

**Hossam Aly**

In collaboration with Sijme-Jan Paardekooper

# The Polydisperse Settling Instability with Idefix



European Research Council  
Established by the European Commission

# The Resonant Drag Instability framework

A family of instabilities identified by Squire & Hopkins 2018

Includes: Streaming, Acoustic, and Settling instabilities

Settling instability (new) related to streaming, but vertical drift

Faster growth, low dust to gas requirement

# Settling Instability: Numerical Investigation

Krapp et al 2020 (FARGO3D)

Linear analysis: convergence with number of species  
(Though see upcoming Paardekooper & Aly, in prep.)

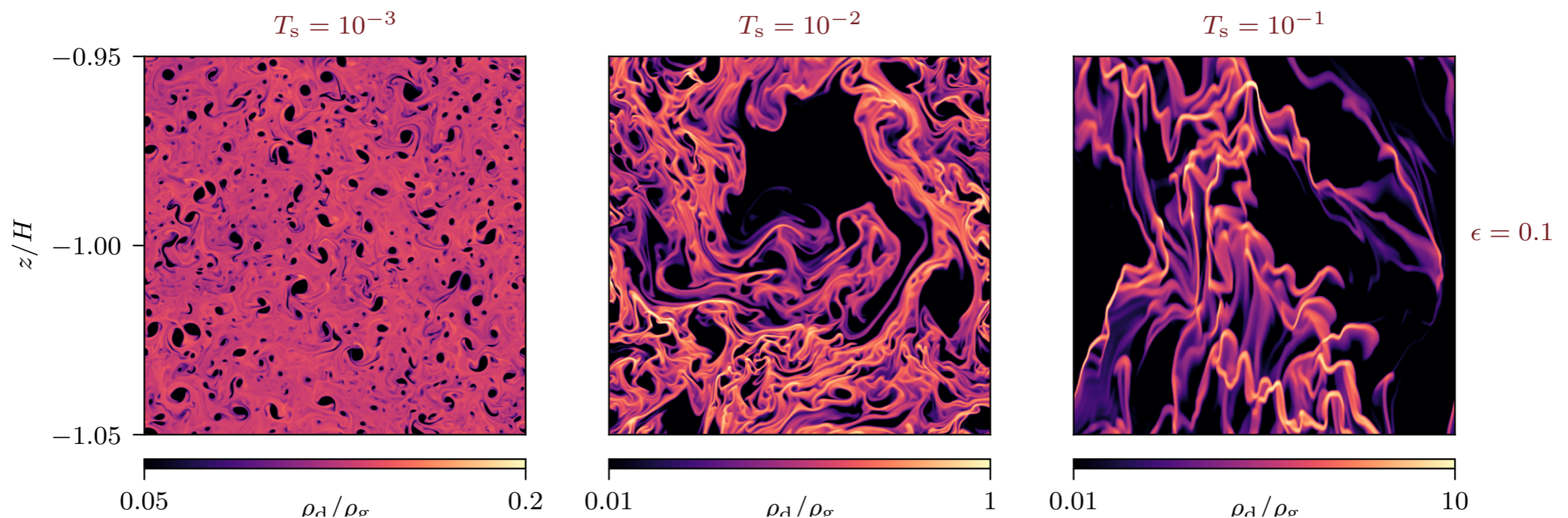
Nonlinear (multi-monodisperse): no dust enhancement at low St. No clumping.

