Coronal Seismology

ASTR 598

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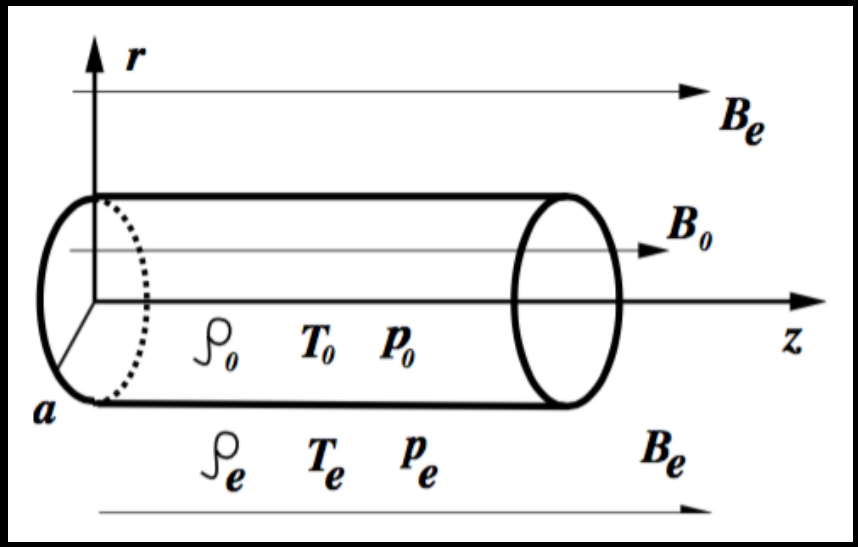
Magnetohydrodynamics (MHD)

Theory



- Straight flux tube in uniform magnetic field.
- $\xi(x) = \xi(r)e^{i(kz+m\phi)}$
- Characteristic speeds are determined by the environment

Types of waves/oscillations:

- Alfvén: $V_A = \frac{B}{\mu_0 \rho}$
- Magnetoacoustic: $C_s = \sqrt{\frac{\gamma P}{\rho}}$
  - Fast $C_{A_0} < C_{fast} < C_{A_e}$
  - Slow $C_{T_0} < C_{slow} < C_{s_0}$

Coronal seismology

Technique and motivation

Problem: properties of the corona, such as magnetic field strength, densities, and Alfvén velocities, are difficult to measure.

Solution: coronal seismology.

- Observe disturbances in the corona:
  - Period
  - Velocity
  - Timescales
- Compare observed quantities to MHD theory to identify the type of wave or mode.
- Insert observed properties into appropriate equations to derive coronal parameters.

