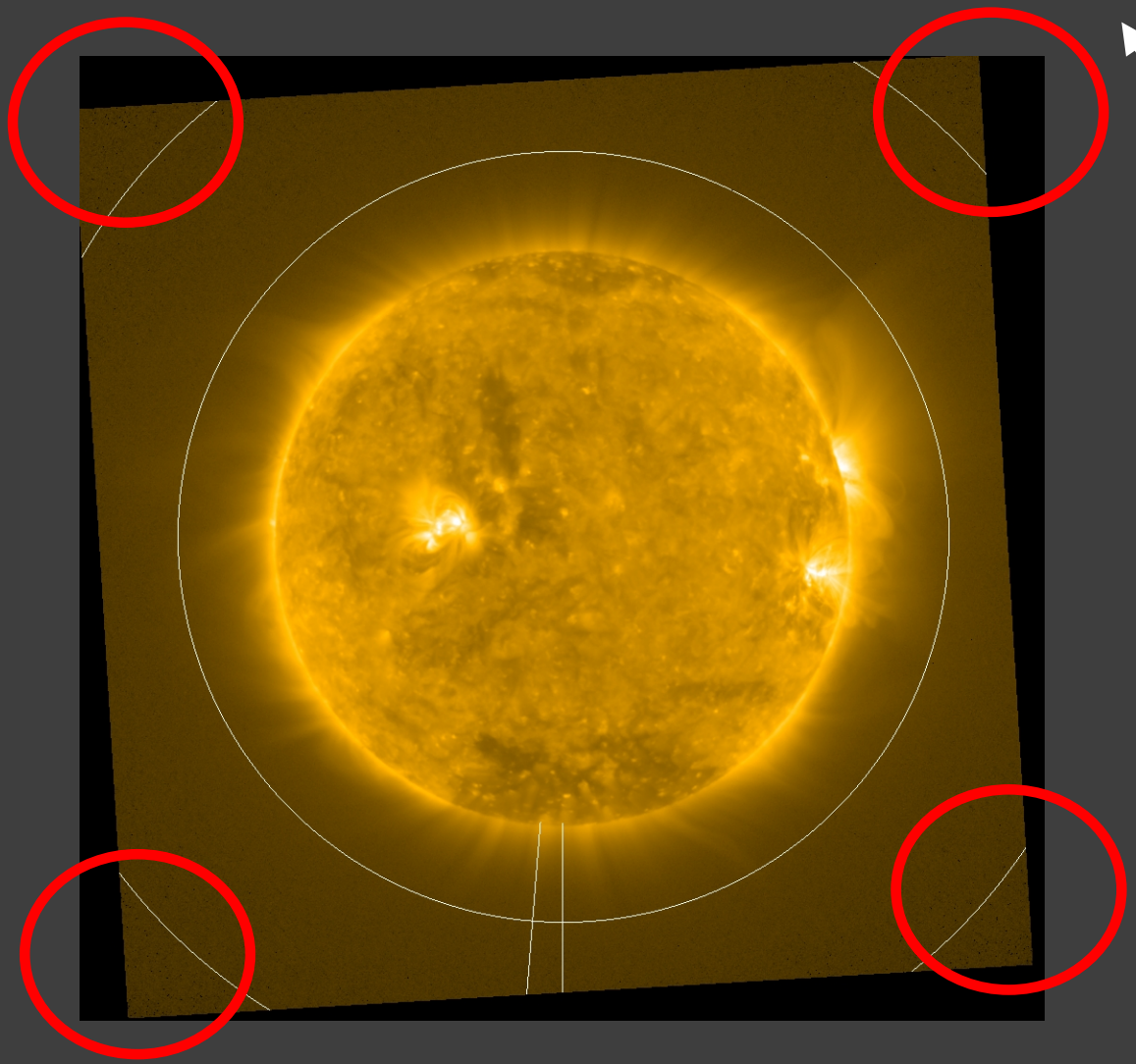
$$\Delta I^2_{\text{meas}} = \Delta I^2 + \Delta I^2_{\text{phot}} + \Delta I^2_{\text{detector}} + \Delta I^2_{\text{scattered}}$$

