

A catalog of waves

-or-

A systems approach to studying waves in the solar atmosphere

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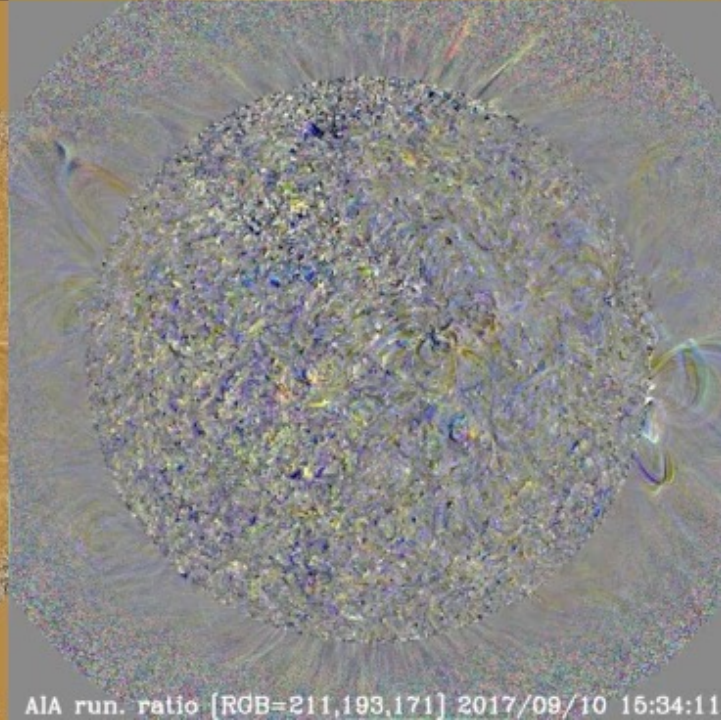
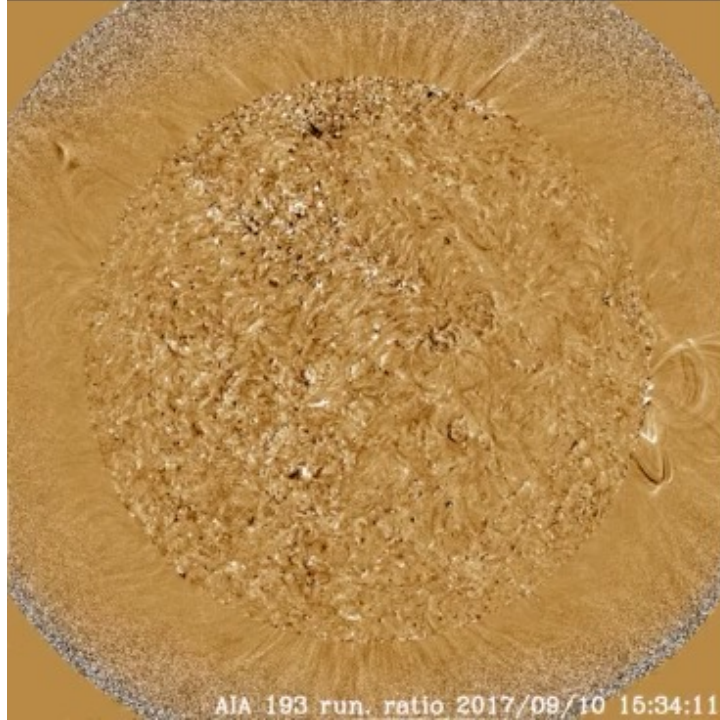
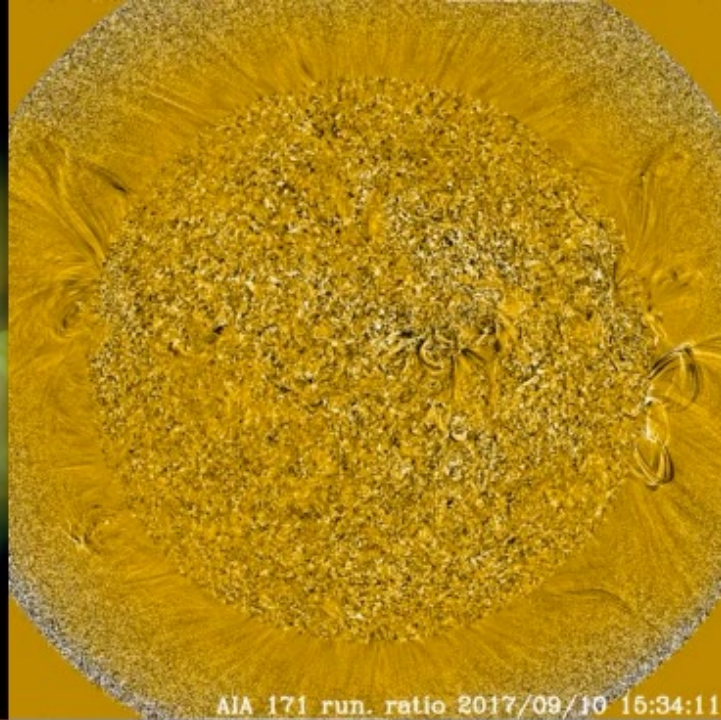
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Background image:

<https://www.etsy.com/shop/HiddenHale>



Outline:

1. Wave ubiquity
2. Power dependence
3. Sources
4. Propagation
5. The global picture

Liu+2018 ApJ 864

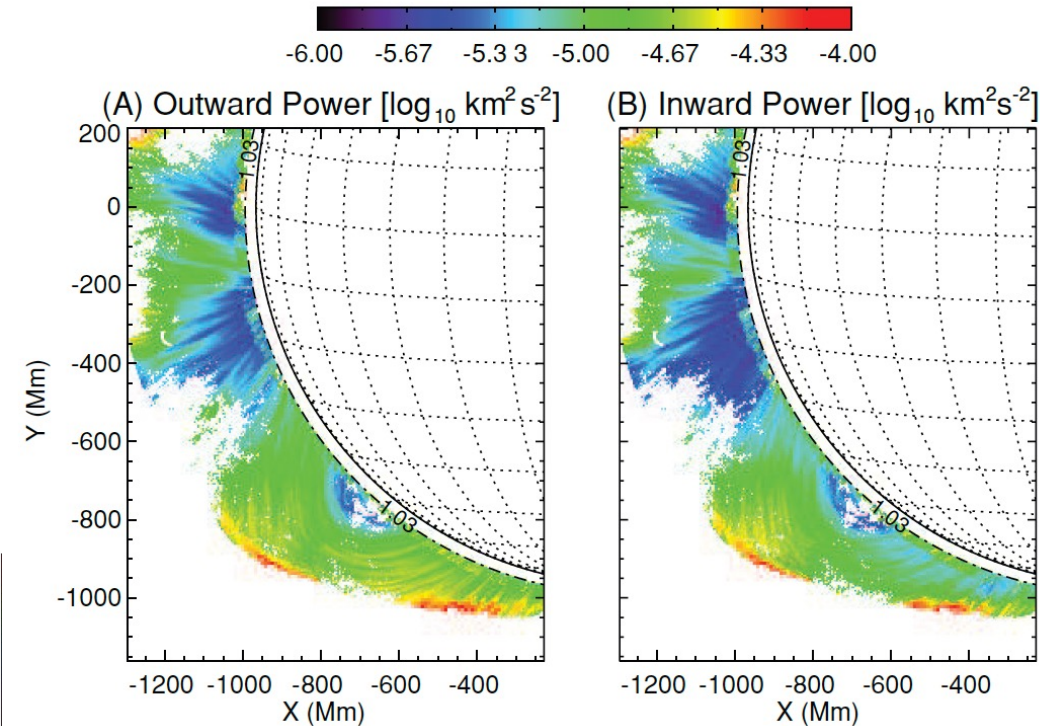