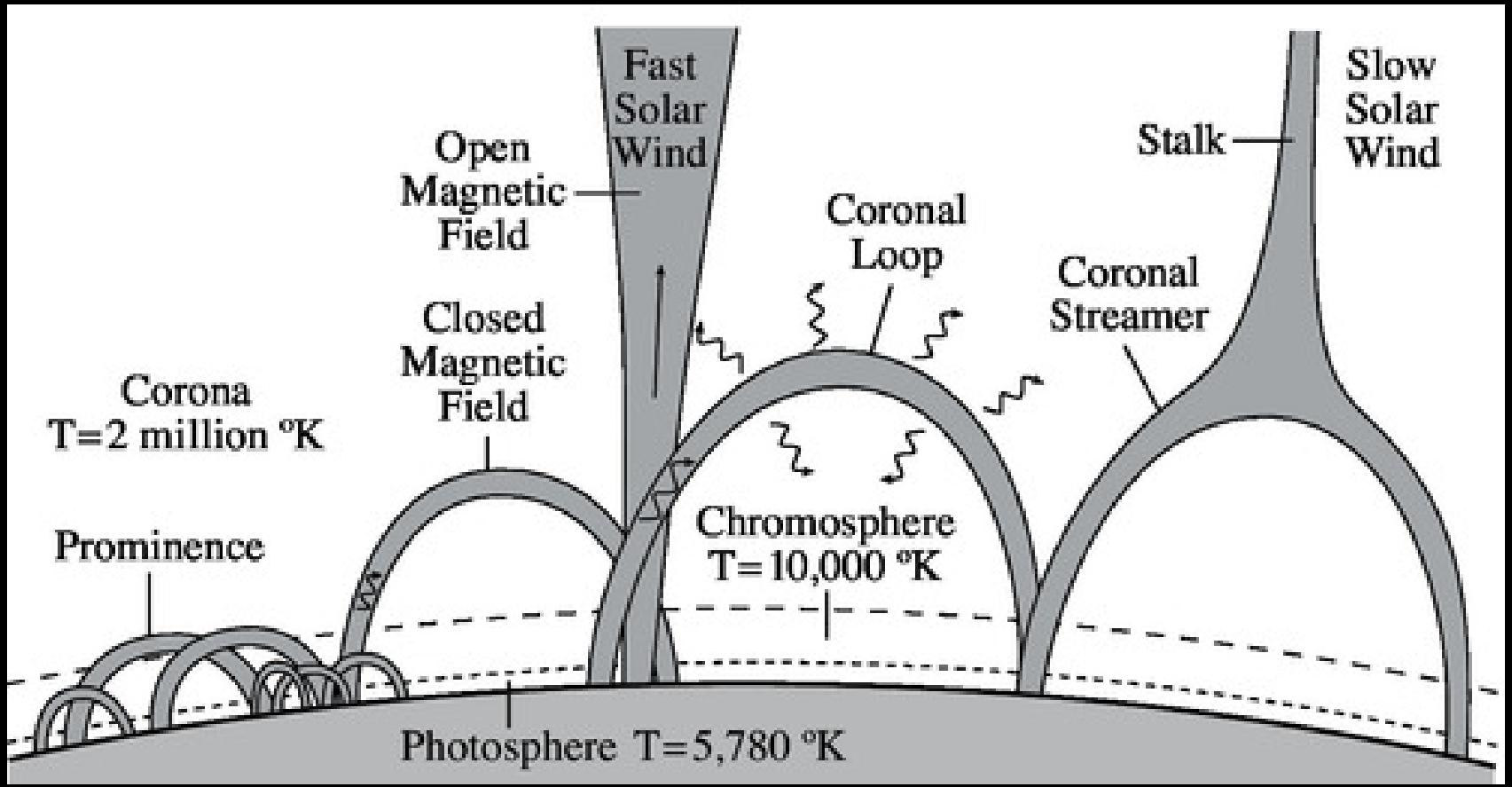
Current questions:

- How are these disturbances initiated?