Counting statistics

$\propto \sqrt{N}$

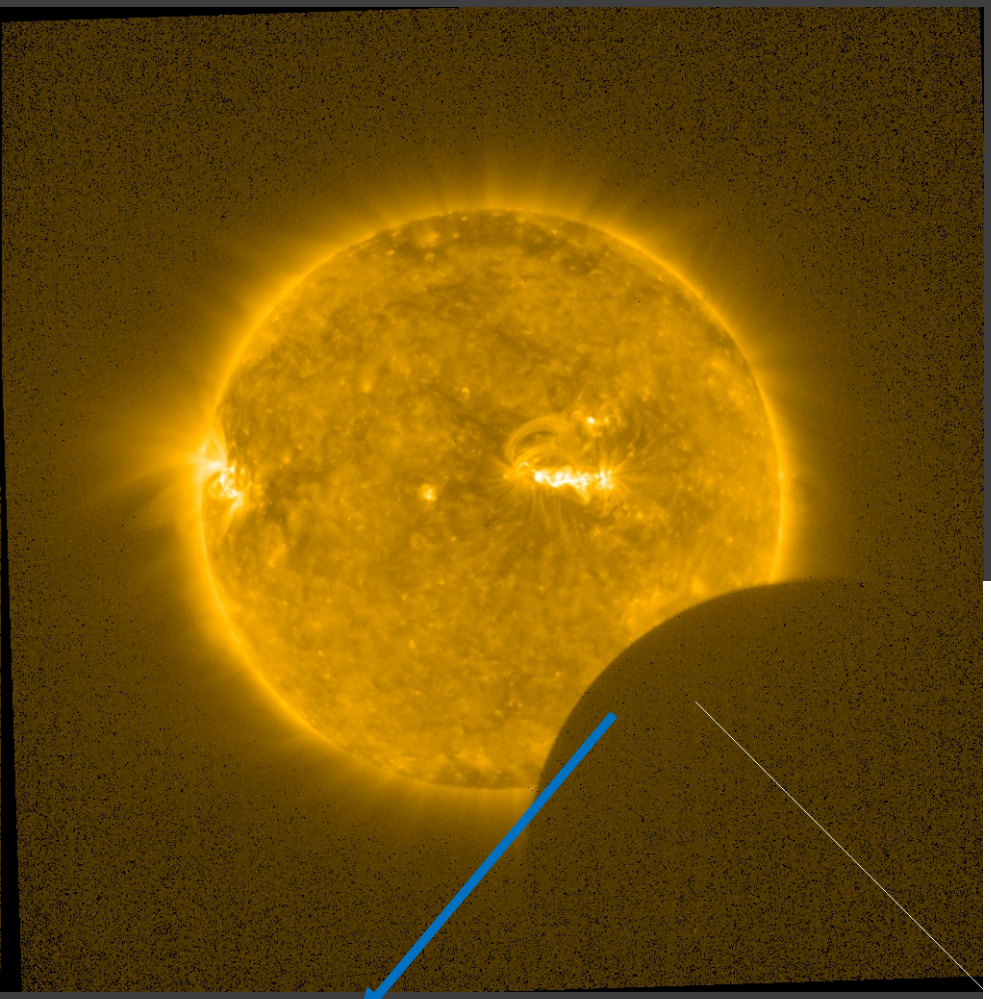
Fluctuations and Noise Sources

$$\Delta I^2_{\text{meas}} = \Delta I^2 + \Delta I^2_{\text{phot}} + \Delta I^2_{\text{detector}} + \Delta I^2_{\text{scattered}}$$



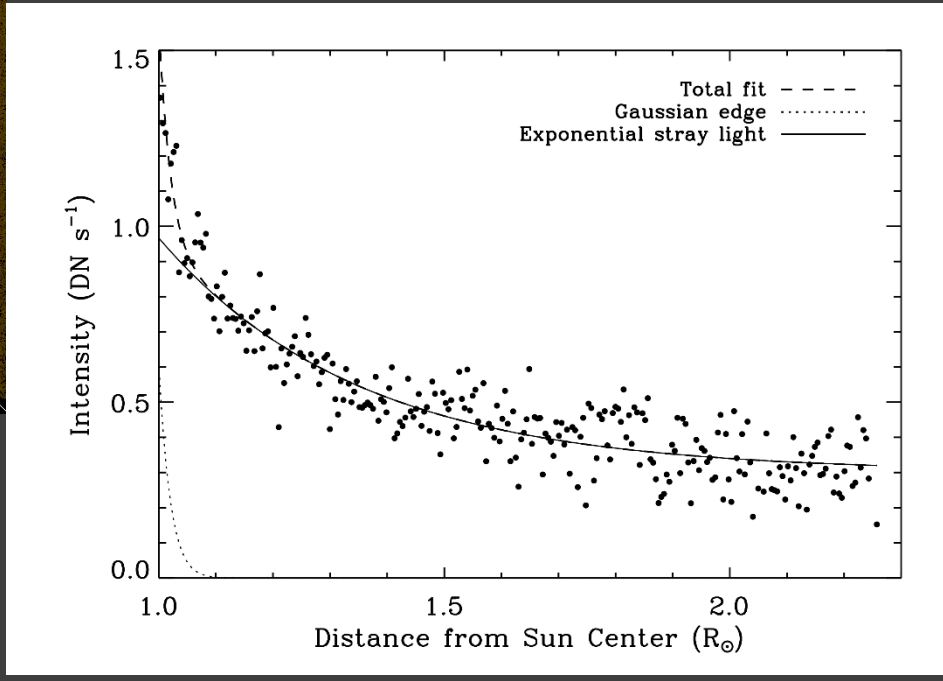
Assume that at $r > 1.95\ R_\odot$ all fluctuations are from detector or stray light