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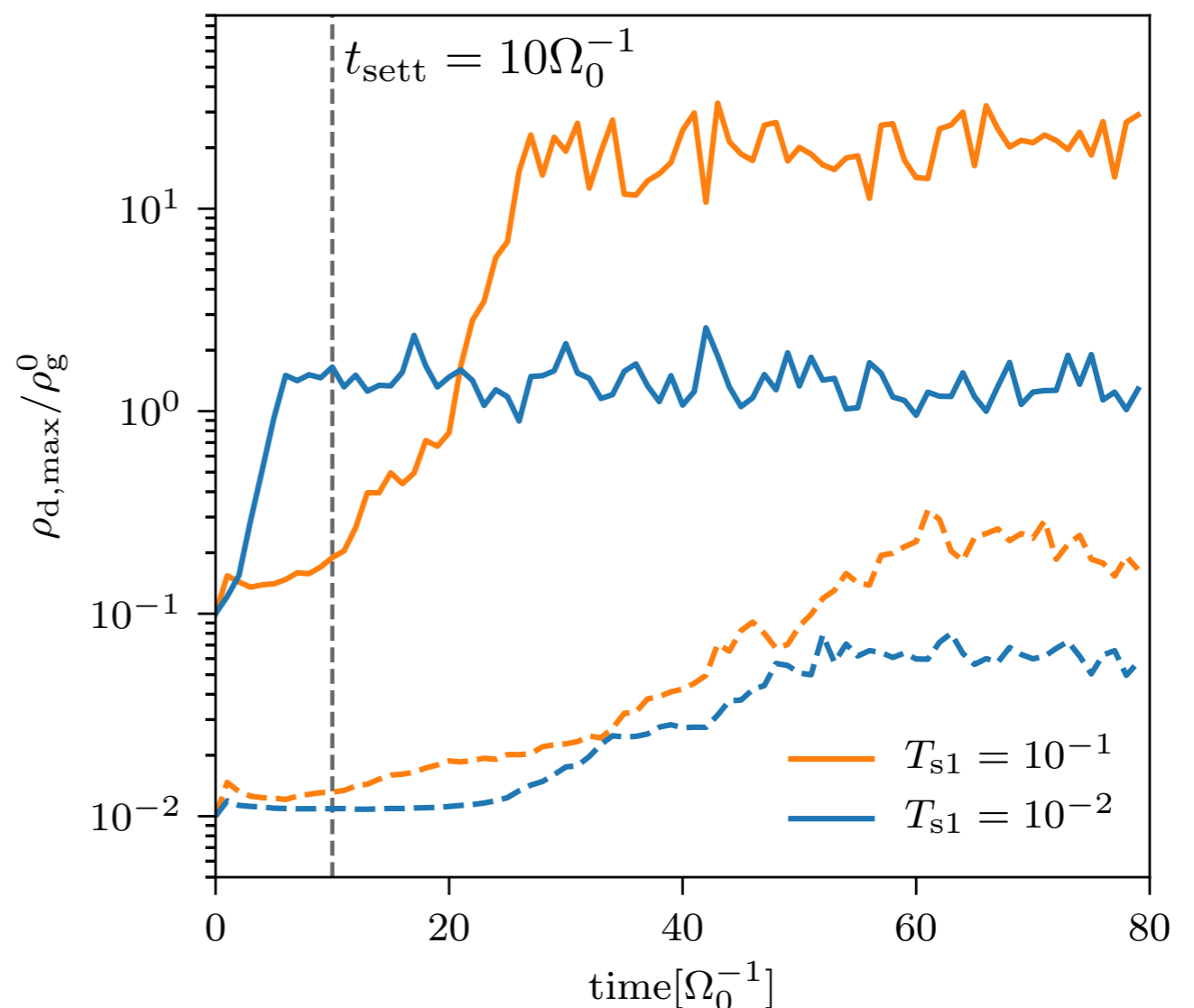
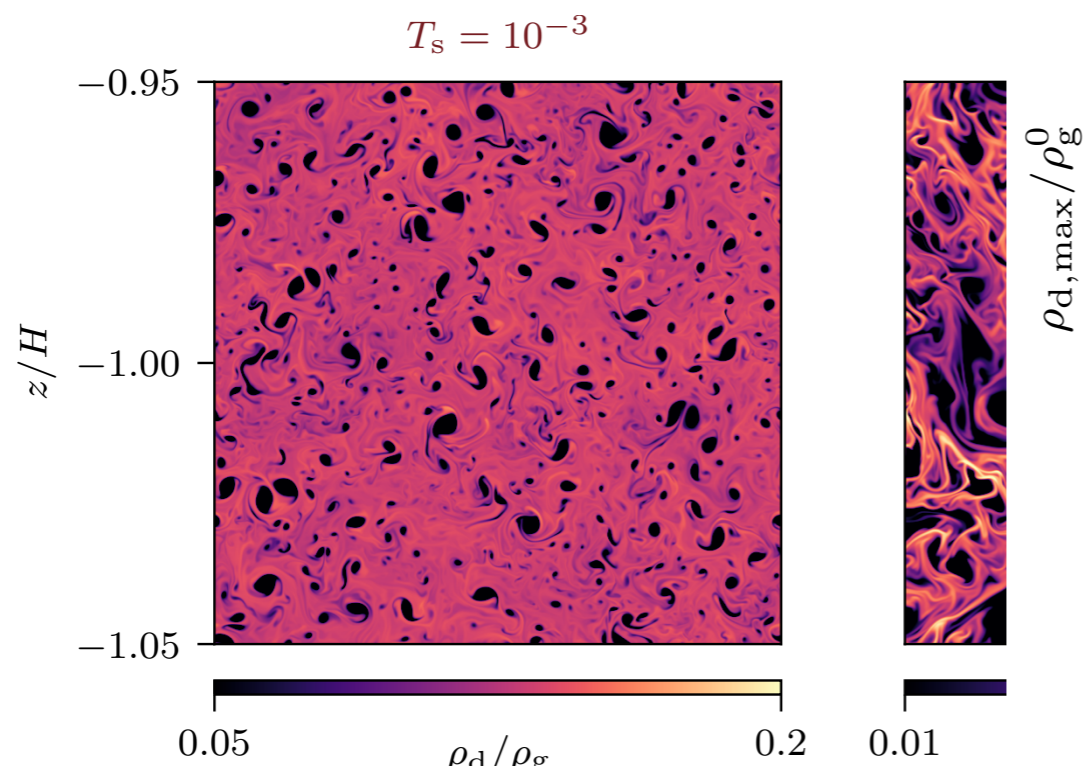


