How transverse MHD wave-driven turbulence influences the density filling factor in the solar corona?

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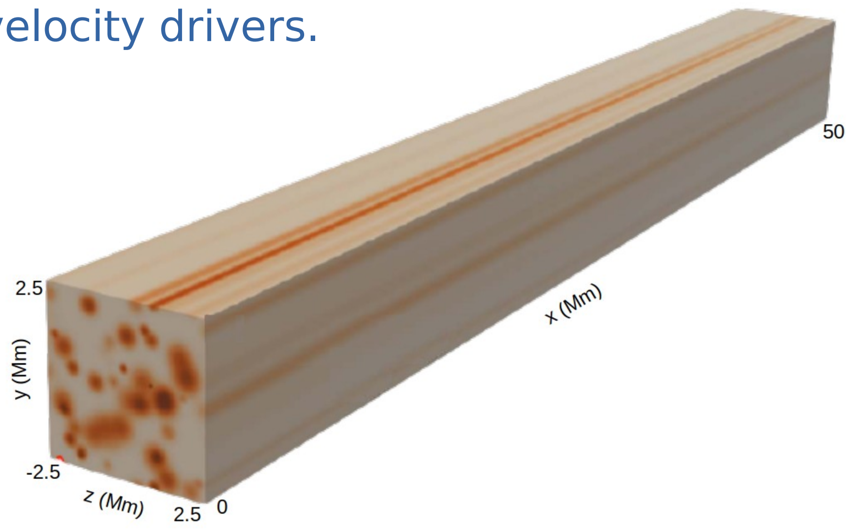
Background and Motivation

- A class of solar coronal heating model that has drawn attention from the last decade is the **MHD wave driven turbulence,** which also plays an important role in the density inhomogeneity in the solar corona.
- The **density filling factor** is defined as the fraction of the volume occupied by the overdense plasma columns with respect to the total volume of the region.
- The study of the density filling factor is imperative to estimate the true energy flux carried by the waves in the solar corona.

We have studied the variation of density filling factor in the solar corona due to the generation of the transverse MHD wave-driven turbulence

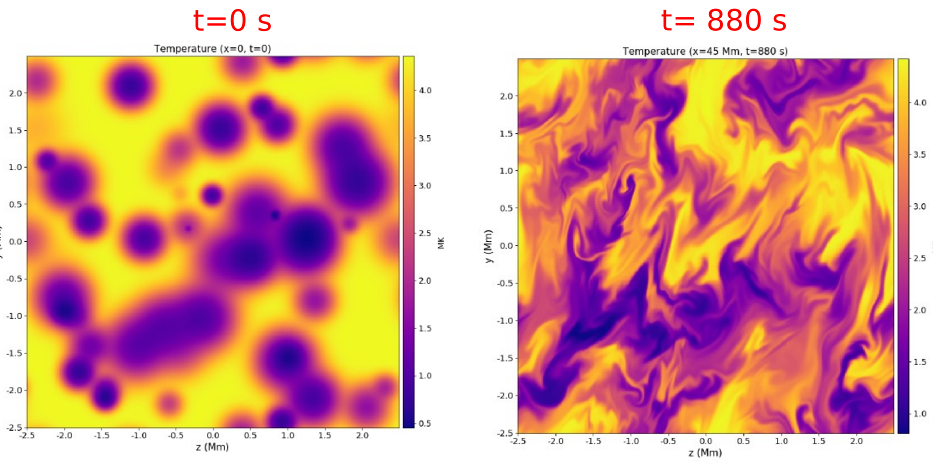
AMRVAC Simulation

- **Incorporation of density inhomogeneties** along x direction following Gaussian distribution along y-z direction (Pant et al. 2019).
- **Waves are excited** at the bottom boundary (x=0) by incorporating velocity drivers.