Stray Light from Eclipse Observation

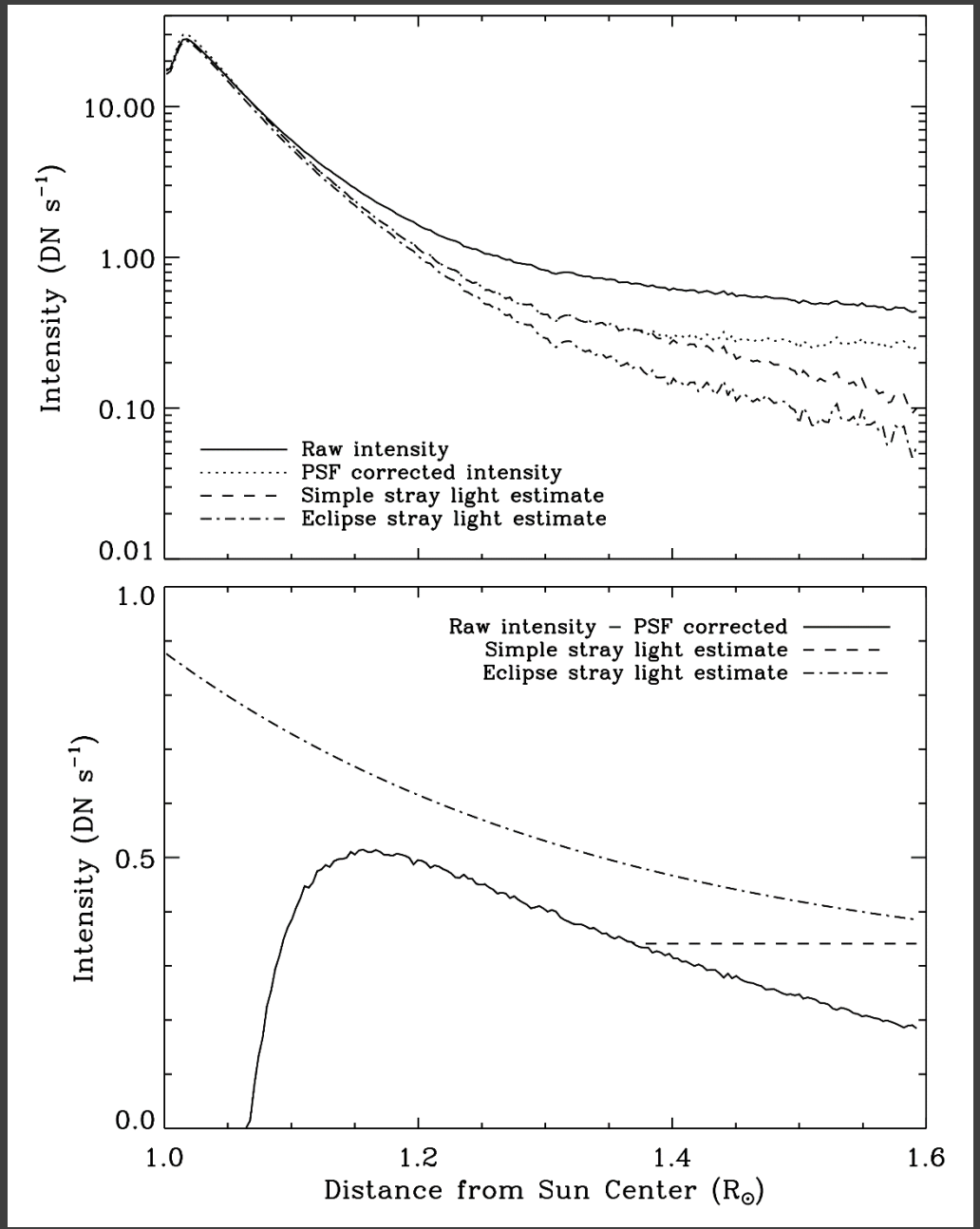


Direction of moon's motion through image.