- How are they damped, and what determines the timescales?

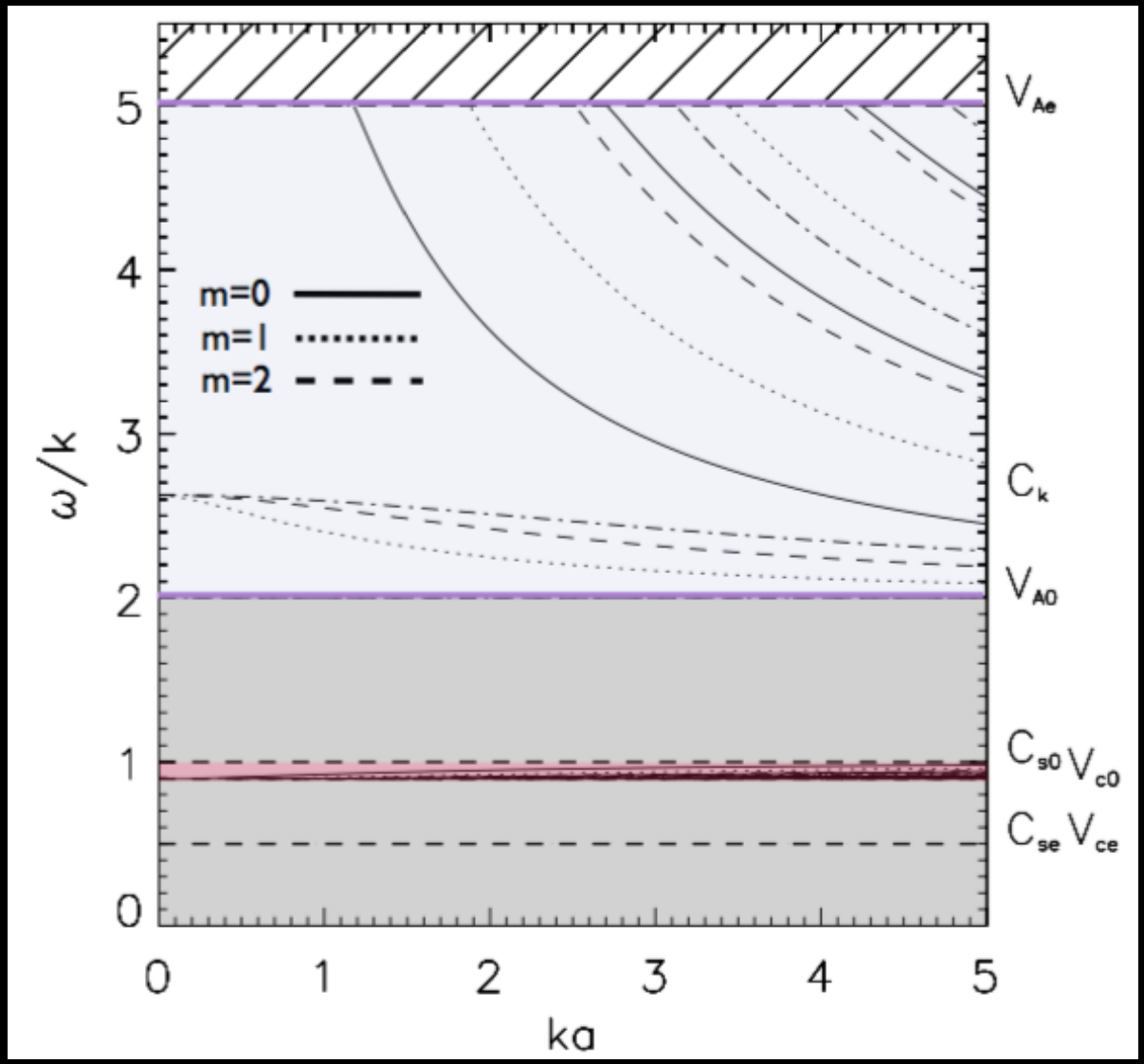
Motivation:

- Coronal heating problem
- Constraining flare/CME environment

Coronal seismology



Dispersion diagram



MHD modes

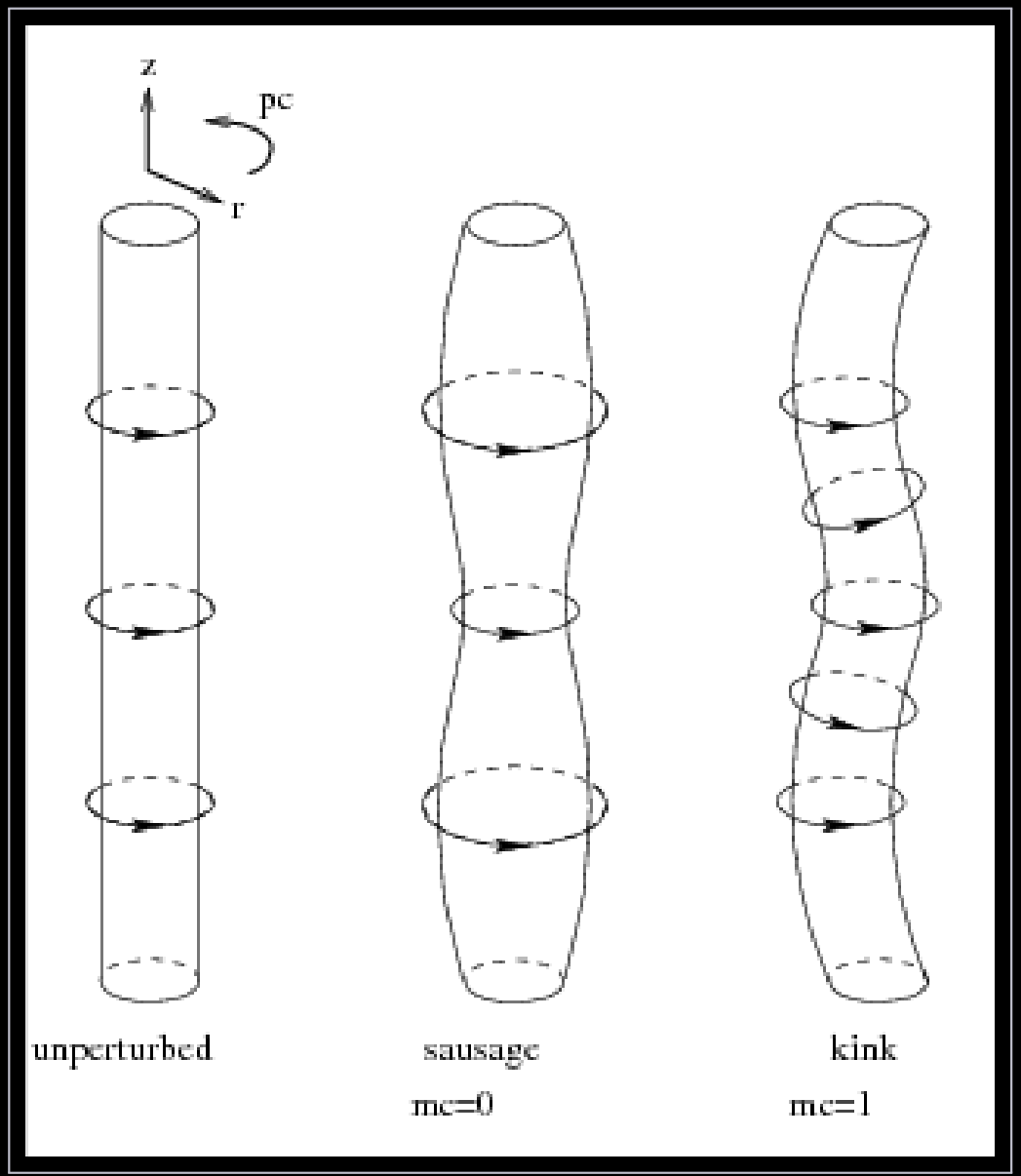
Oscillations vs. waves

(Or magnetoacoustic vs. Alfvén.) (Or fast vs. slow.) [insert characteristic speeds, periods, how observed, etc. here].

- Fast standing oscillations
  - Kink
  - Sausage
- Slow standing oscillations
  - Acoustic
- Propagating slow waves
  - Acoustic
- Propagating fast waves
  - Moreton
  - EIT waves
- Torsional modes (aka. Alfvén waves)

Fast standing oscillations

Kinks vs. Sausages



Kink

- loop spatial displacement
- Asymmetric
- No intensity change
- $k\sigma \ll 1$, or $\sigma \ll \lambda$

Sausage

- No loop spatial displacement
- Symmetric
- Intensity change $\rightarrow$ density change
- $\lambda \sim \sigma$

Important Properties

	period	**wavelength**	**velocity**
kink osc	value	value	value
sausage osc	value	value	value
acoustic osc	value	value	value
acoustic waves	value	value	value
fast waves	value	value	value
torsional modes	10 m	value	1000 km s^{-1}