Temperature distribution in y-z plane obtained from simulation

t=0 s t= 880 s



We have estimated the density filling factor by two methods

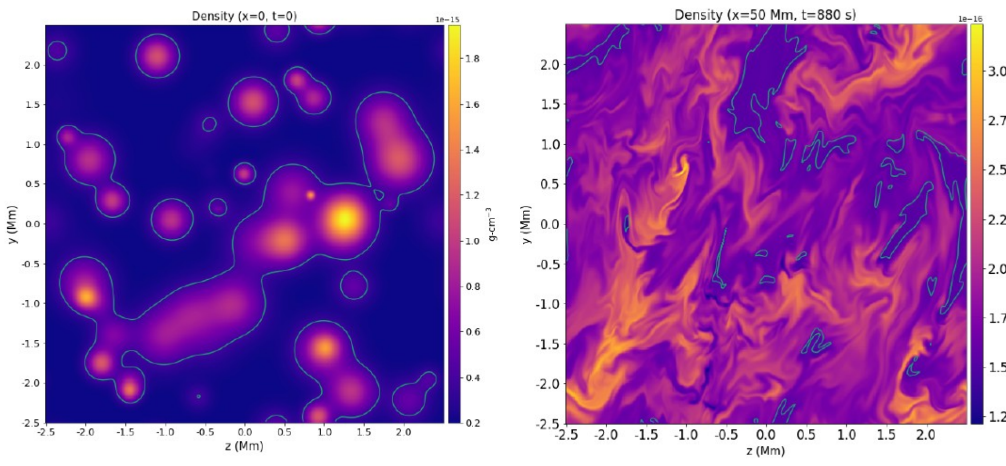
Estimation of density filling factor

Method-1

From the area measurement of the density enhanced regions

Density distribution in y-z plane from simulation

t=0 s t=880 s



Contours for density threshold

$$\rho_{th}(x) = \rho_{min}(x) + \lambda_f(\rho_{max}(x) - \rho_{min}(x))$$

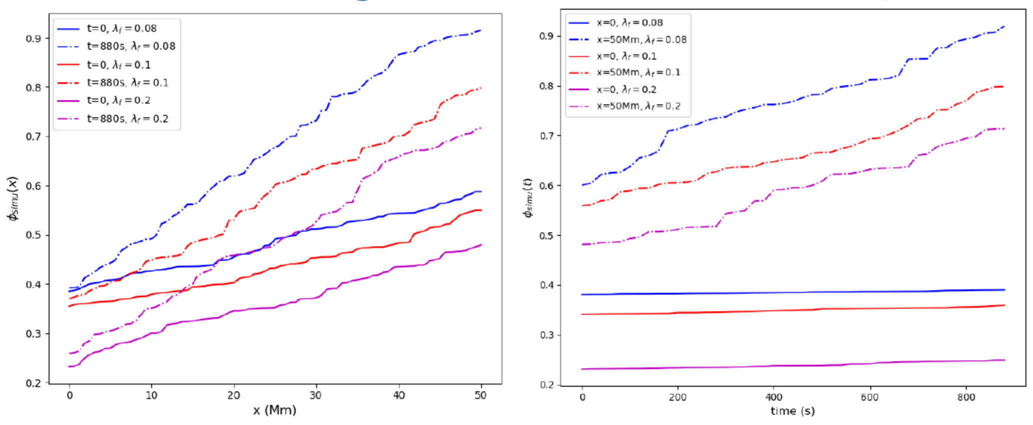
Density filling factor from area measurement

$$\phi_{\text{simu}}(x) = \frac{\text{Area of the region whose density is more than } \rho_{th}(x)}{\text{Area of the } y - z \text{ plane}}$$

Results

Variation of density filling factor

with height with time



Method-2

From forward modeling using FoMo

- We convert the physical variables obtained from the simulation into spectroscopic observables (specific intensity) using **forward modeling by FoMo** (Van Doorsselaere et al. 2016).
- We degrade the generated synthetic images into the spatial resolution of EUV imaging Spectrograph (EIS) (1 ”/pixel)
- We estimate of filling factor from Gupta et al. (2015)

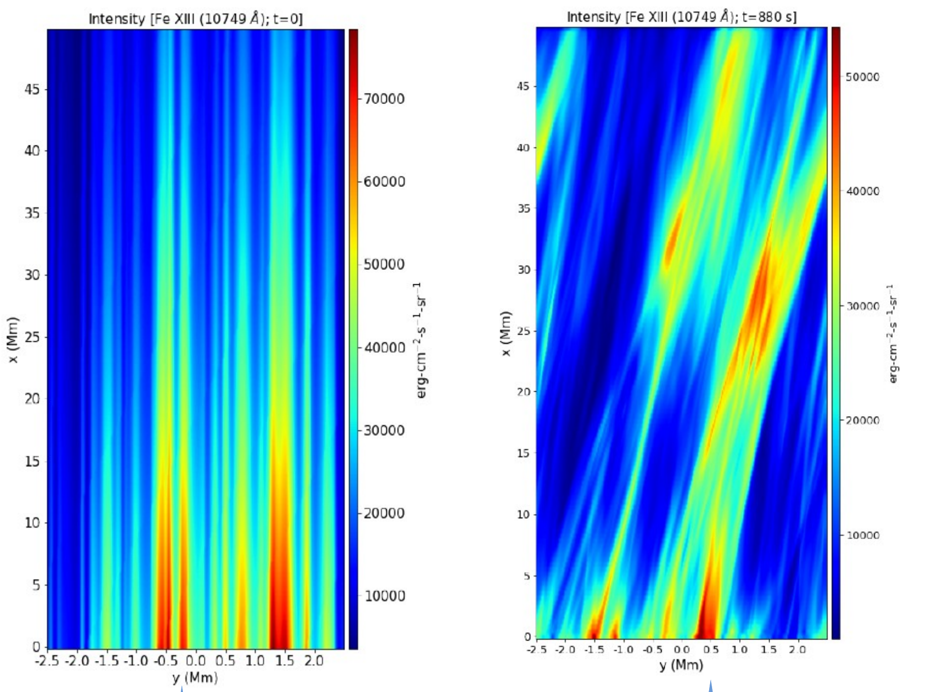
$$\phi = \frac{I_{EIS}}{0.83 A_b G(n_e, T) n_e^2\ h_{eff}}.$$

- **Effective depth** of the overdense plasma regions, $\mathbf{h_{eff}}$ is calculated by fitting Gaussian to the intensity across the overdense plasma regions at different heights and taking the FWHM.