2017 August 21 Eclipse



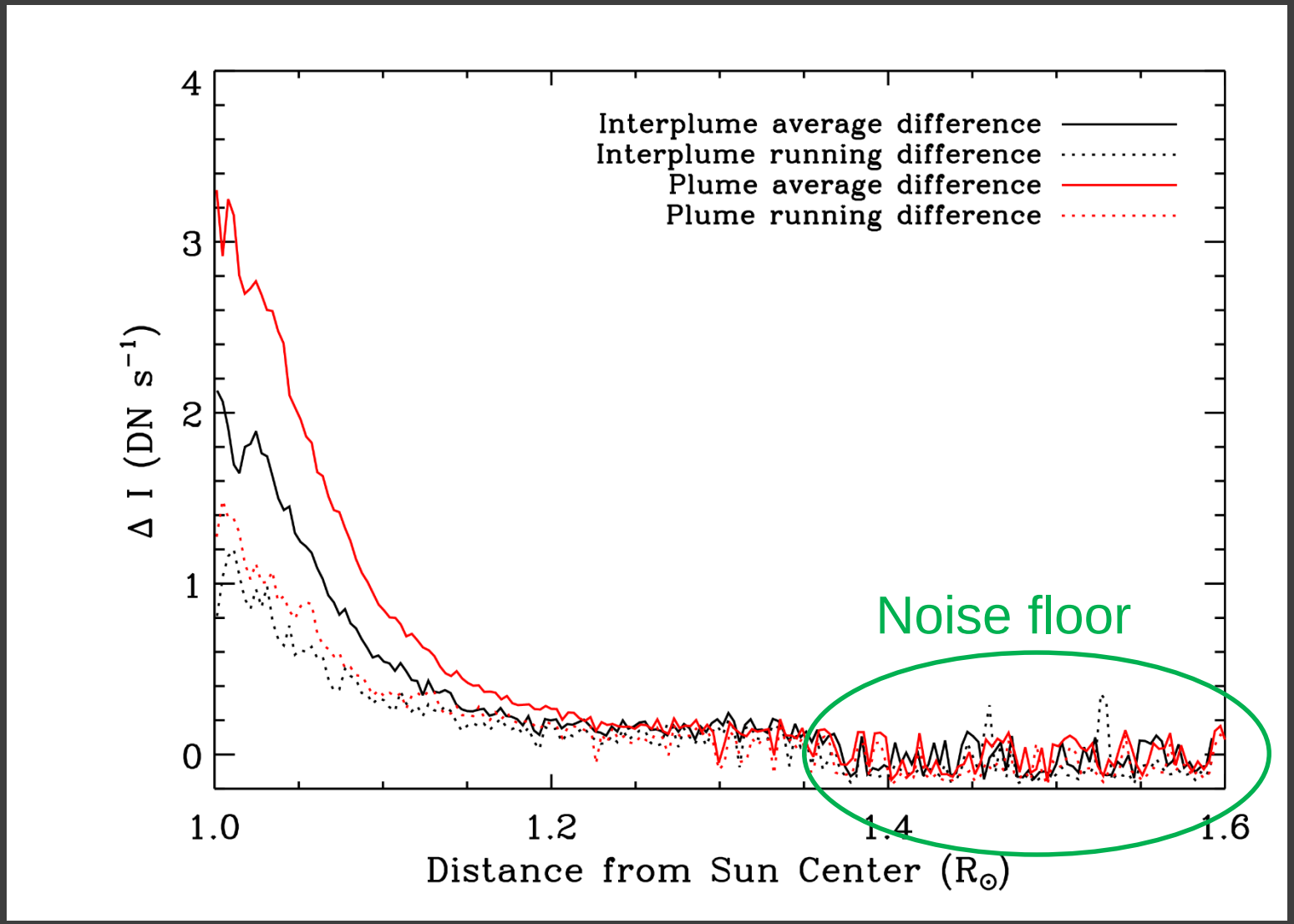
Stray Light and Mean Intensity



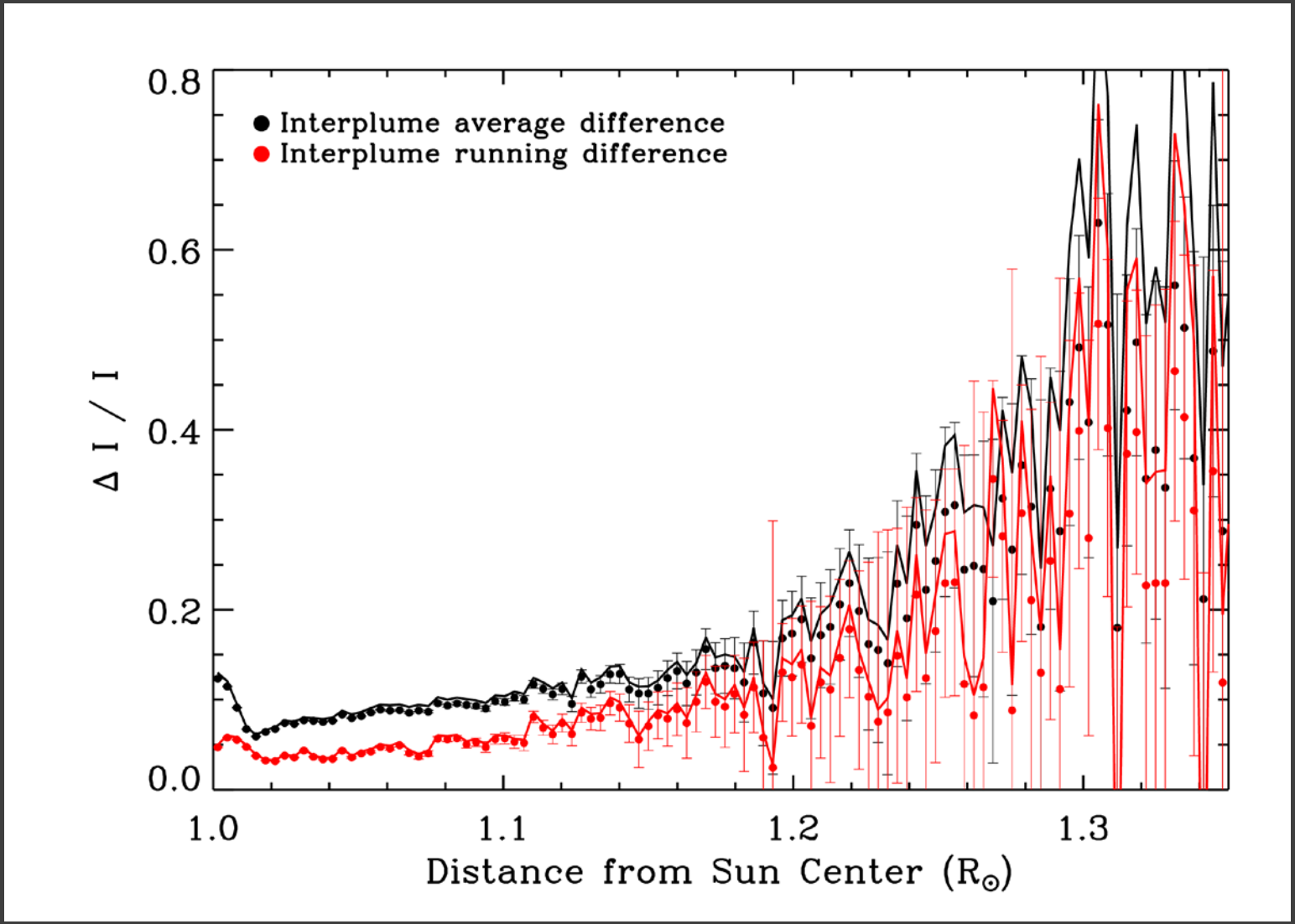
Time-averaged intensity after subtracting scattered light