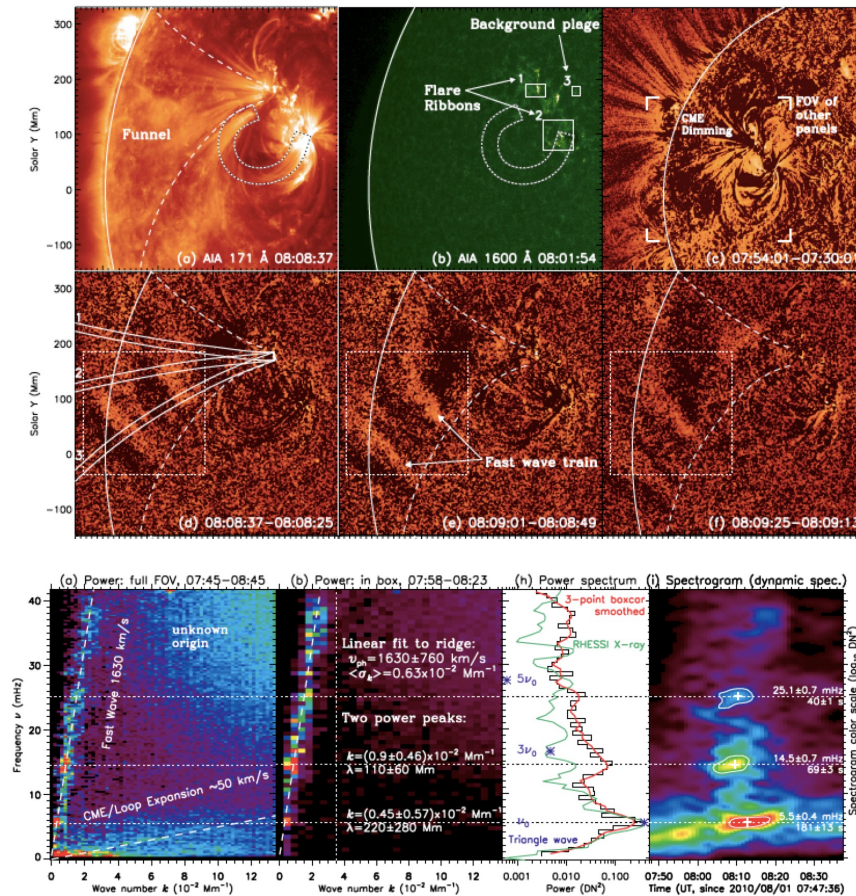
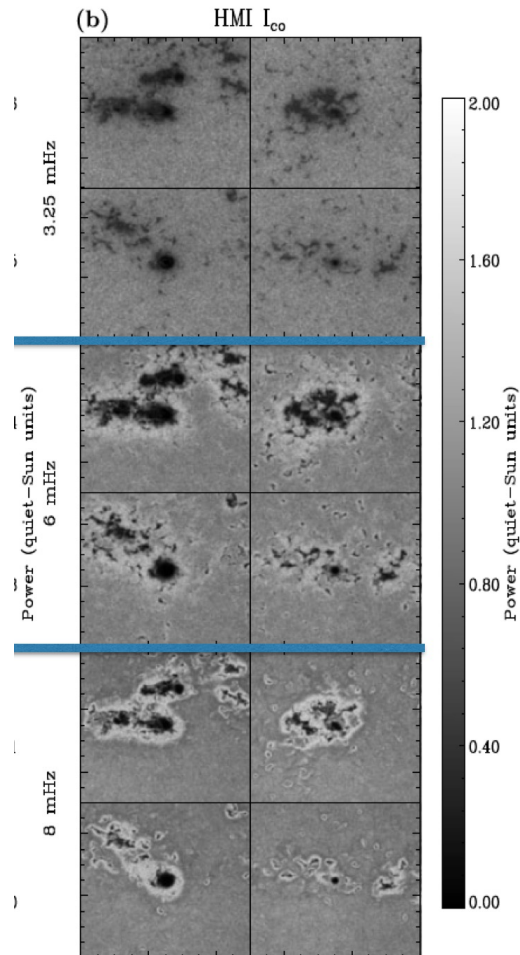
Waves are everywhere!

Why? Because MHD equations are hyperbolic, so basically everything generates waves

