XVIth Astrophysical Colloquium, Hvar

I. Piantschitsch

Figure: Large Scale Propagating Disturbances and Interaction with a Coronal Hole (Taken from Olmedo 2012)

unilogo

Motivation

- **Coronal Waves (CWs):**
  - large scale propagating disturbances in the corona
- **Coronal Holes (CHs):**
  - regions of low-density plasma
  - magnetic field lines open freely into interplanetary space
- **Interactions between CWs and CHs**
  - Which effects can be expected?
  - What are these effects useful for?

unilogo

Questions & Problems

- What is the nature of a CW?
  - wave - pseudo wave - hybrid
- Which effects are caused by CH-CW- Interaction?
  - secondary waves (reflected, transmitted, ...)
  - stationary features
  - density depletion
- How are these effects related to actual problems?
  - Solar wind models / CH boundaries
  - diagnostic tool for plasma parameters
  - multi-fluid vs. single-fluid
  - projection effects in observations

unilogo

Questions & Problems

- **What is the nature of a CW?**
  - wave - pseudo wave - hybrid
- **Which effects are caused by CH-CW- Interaction?**
  - secondary waves (reflected, transmitted, ...)
  - stationary features
  - density depletion
- **How are these effects related to actual problems?**
  - Solar wind models / CH boundaries
  - diagnostic tool for plasma parameters
  - multi-fluid vs. single-fluid
  - projection effects in observations

unilogo

Questions & Problems

- **What is the nature of a CW?**
  - wave - pseudo wave - hybrid
- **Which effects are caused by CH-CW- Interaction?**
  - secondary waves (reflected, transmitted, ...)
  - stationary features
  - density depletion
- **How are these effects related to actual problems?**
  - Solar wind models / CH boundaries
  - diagnostic tool for plasma parameters
  - multi-fluid vs. single-fluid
  - projection effects in observations

unilogo

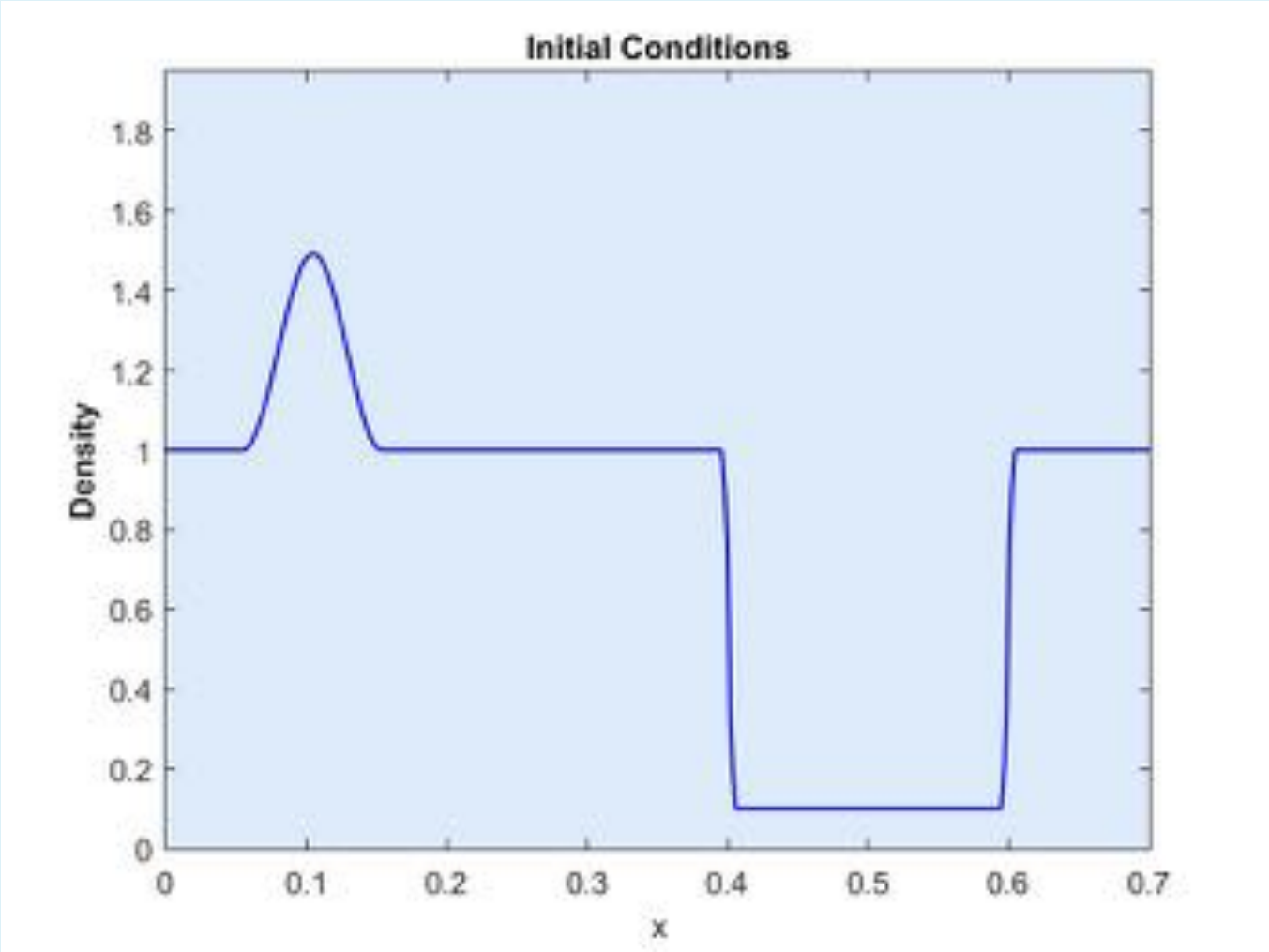
Code Description

2.5D MHD Code

- TVDLF Method (first described by Toth & Odstrčil 1996)
- Fully explicit method
- standard MHD equations
- 2nd order accuracy in space and time
- transmissive boundary conditions