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# Polydisperse Settling Instability

Aly & Pardekooper, in prep. (FARGO3D)

Initial plan: follow up on Krapp et al 2020, but polydisperse (still with FARGO3D)

# Polydisperse Settling Instability

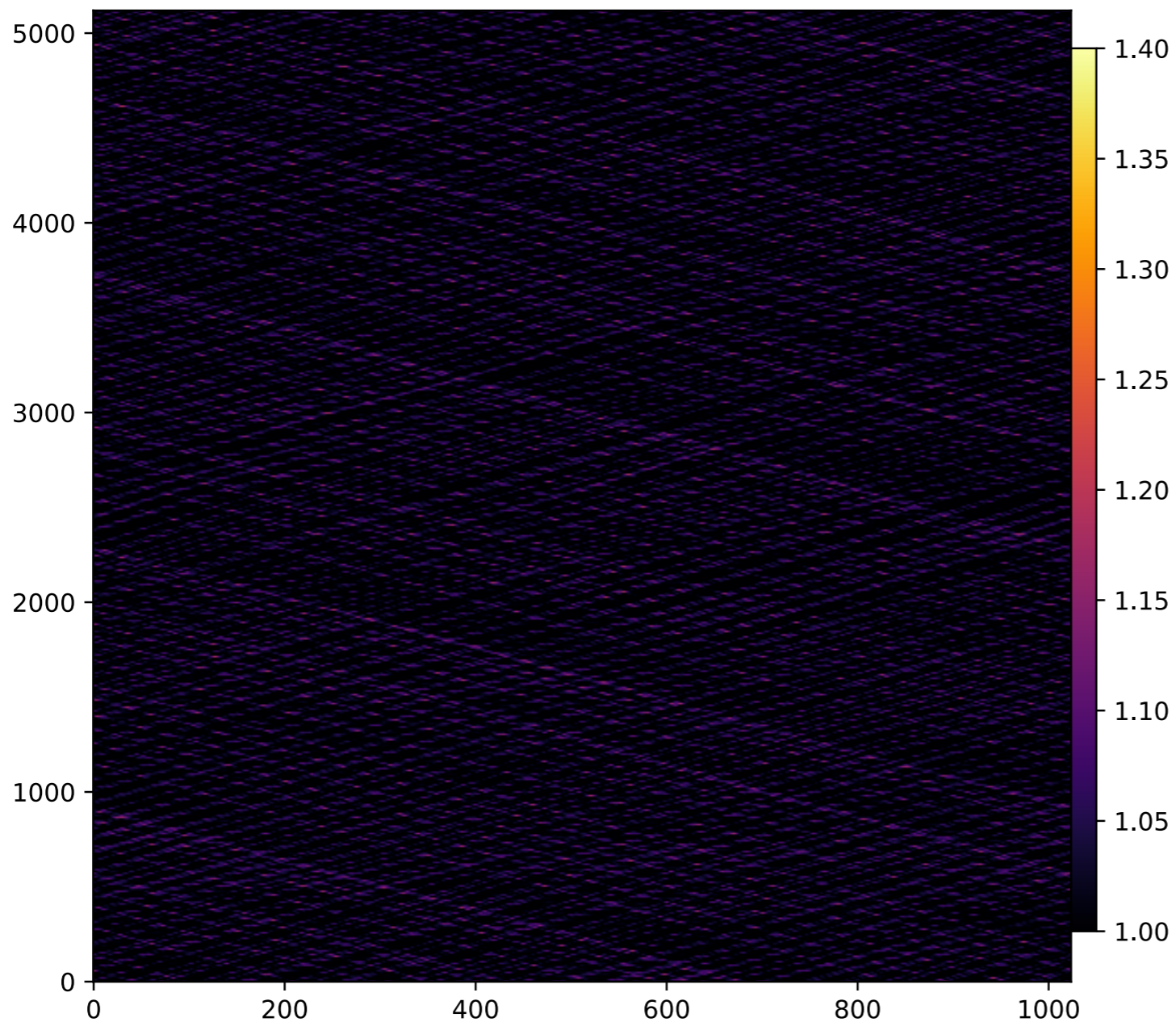
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Problems with gas (numerical artifacts?):