Rajaguru +2013 SolPhys 287

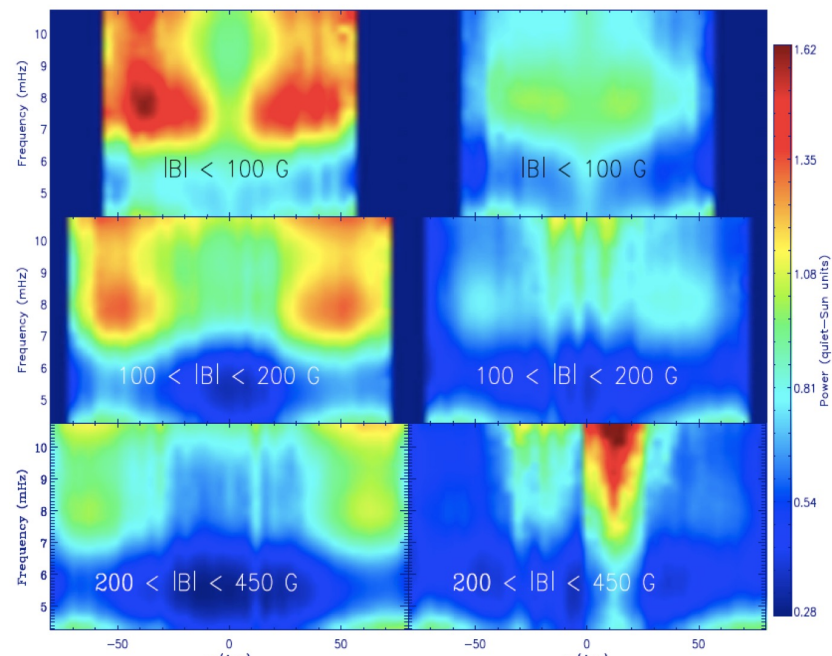
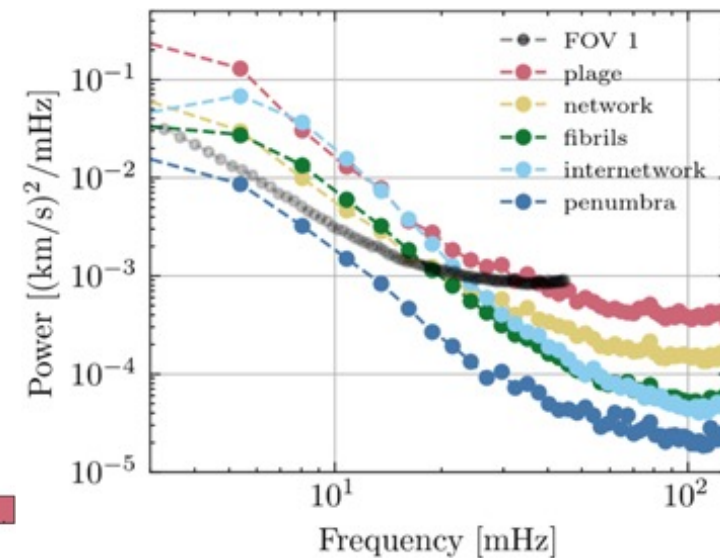
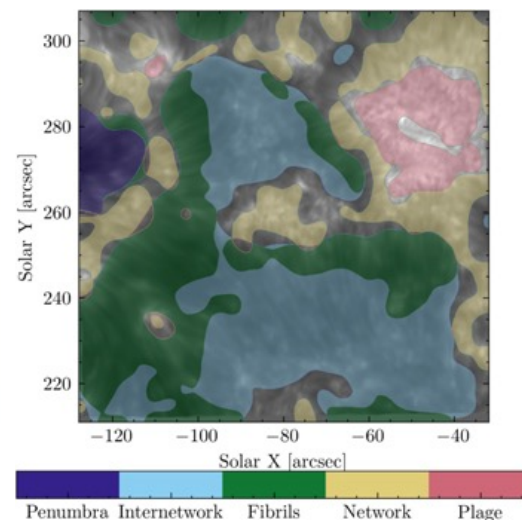
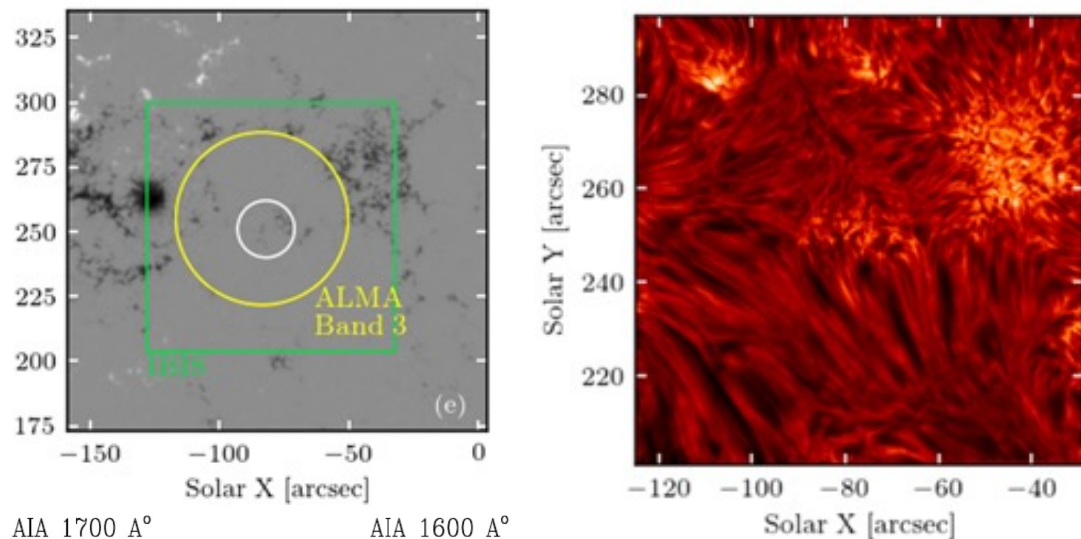
Liu+ 2011 ApJL 736