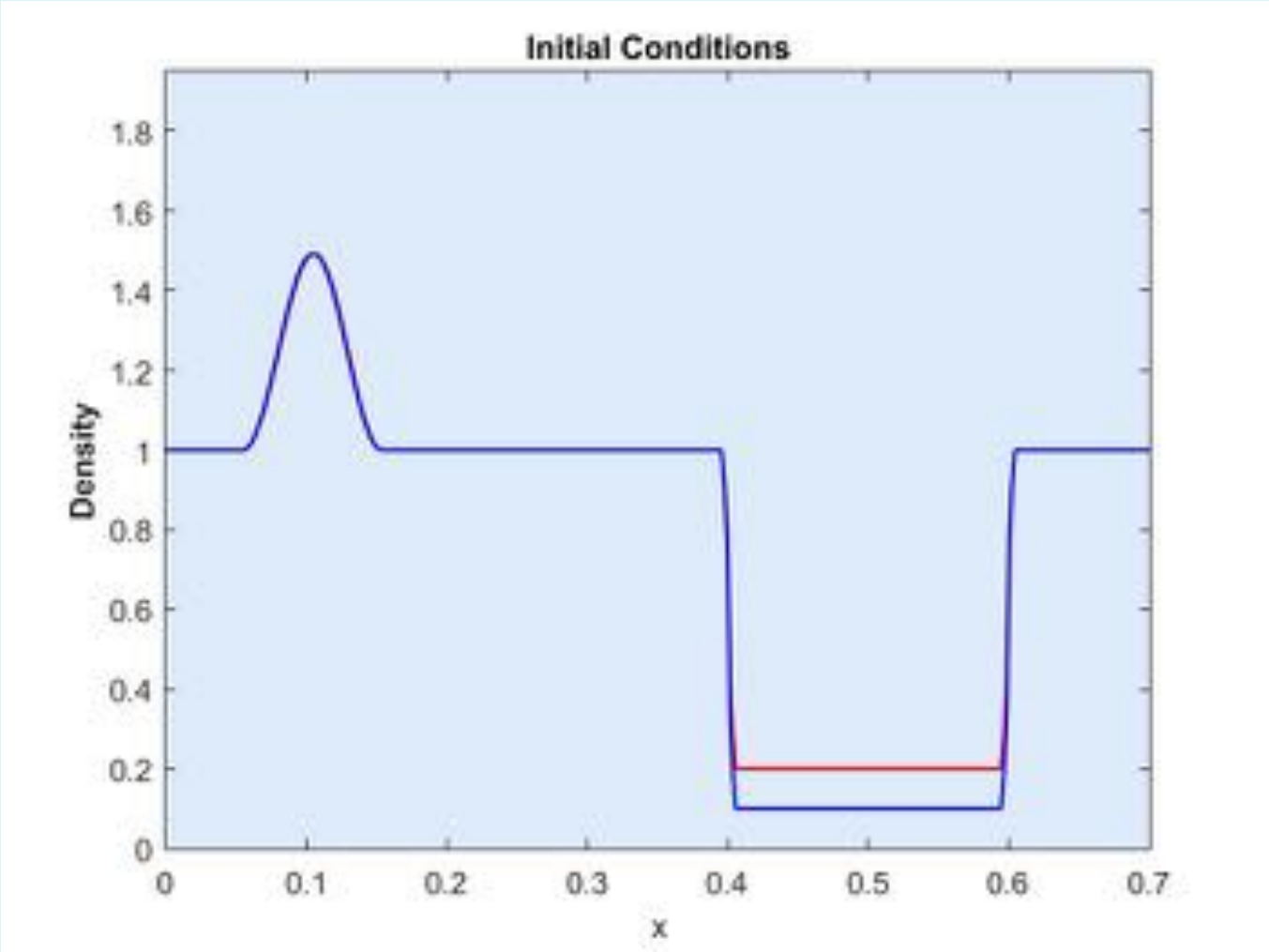
unilogo

Initial Setup



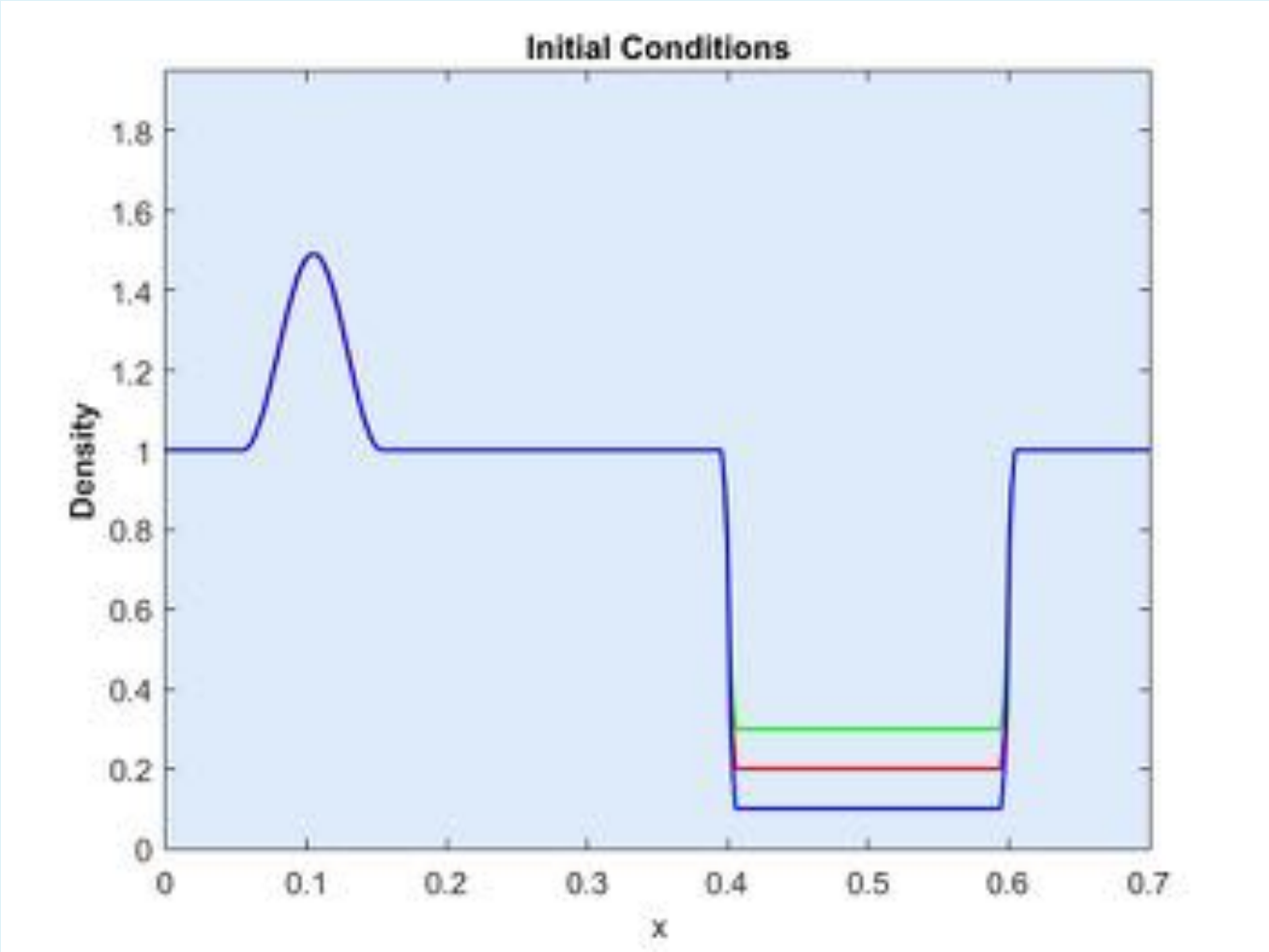
unilogo

Initial Setup



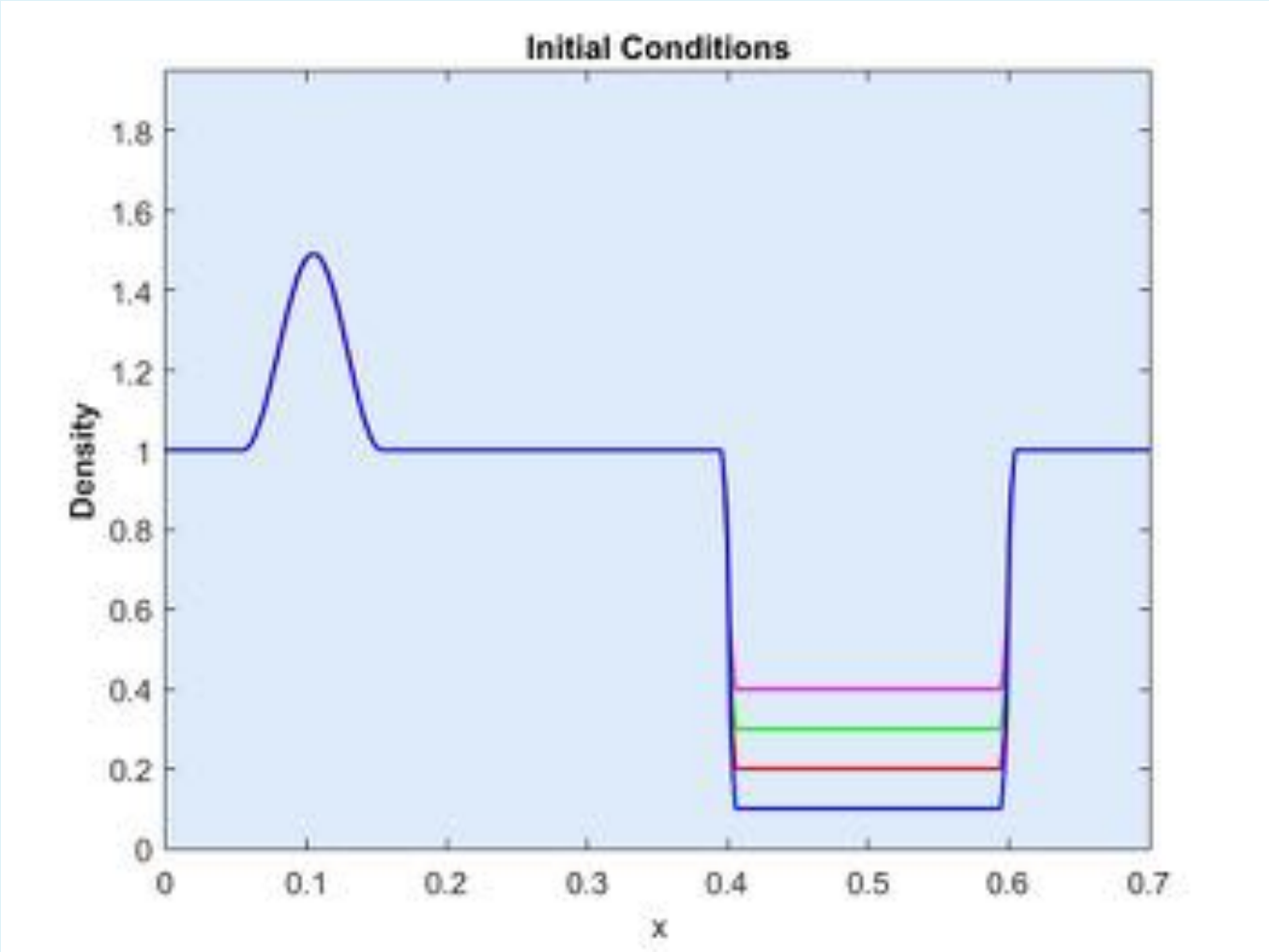
unilogo

Initial Setup