Scattered light intensity estimates

Intensity fluctuation amplitude

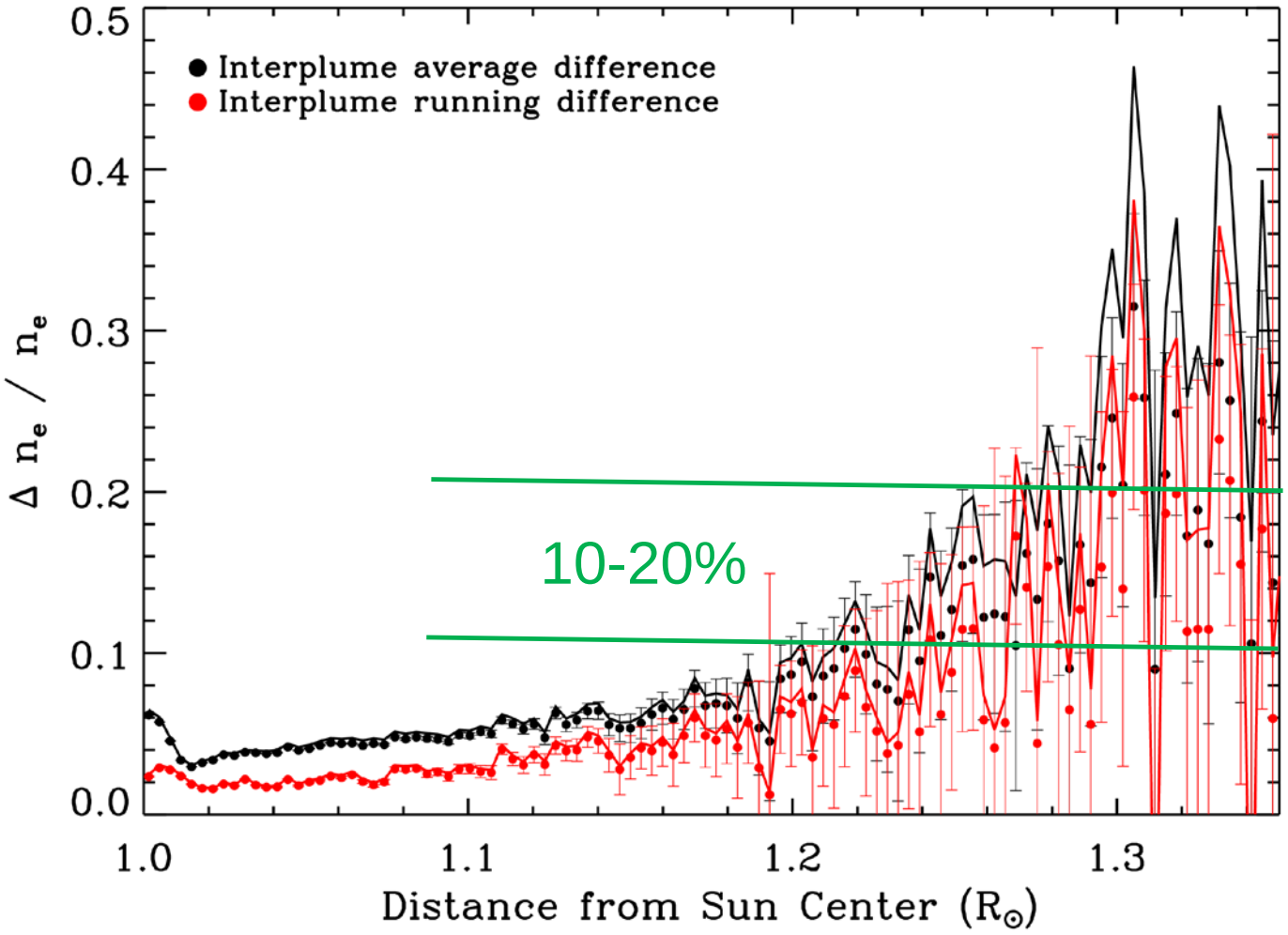


Relative intensity fluctuation

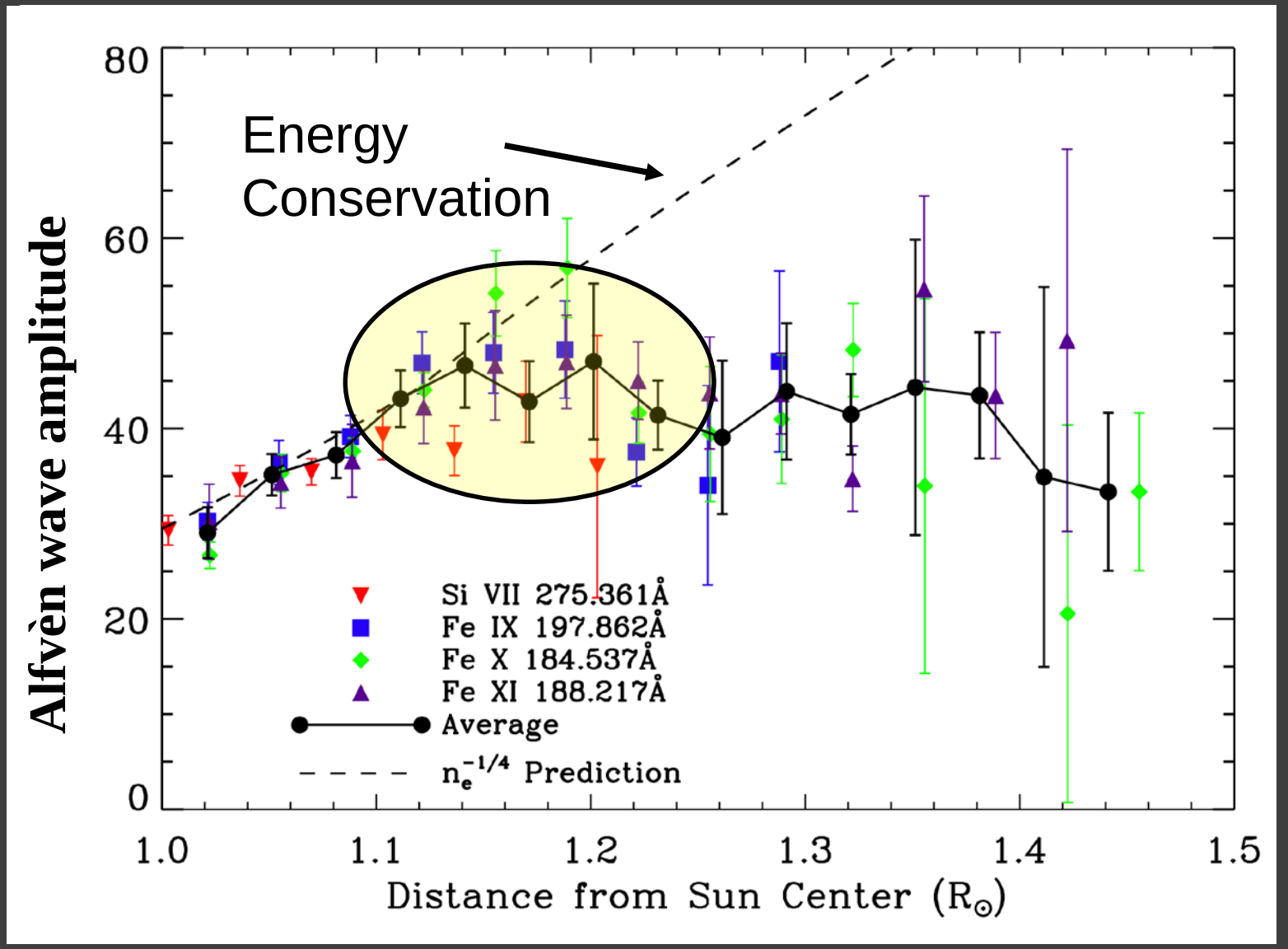


Relative density fluctuation