Tomczyk & McIntosh 2009 ApJ 697

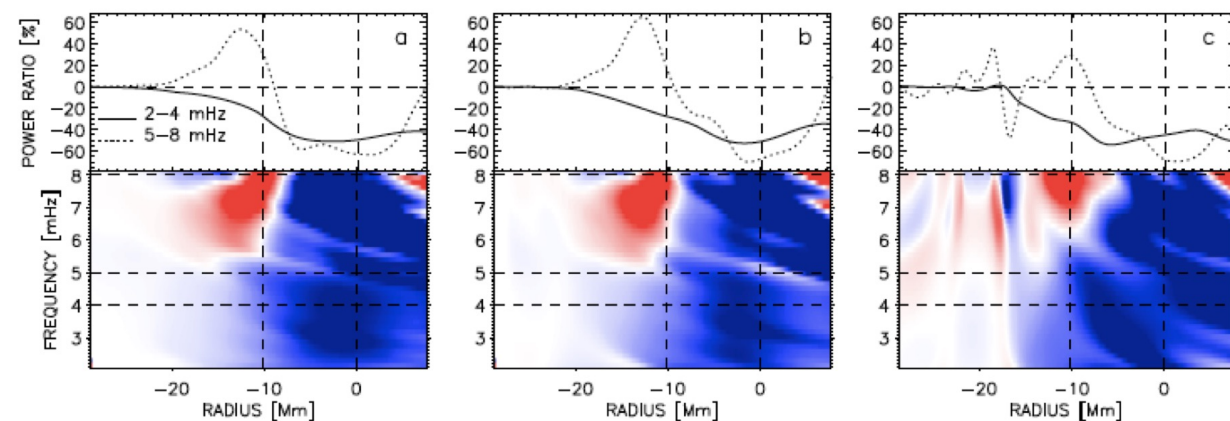


Wave power varies with everything

Molnar + 2021 ApJ 920

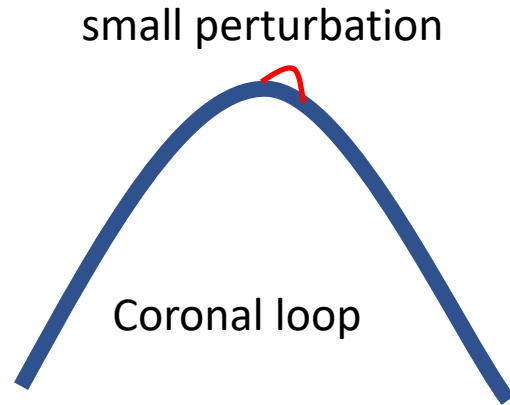
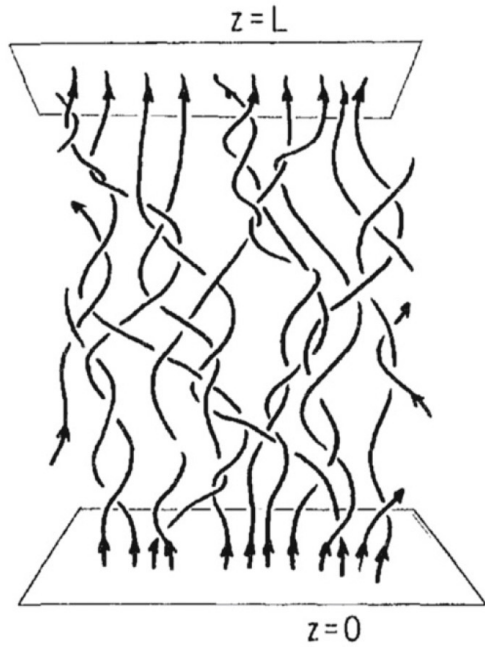