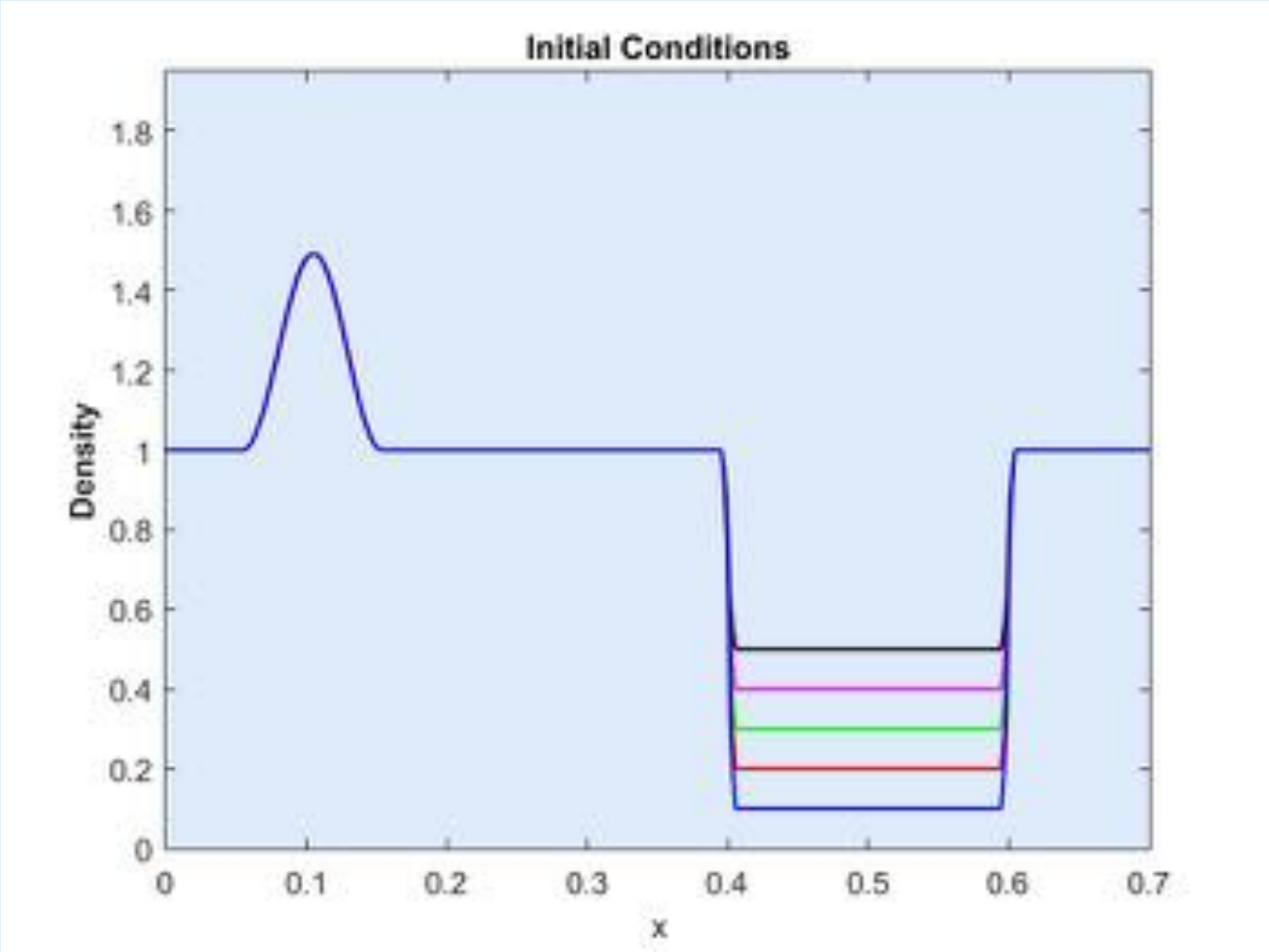
unilogo

Initial Setup



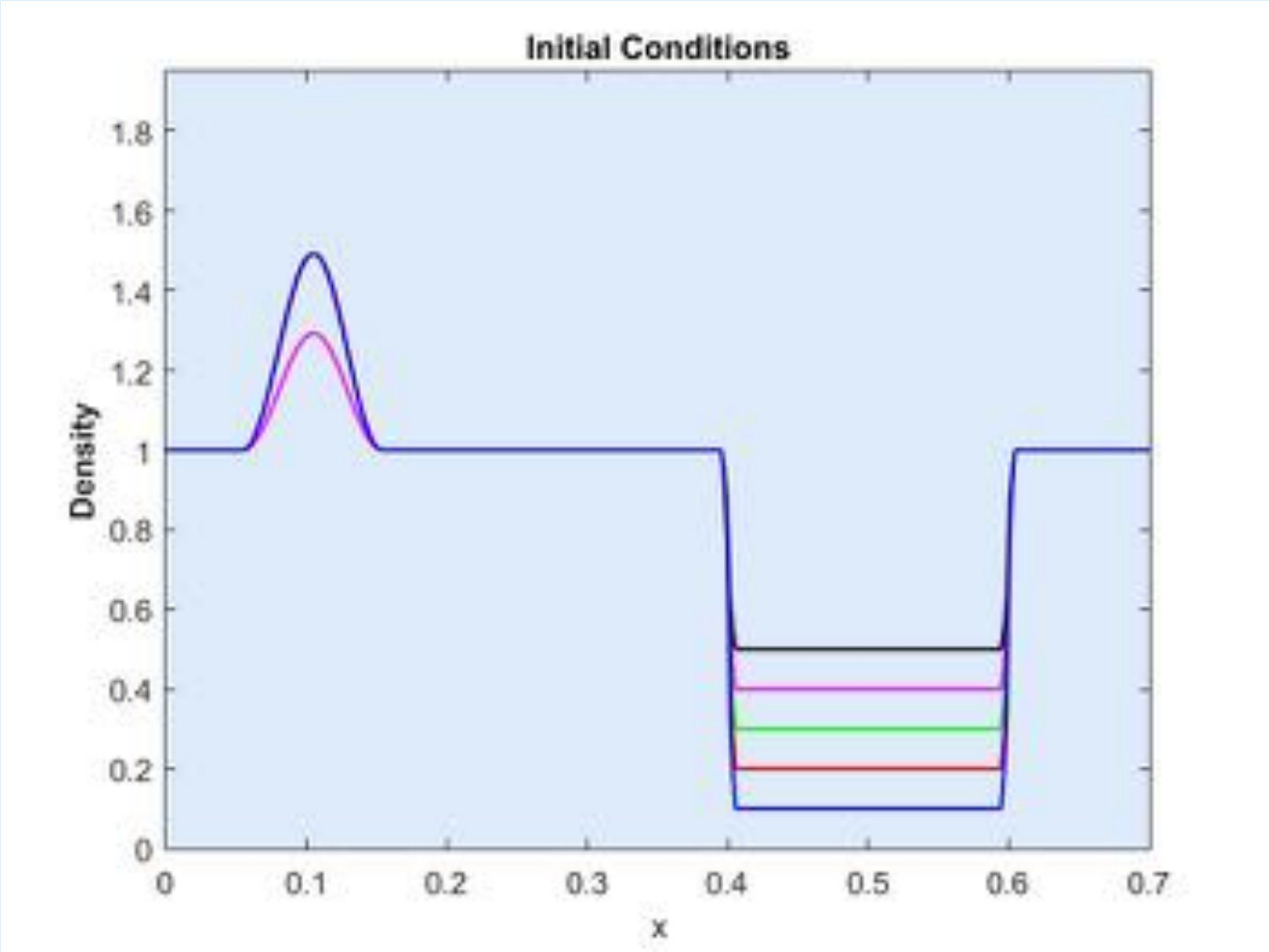
unilogo

Initial Setup



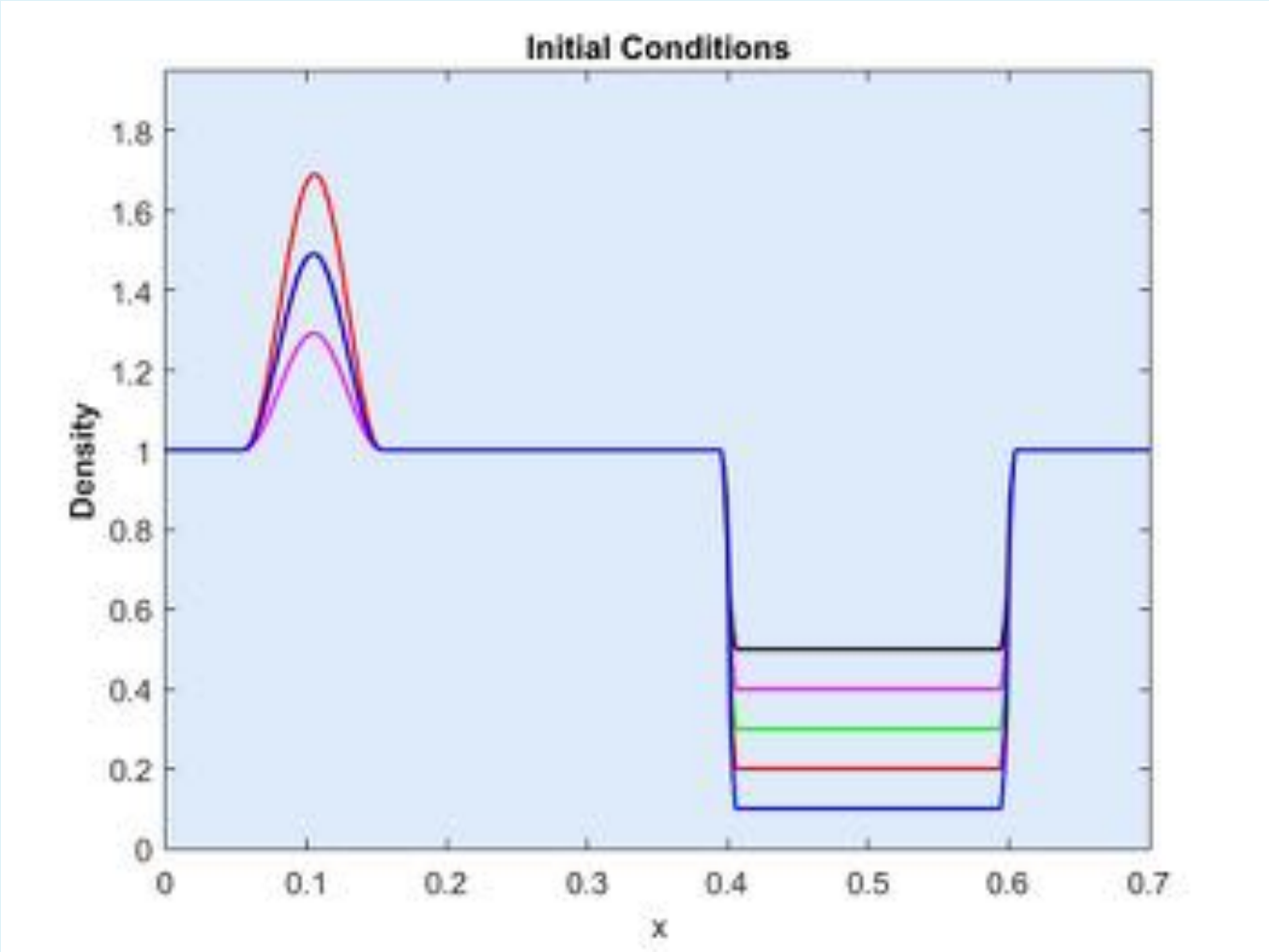
unilogo