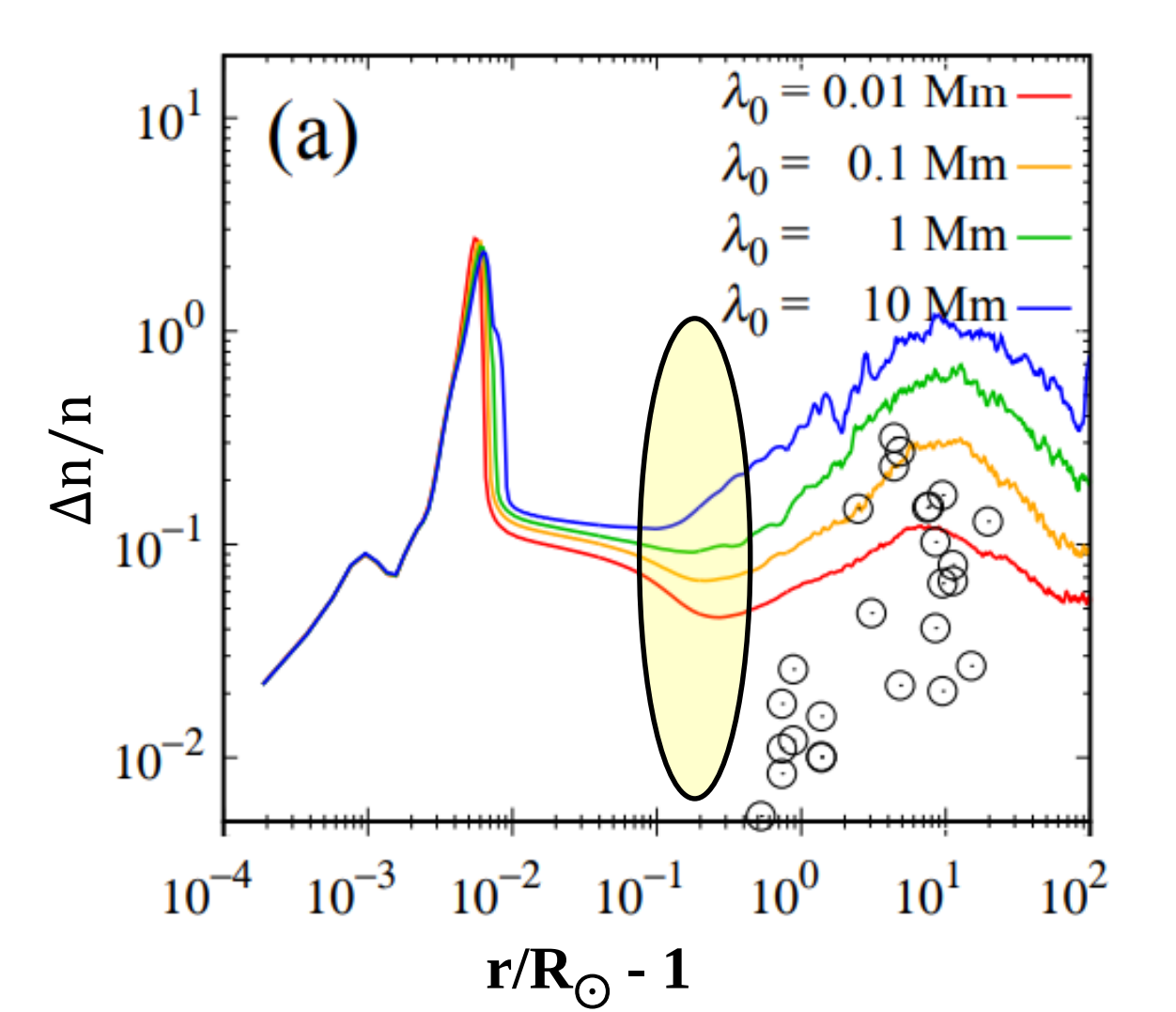
$$I \propto n^2 \longrightarrow \frac{\Delta n}{n} = \frac{1}{2}\frac{\Delta I}{I}$$



Density fluctuations grow at same heights where Alfvèn waves damp.