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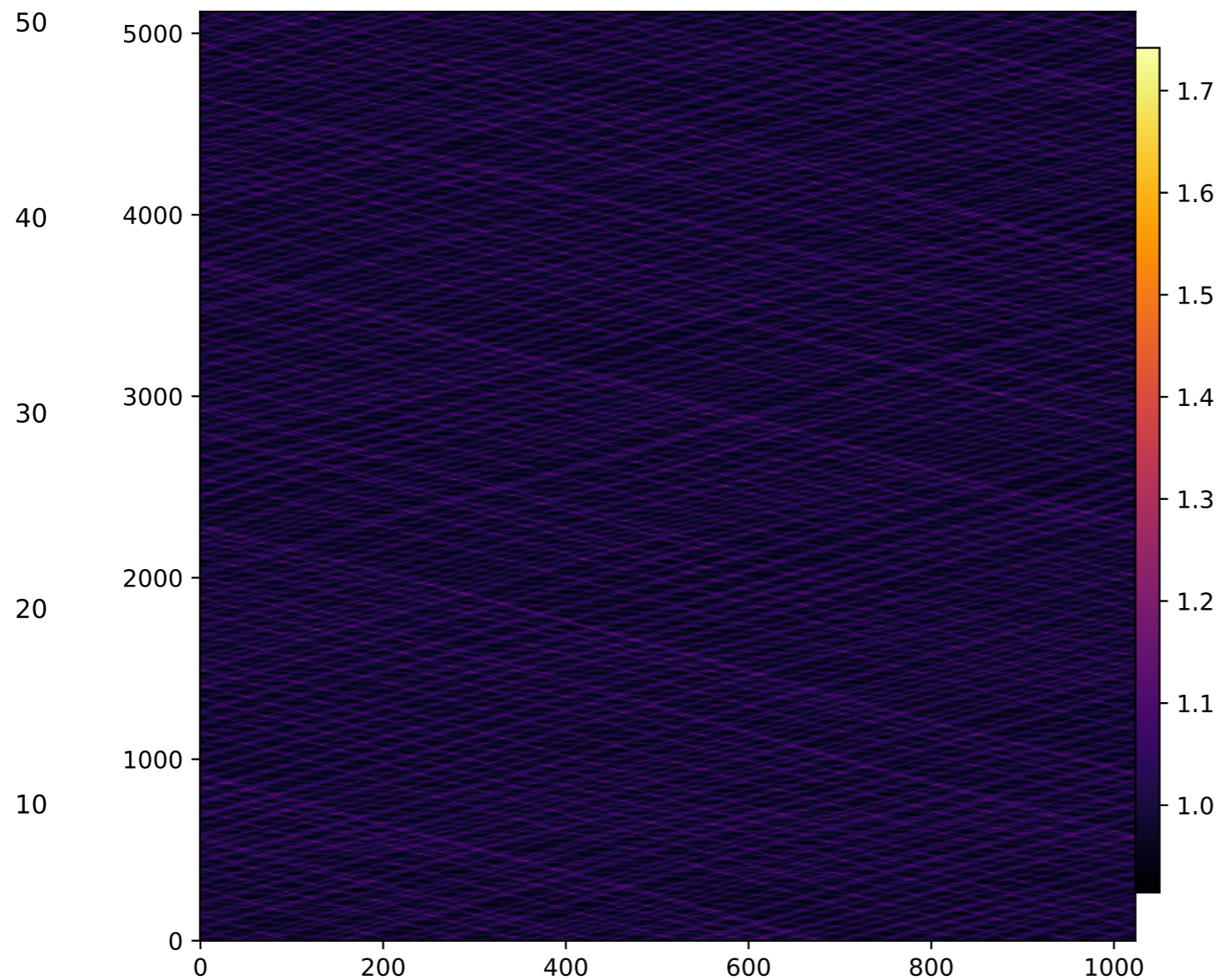