Rajaguru +2013
SolPhys 287



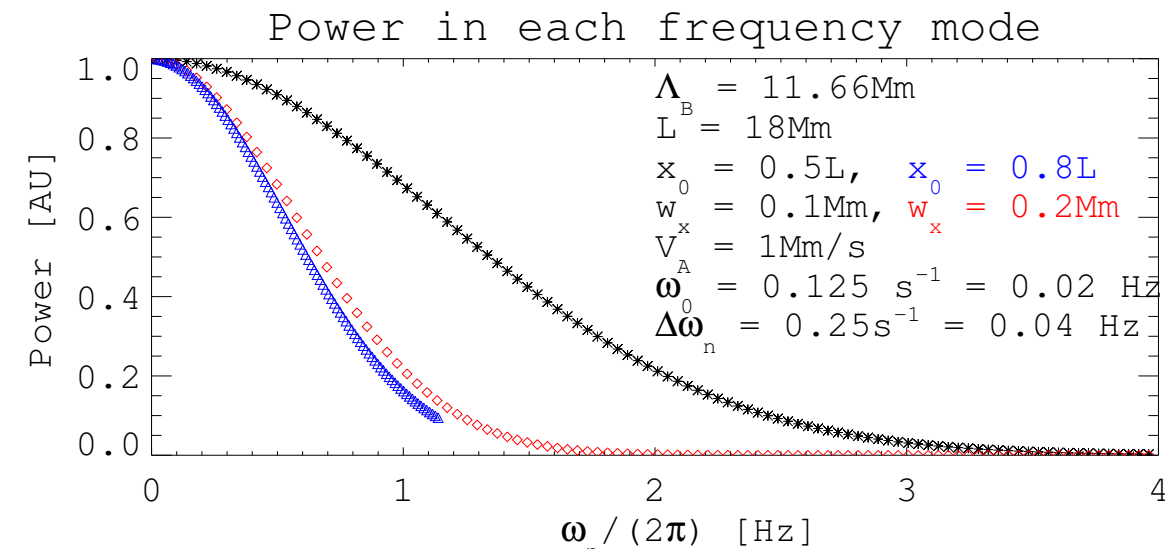
Power vs Source depth: a) -35Mm, b) -30Mm, c) -20Mm –
Khomenko+ 2009 AA

In addition to photospheric convective driving, there's at least some wave emission in the corona