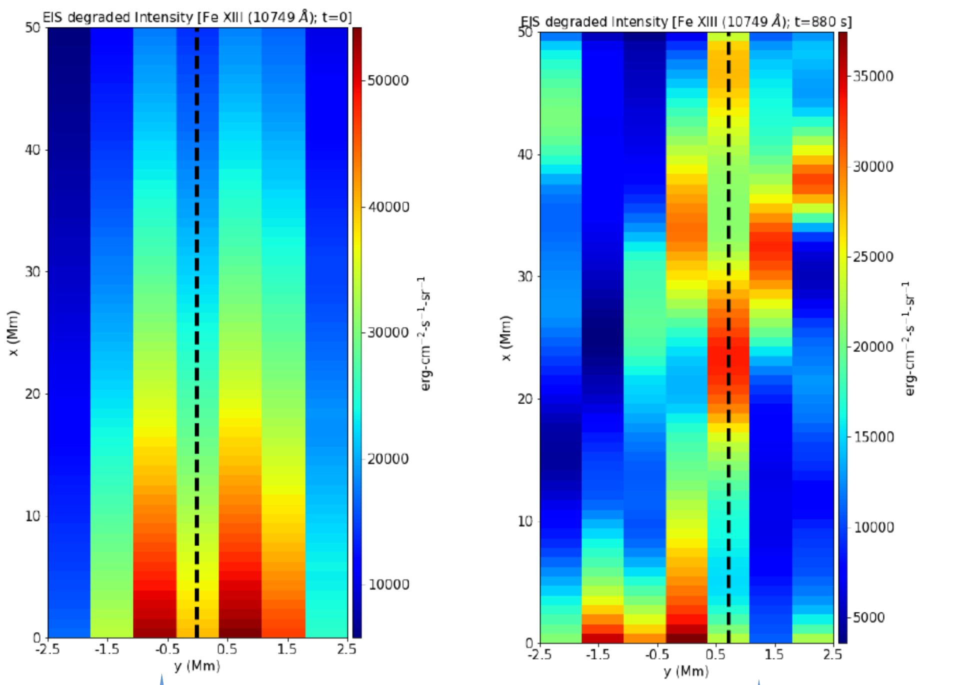
Synthetic Images from FoMo

without turbulence with turbulence

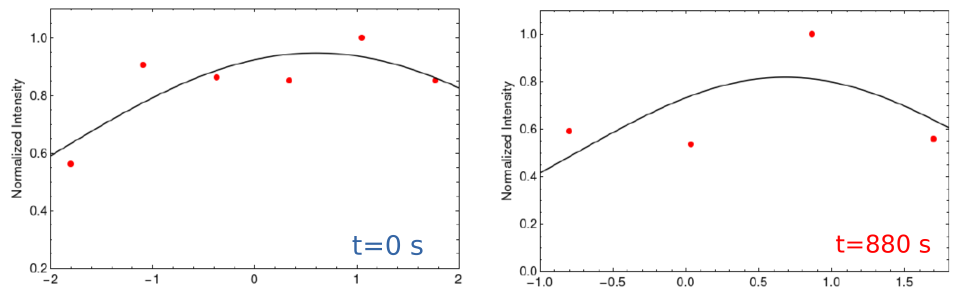
Without degradation



EIS degradation



Intensity gaussian fit

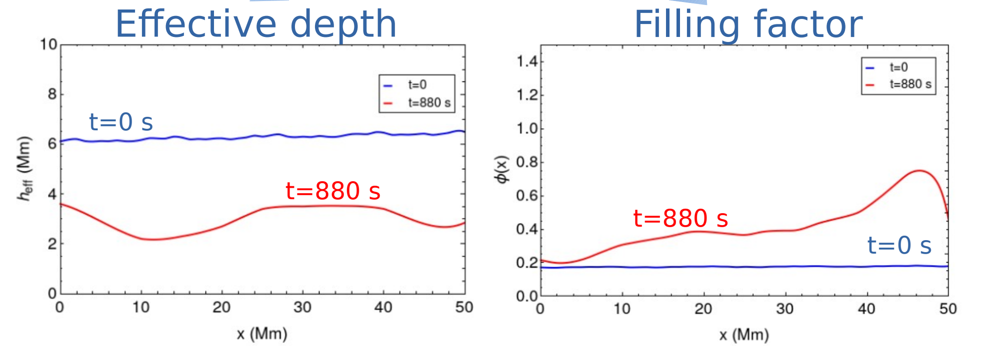


Density, n_e is estimated from intensity ratio of **FeXIII 10749** and **10800 Å** and the calibration of intenisty ratio vs n_e obtained from **CHIANTI**.

Results

Variation with height

Effective depth Filling factor



Take home message:

Filling factor of the overdense structures increases due to wave driven turbulence, and the medium becomes more density homogeneous.

References

- Gupta et al. (2015), ApJ, 800:140
- Pant et al. (2019), ApJ, 881:95
- Van Doorsselaere et al. (2016), FASS, 3, 4