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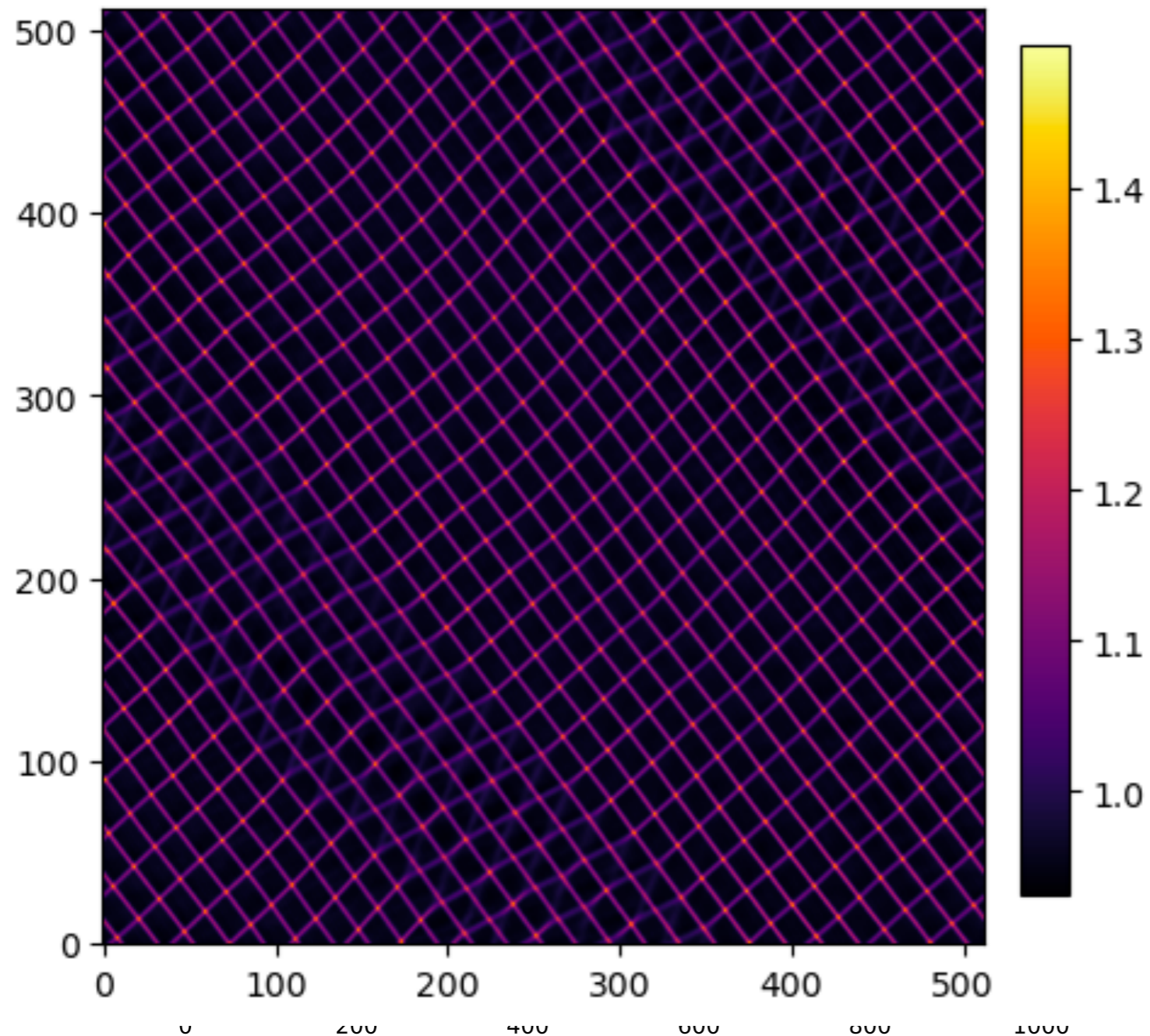
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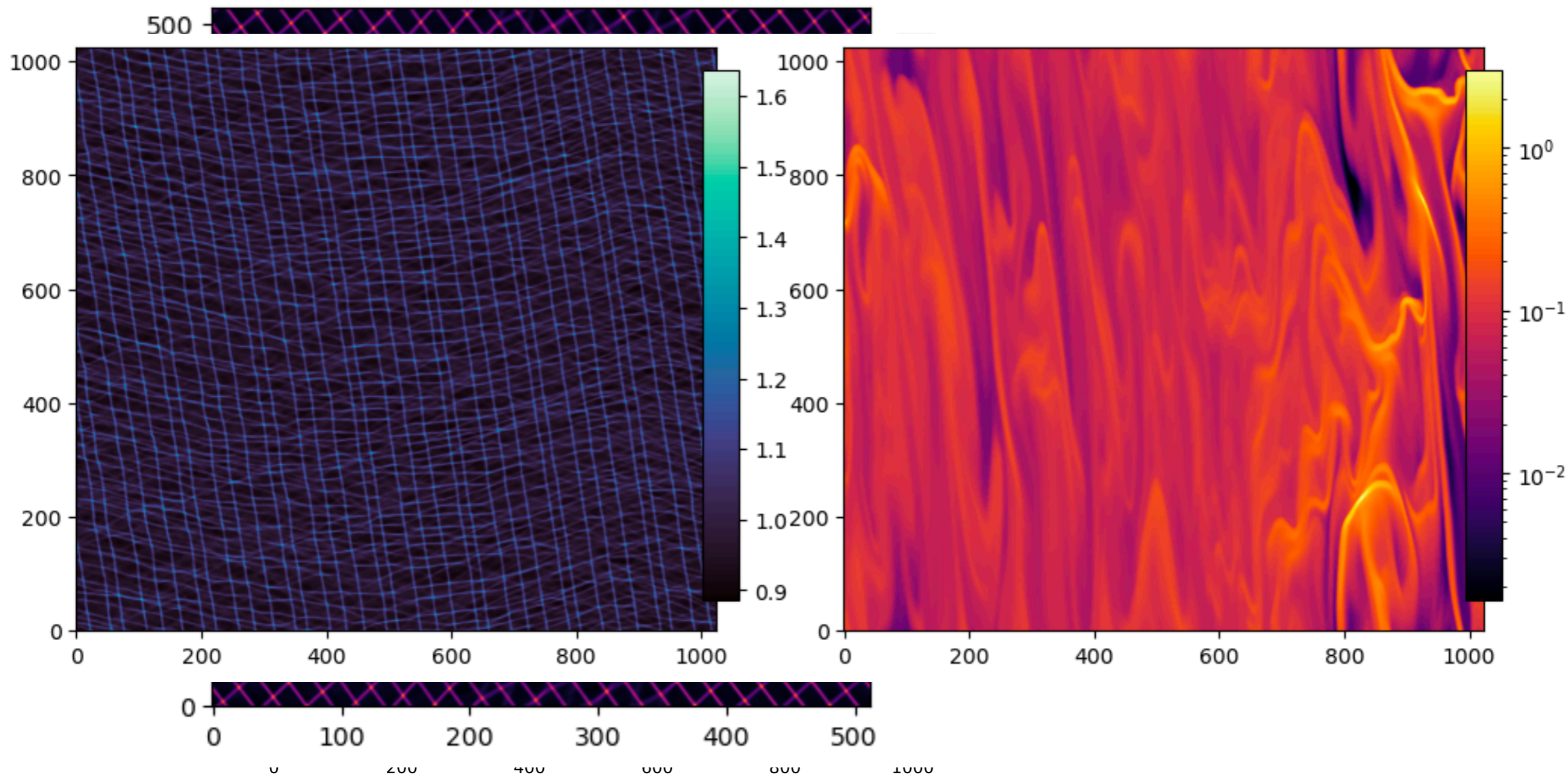