Initial Setup



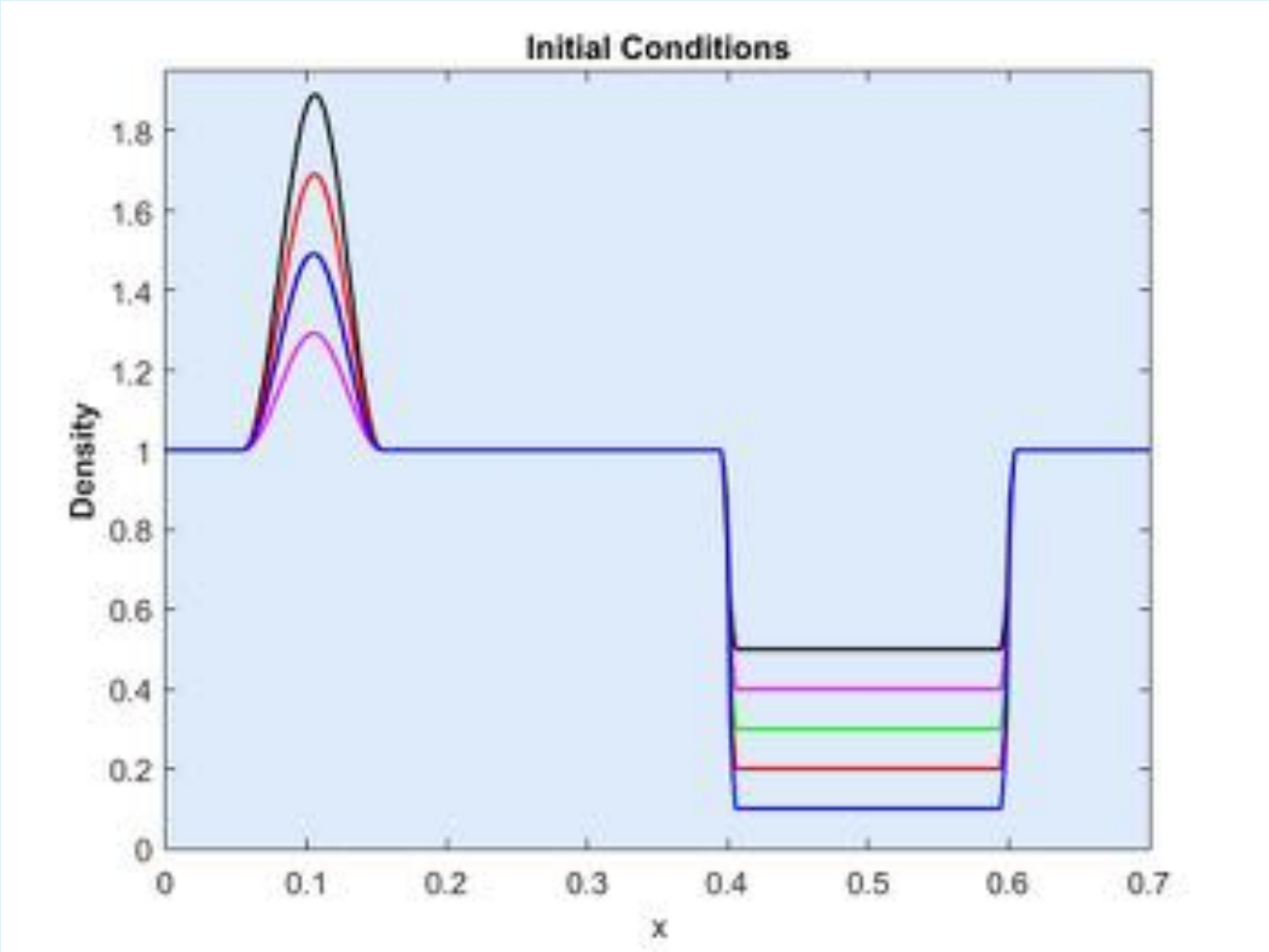
unilogo

Initial Setup

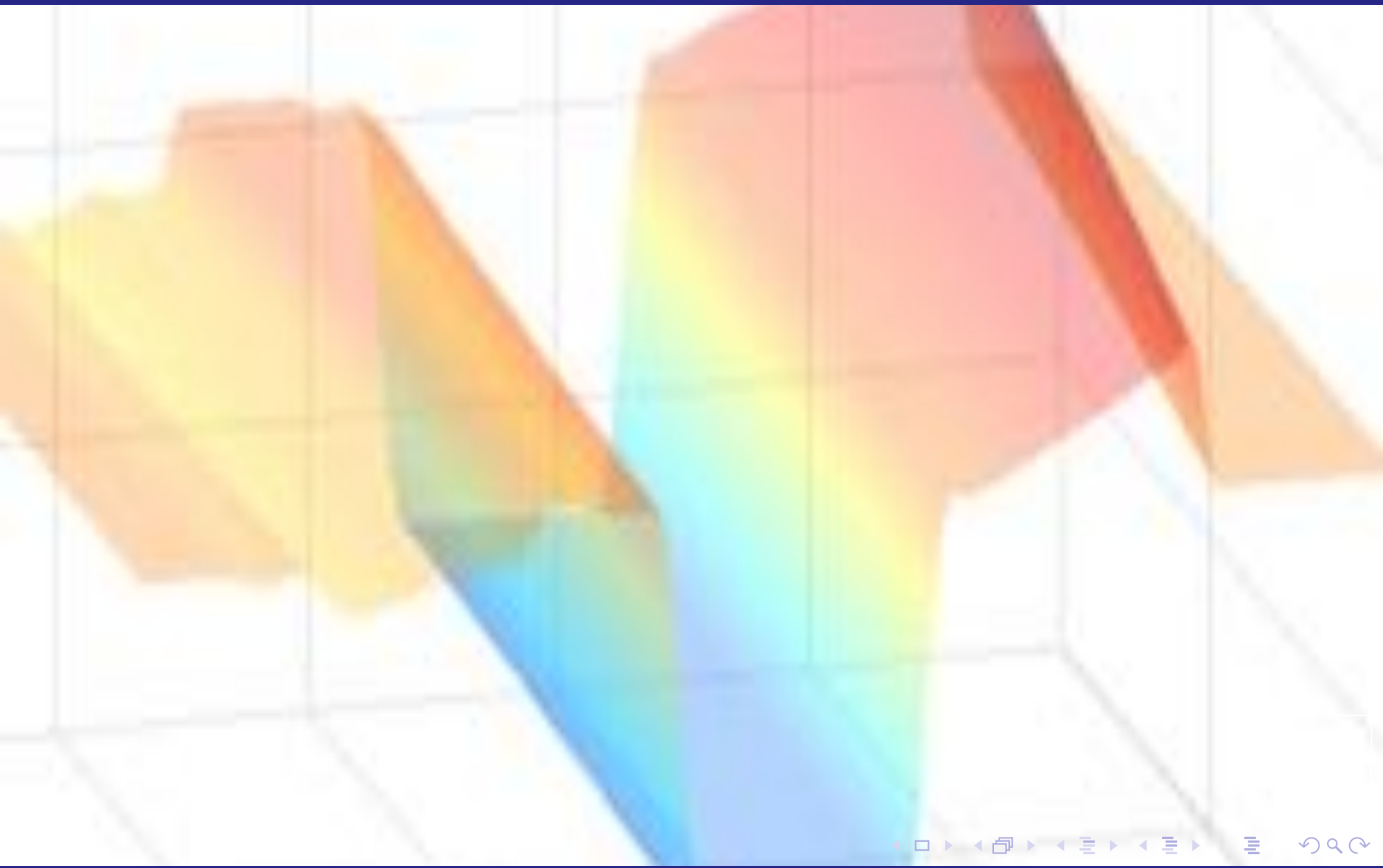


unilogo

Initial Setup



unilogo



unilogo

unilogo

EXTREME VALUES