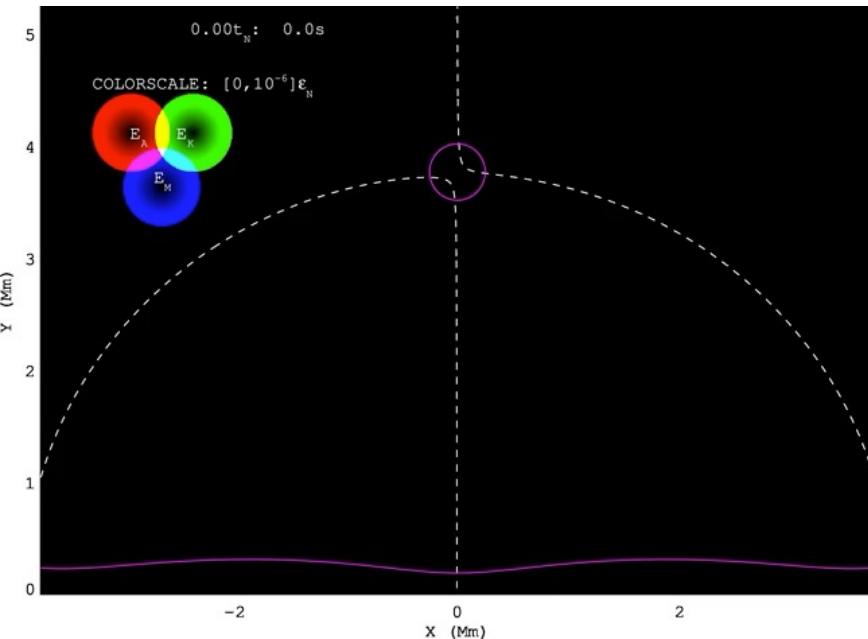
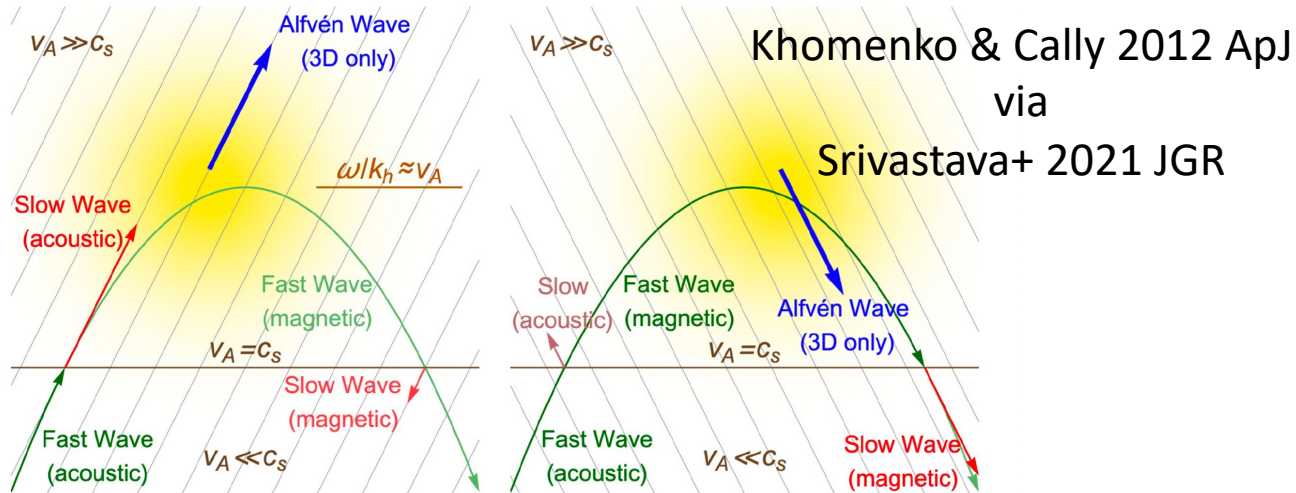
Open Questions:

1. What waves are generated?
2. How much power do they have?
3. How often are they emitted?



Tarr 2017 ApJ 847; see also Jain 2020 PP 27

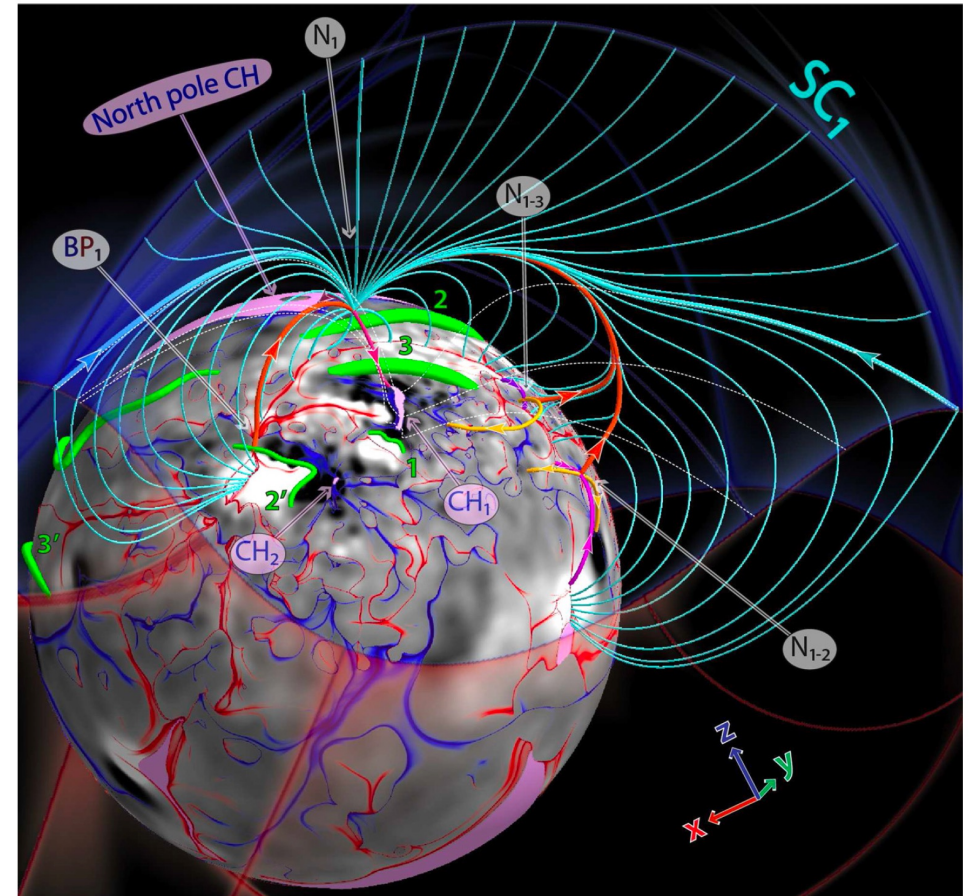
Inhomogeneous atmosphere: Complicated and interesting wave propagation



Tarr & Linton 2019
ApJ 879

Essentially a scattering process

In total, 70% conversion, 7% transmission, 23% dissipation



Topology in a coronal Model (Titov+ 2012 ApJ 759)

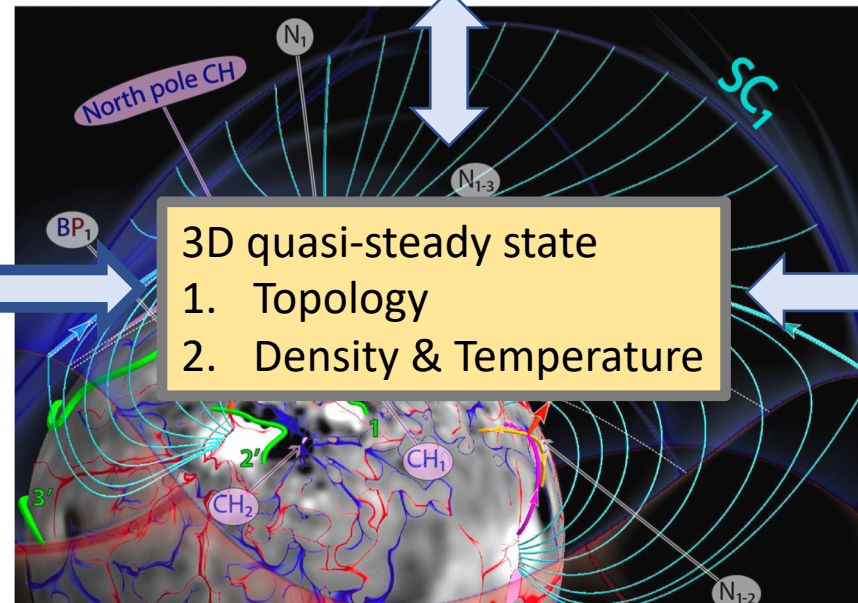
Building a 'system model' for solar atmospheric wave mechanics

Wave Sources:

1. locations
2. temporal emission frequency
3. Power into each spatial/frequency/mode bin

Propagation Aspects

1. scattering locations
2. Ideal mode conversion
3. Coupling to partially-ionized modes
4. Interaction with "structured flux tubes"



Higher-level science questions

1. Dissipation (cascade, ion-neutral, phase mixing, shock)
2. Differential abundances (FIP effect -> solar wind)
3. Seismology

Observable properties

Phase speed, group speed and direction, phase relation between inferred quantities (intensity, temperature, velocity,...)
all need 2 fluid treatment in photosphere and chromosphere; time-averaged vs "quasi-particle" analysis

Effect of adaptive optics/post-processing?