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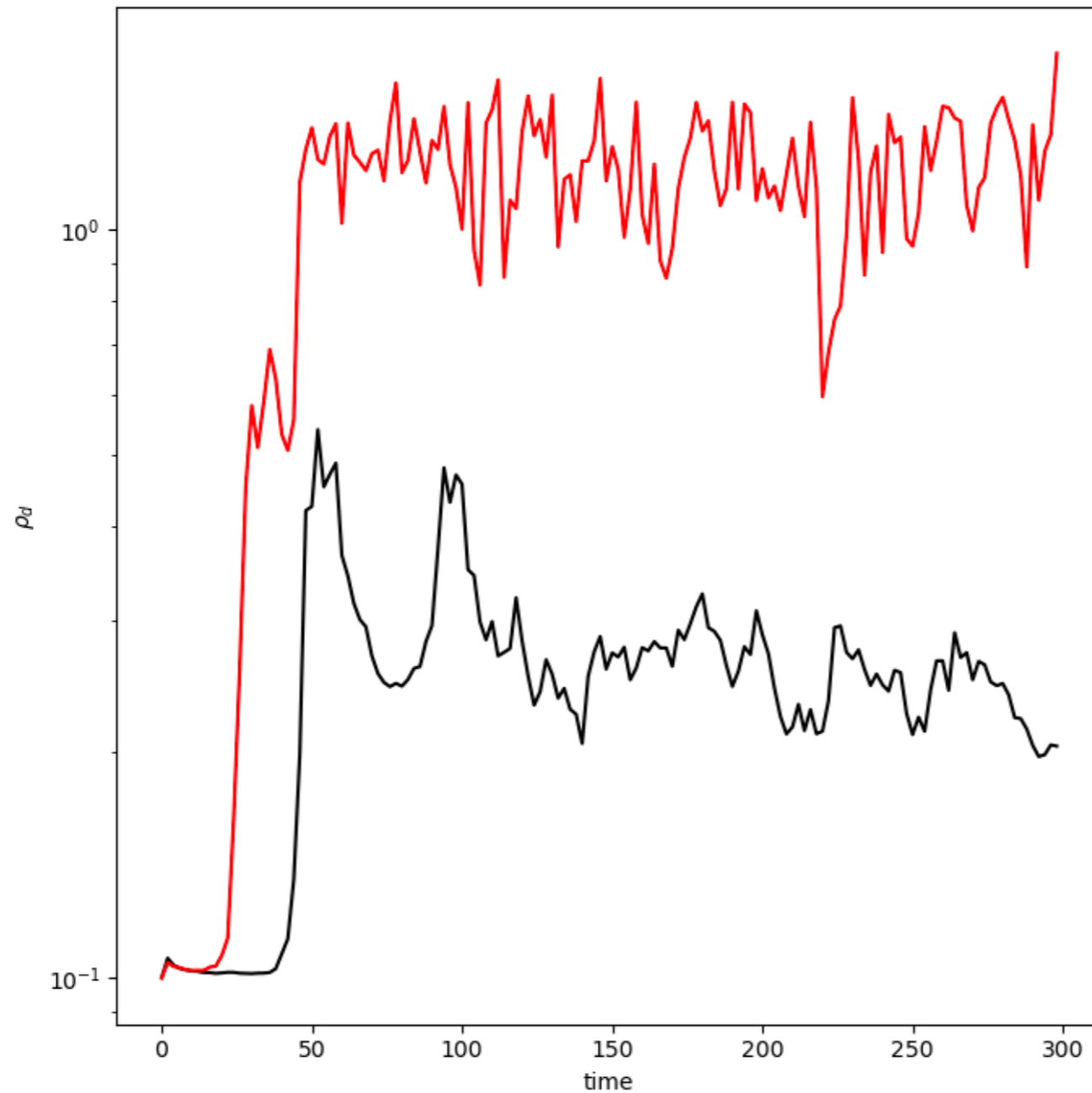
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# Polydisperse Settling Instability