- Large (small) phase speed of secondary waves if:
  - large (small) initial density amplitude
  - small (large) CH density
- Large (small) peak value of 1st stationary feature if:
  - large (small) initial density amplitude
  - large (small) CH density

unilogo

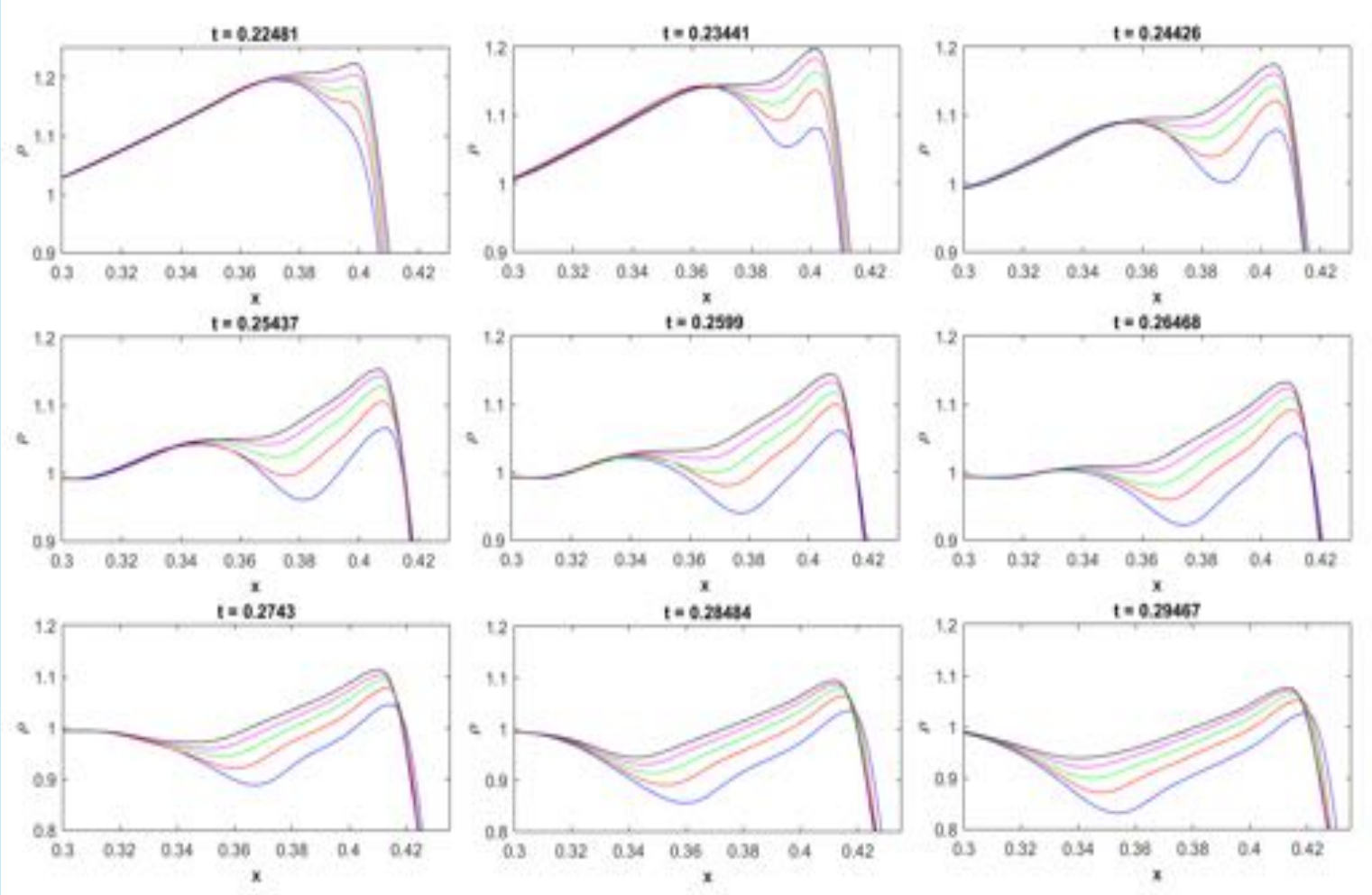


Figure: Morphology of 1st Stationary Feature (Taken from Piantschitsch et al. 2018a)