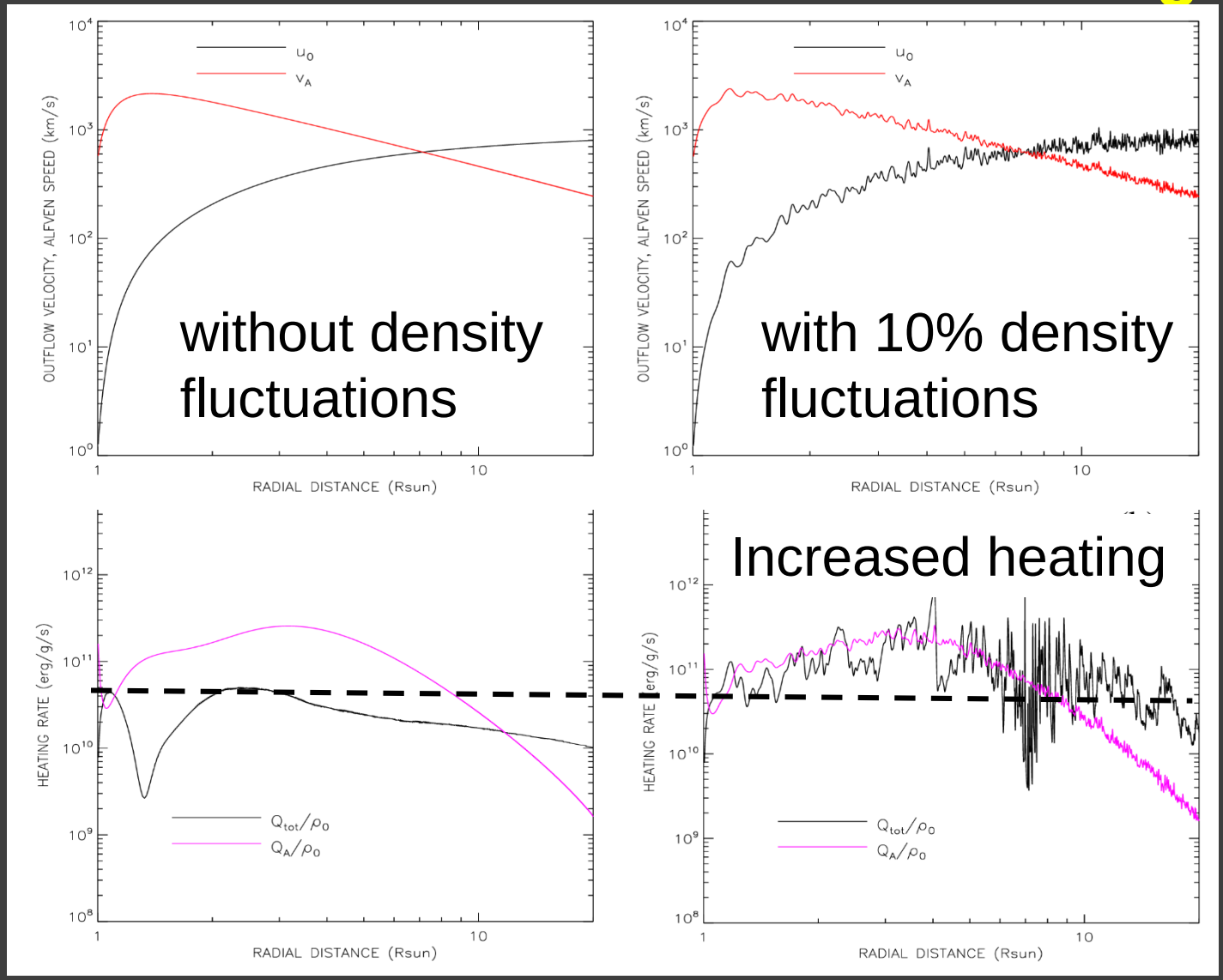


Alfvèn waves may cause density fluctuations via parametric instability



Shoda et al. (2018)

Density fluctuations increase Alfvèn wave reflection and turbulent heating



van Ballegoojen & Asgari-Targhi (2016)

Summary

- Density fluctuations grow in the corona, reaching amplitudes of >10% by 1.35 $R_{\odot}$.

- Theory predicts such fluctuations to promote Alfvèn wave reflection and turbulent heating.

Paper reference: Hahn et al., ApJ, 860, 34 (2018).