Aly & Pardekooper, in prep. (FARGO3D)

Problems with dust: lower maximum density at higher resolution



# Polydisperse Settling Instability

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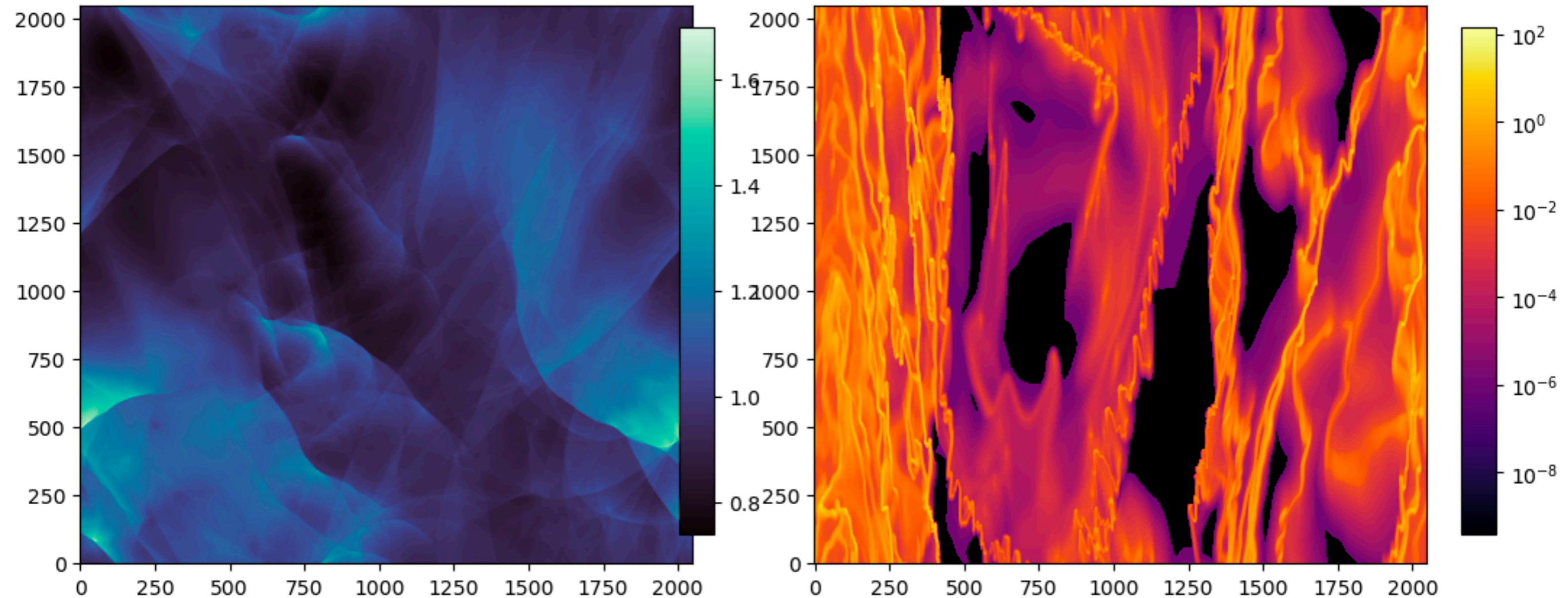
Switching to Idefix (only Riemann solver with dust modules publicly available)

Dust solver modification: locally switching to flat reconstruction when density  $< 0$