Research

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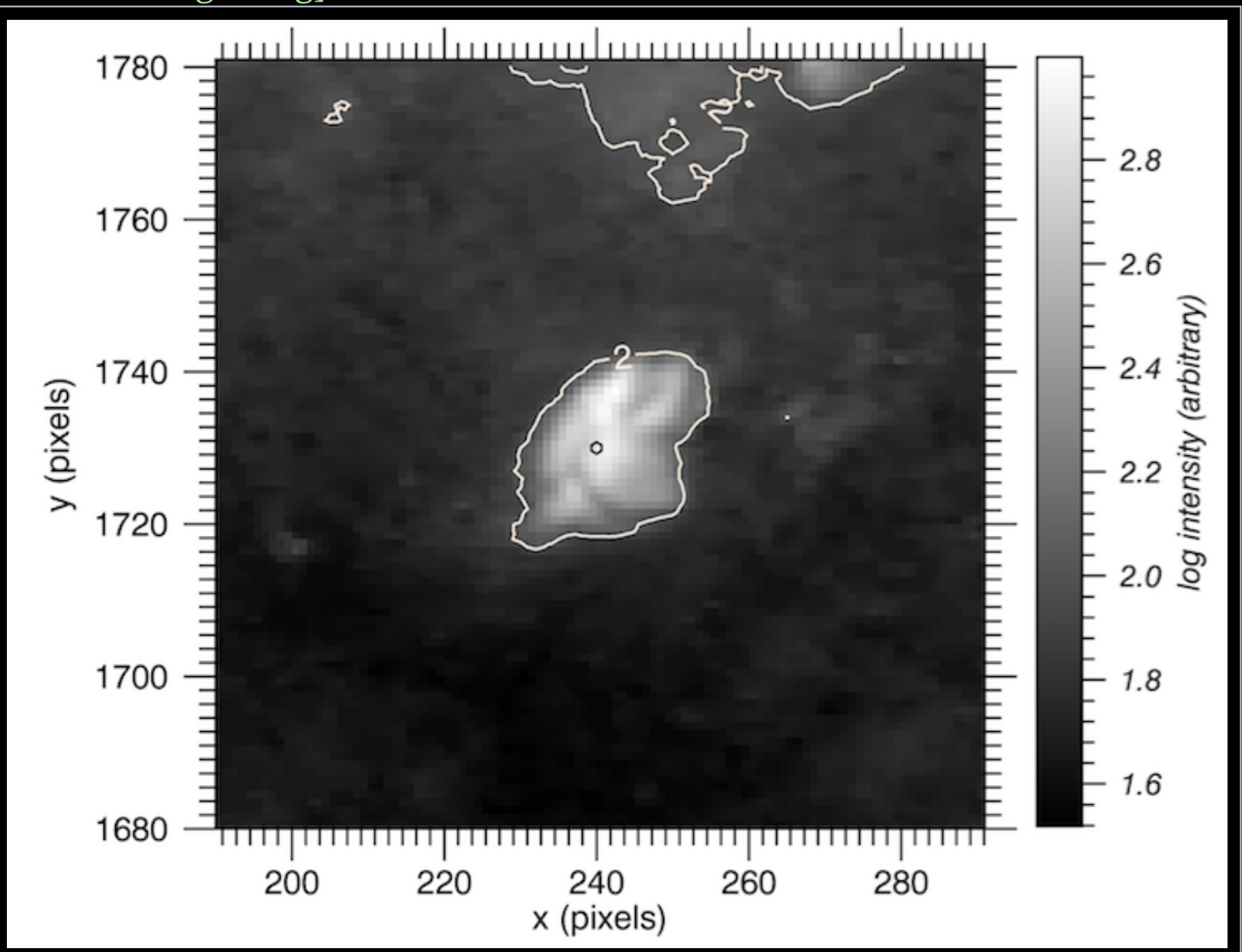
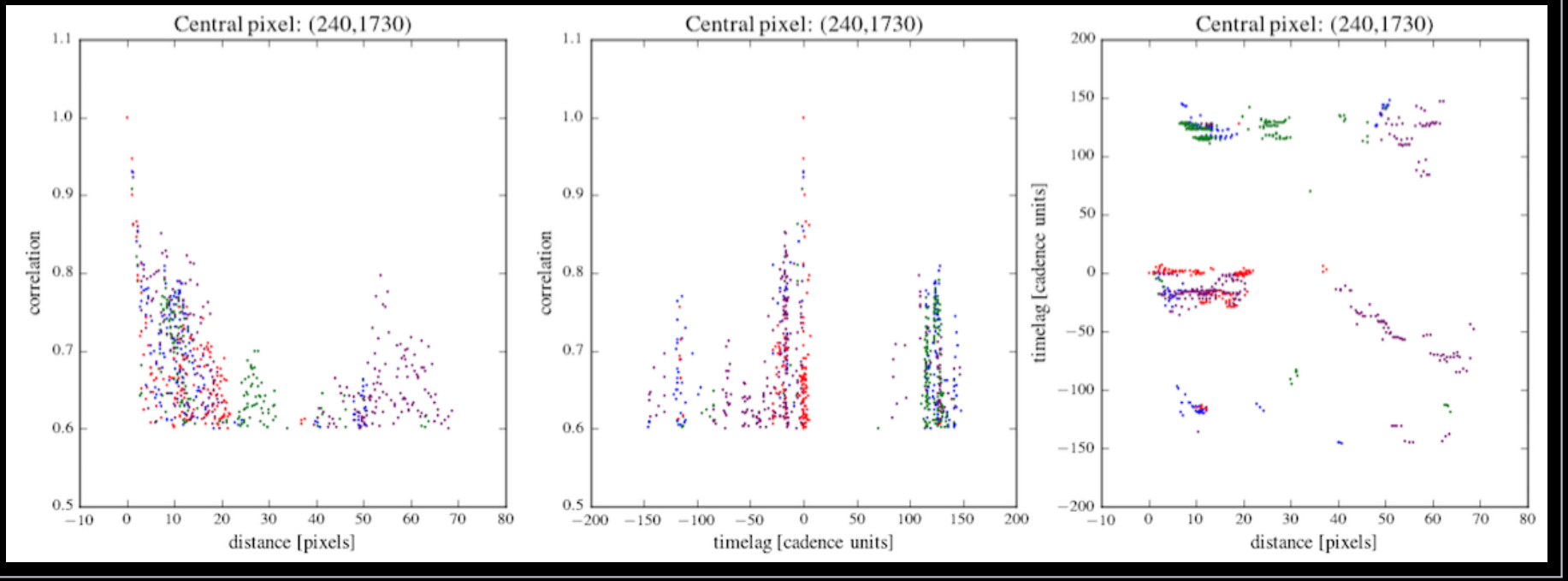


Research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