https://doi.org/10.3847/1538-4357/aac0f3

https://arxiv.org/abs/1804.10138

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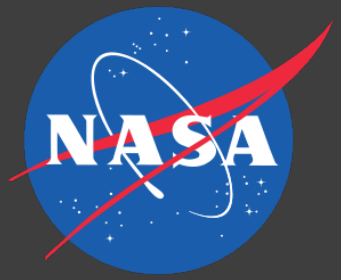
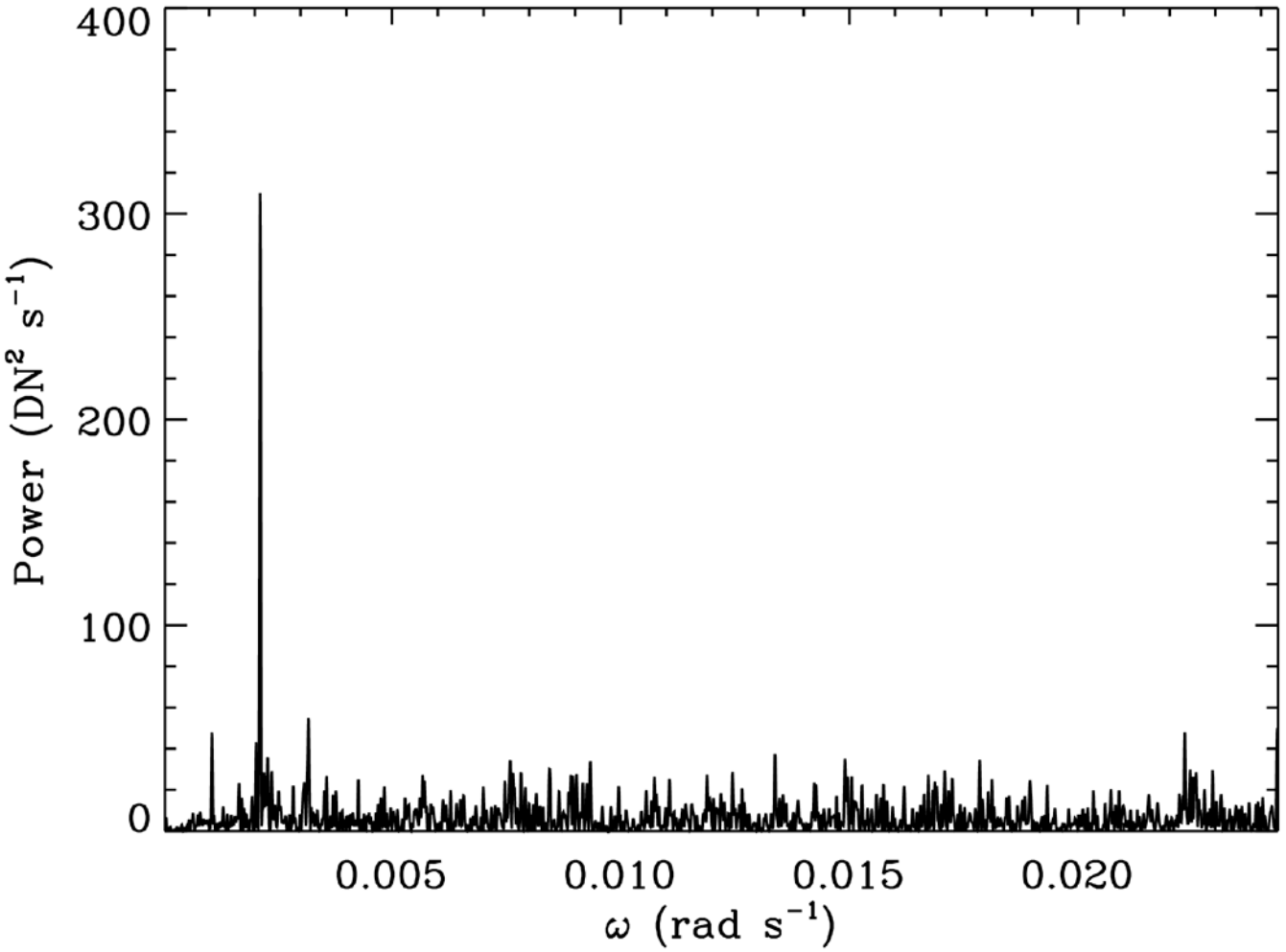
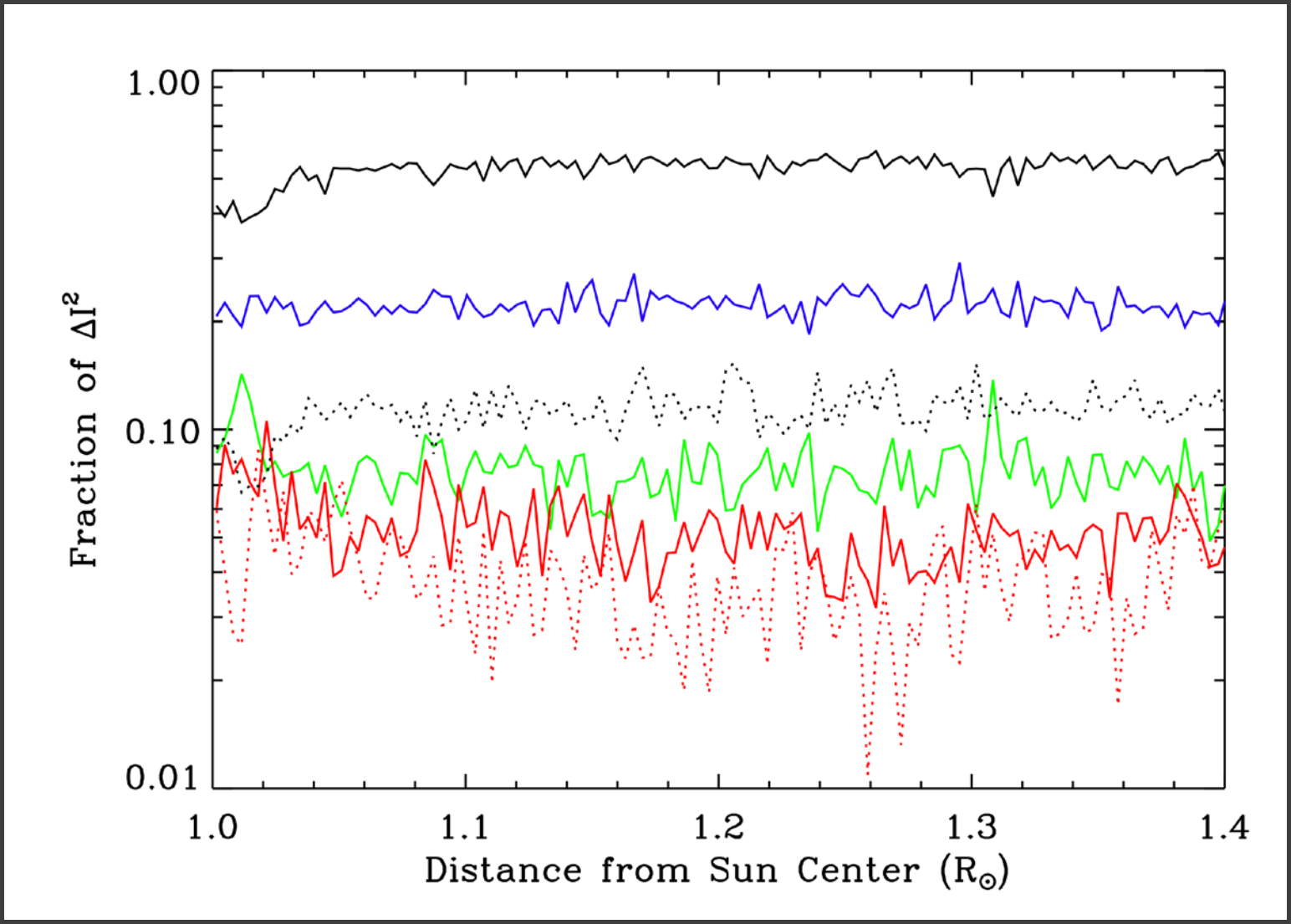



400
300
200
100
0
Power (DN^2 s^{-1})
0.005
0.010
0.015
0.020
ω (rad s^{-1})


1.00
0.10
0.01
Fraction of ΔI²
1.0
1.1
1.2
1.3
1.4
Distance from Sun Center (R⊙)