unilogo

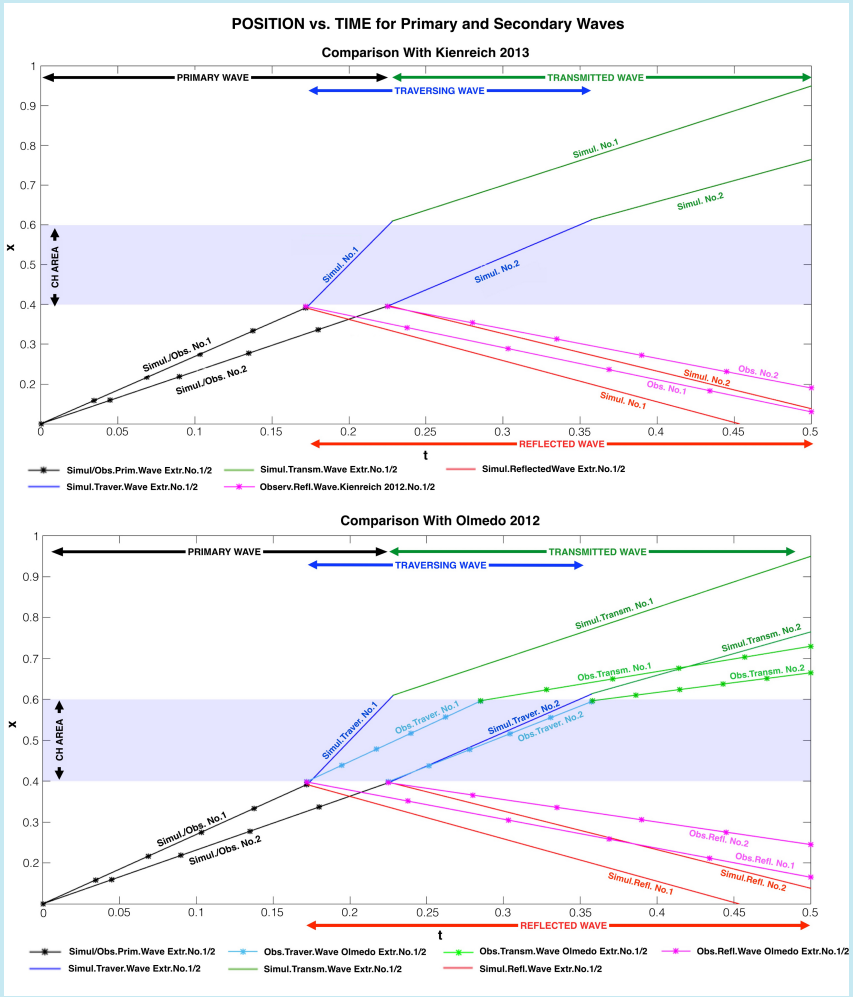


Figure: Comparison of Secondary Waves (Taken from Piantschitsch et al. 2018b)

unilogo

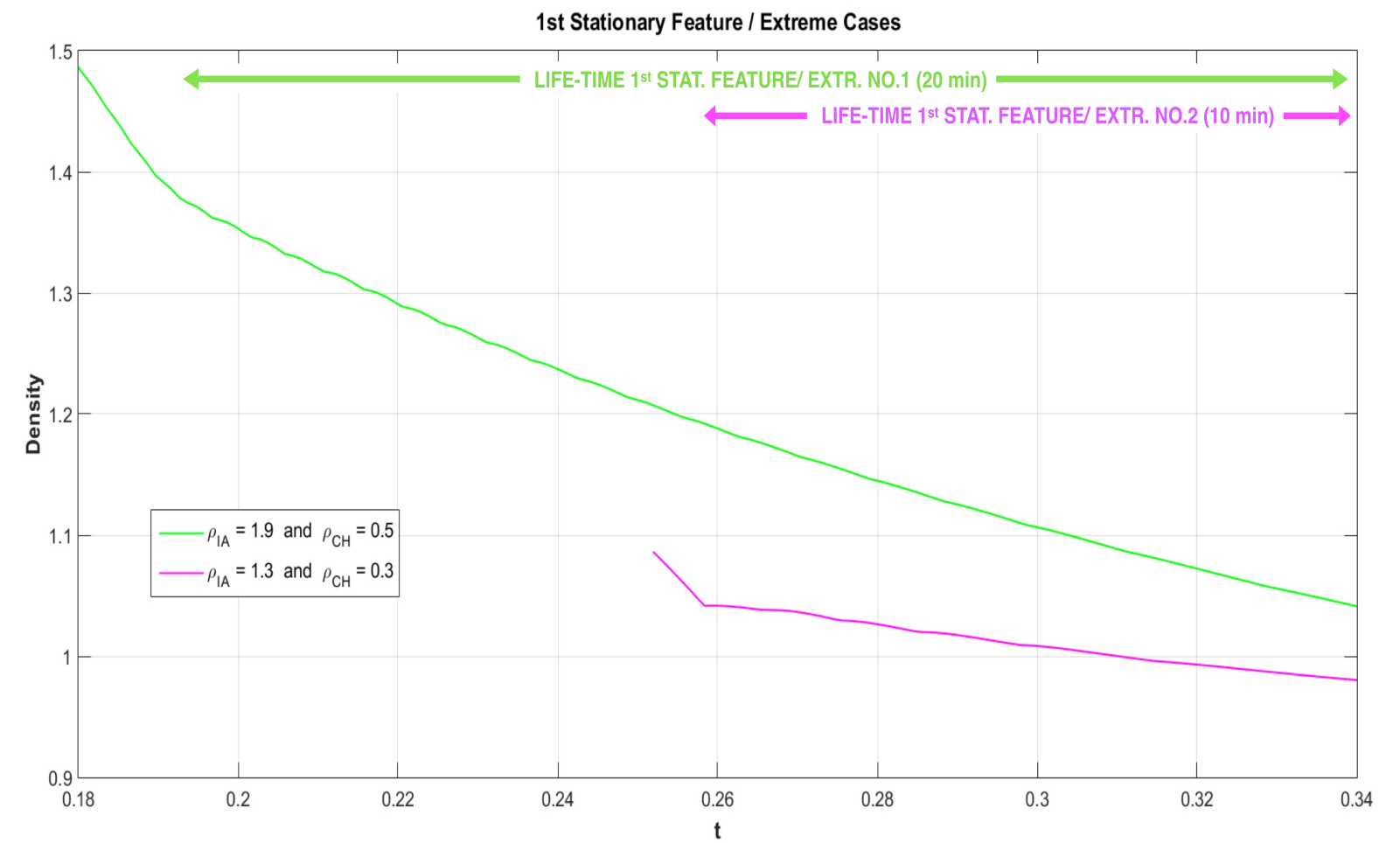


Figure: Lifetime of 1st Stationary Feature (Taken from Piantschitsch et al. 2018b)

unilogo

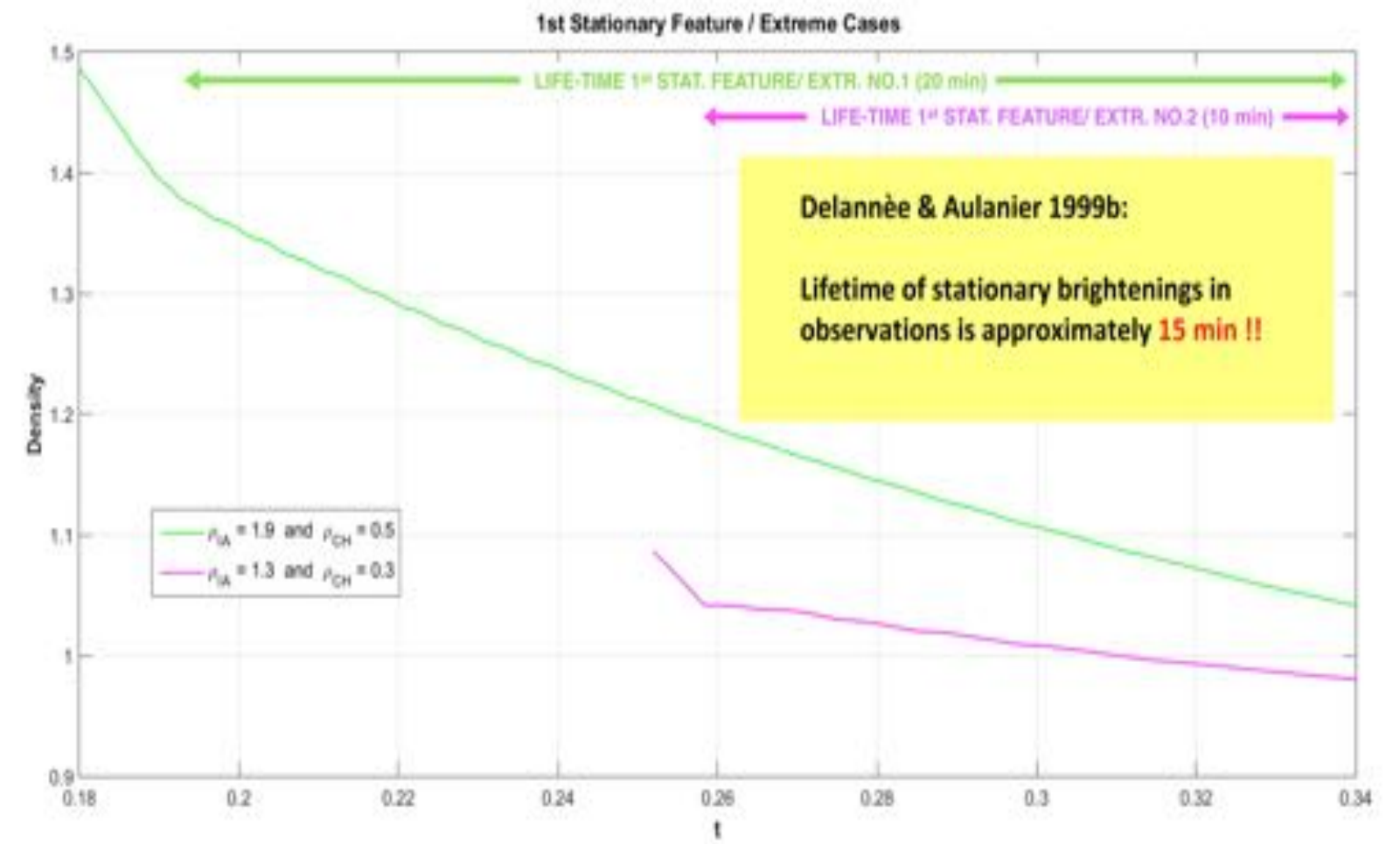


Figure: Lifetime of 1st Stationary Feature (Taken from Piantschitsch et al. 2018b

Idealization & Constraints

- **homogenous** magnetic field
- $p = 0$ over the whole computational box
- simplified **shape of the CH**
- certain **width of the CH**
- **2D** simulations
- **single-fluid** approach

unilogo

SO FAR:

comprehensive comparison of CH-CW interaction with **different initial amplitudes / CH densities**

NEXT STEP:

Variation of parameters:

- shape/size of CH
- magnetic field structure
- pressure
- gravity

unilogo

SO FAR:

2.5D MHD **single-fluid** code

NEXT STEP: Two-fluid Code

- two-fluid description of the electron-proton plasma in the solar corona in order to study the heating of the protons and the electrons separately - model describes a helmet streamer that is surrounded by coronal holes (Endeve et al. 2004)
- effects of weak coupling between the heavy ions and the coronal electron-proton components to different magnetic structures in the corona (van der Holst et al. 2004, Ofman et al. 2014)

unilogo

SO FAR:

2.5D MHD Code

NEXT STEP:

3D MHD Code

- first observations of upwards propagating EUV waves (Zheng et al. 2018)
- projection effects in observations

unilogo

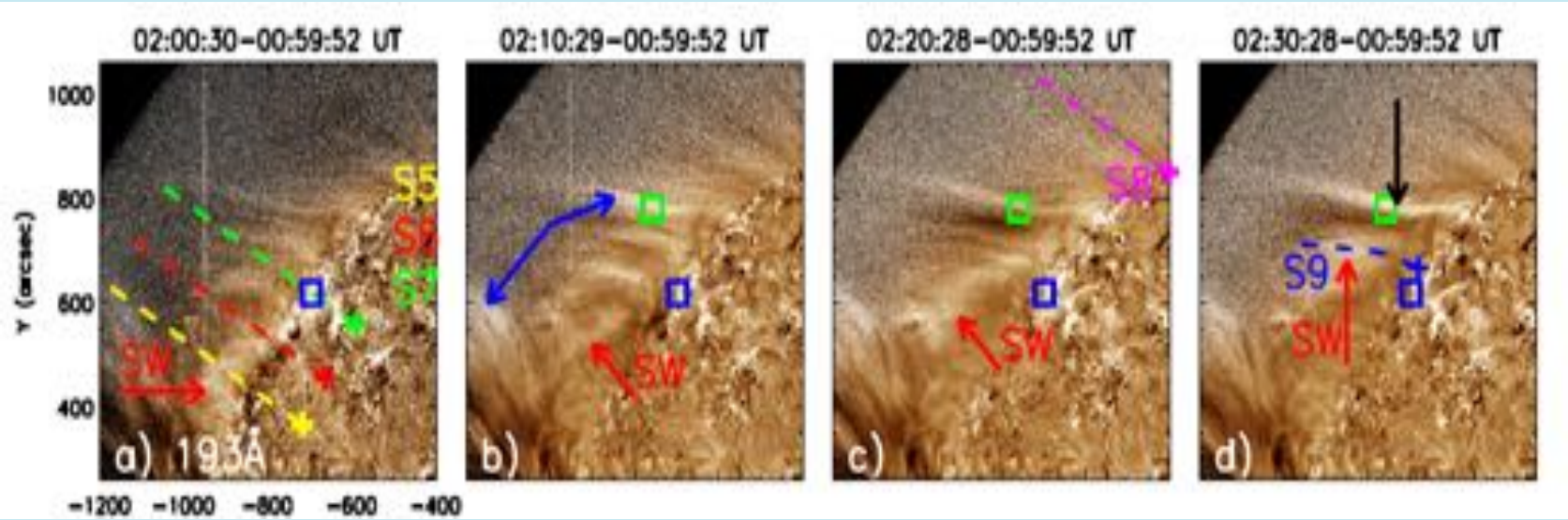


Figure: Base-ratio-difference AIA 193 A images showing upward secondary waves (red arrows) in a streamer-like structure (blue arrows). (Taken from Zheng et al. 2018)

unilogo

FINAL GOAL

3D two-fluid Code + Variation of Parameters

WHY IMPORTANT?

- projection effects
- influence of two-fluid approach on existing single-fluid results
- diagnostic tool for plasma parameters
- ...

unilogo