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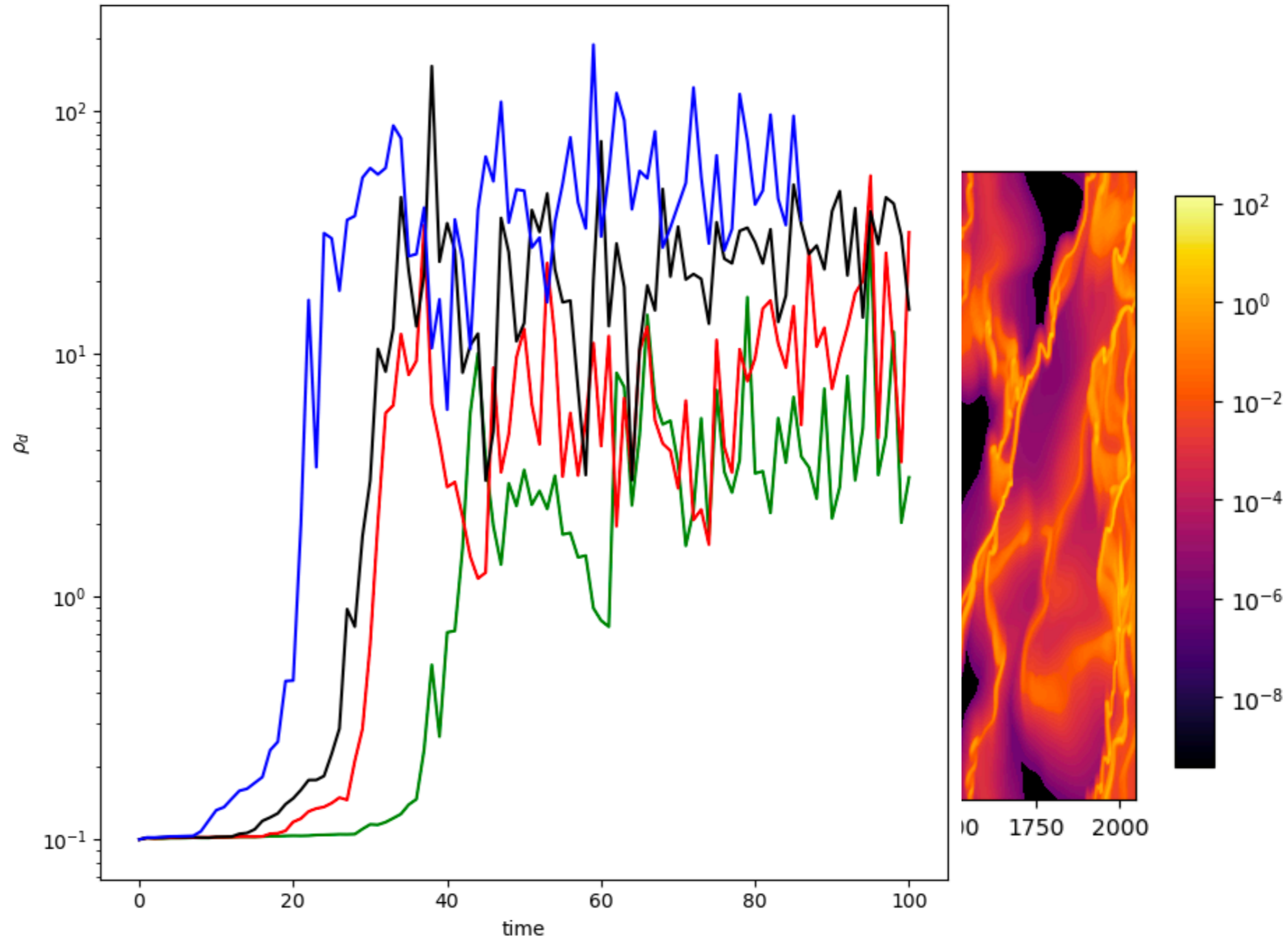
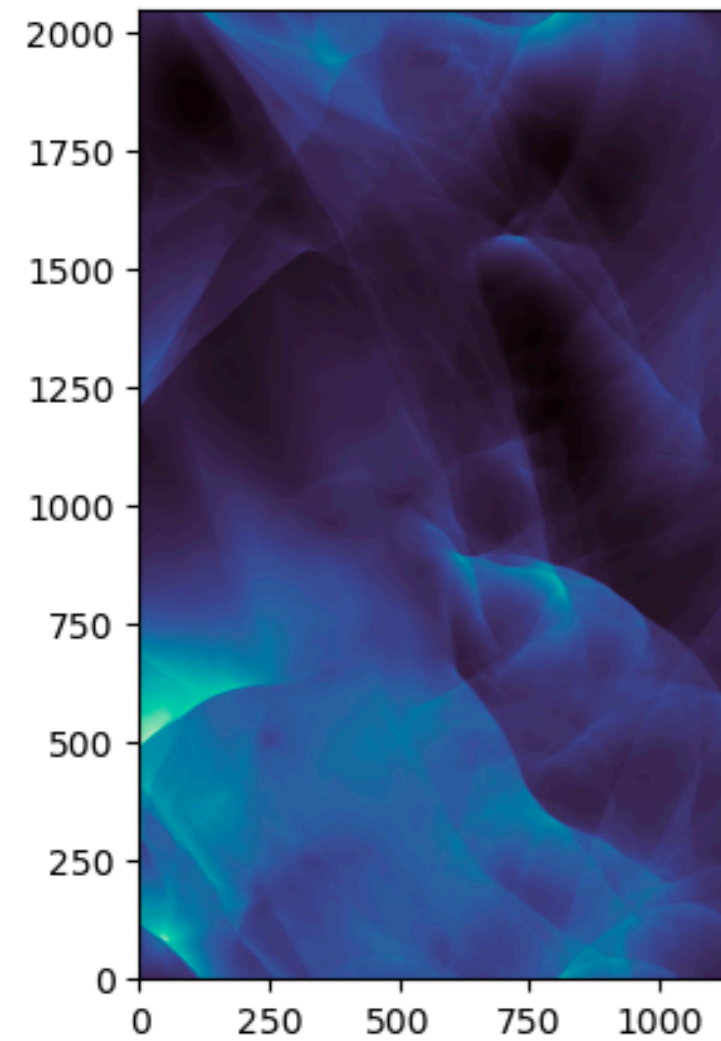
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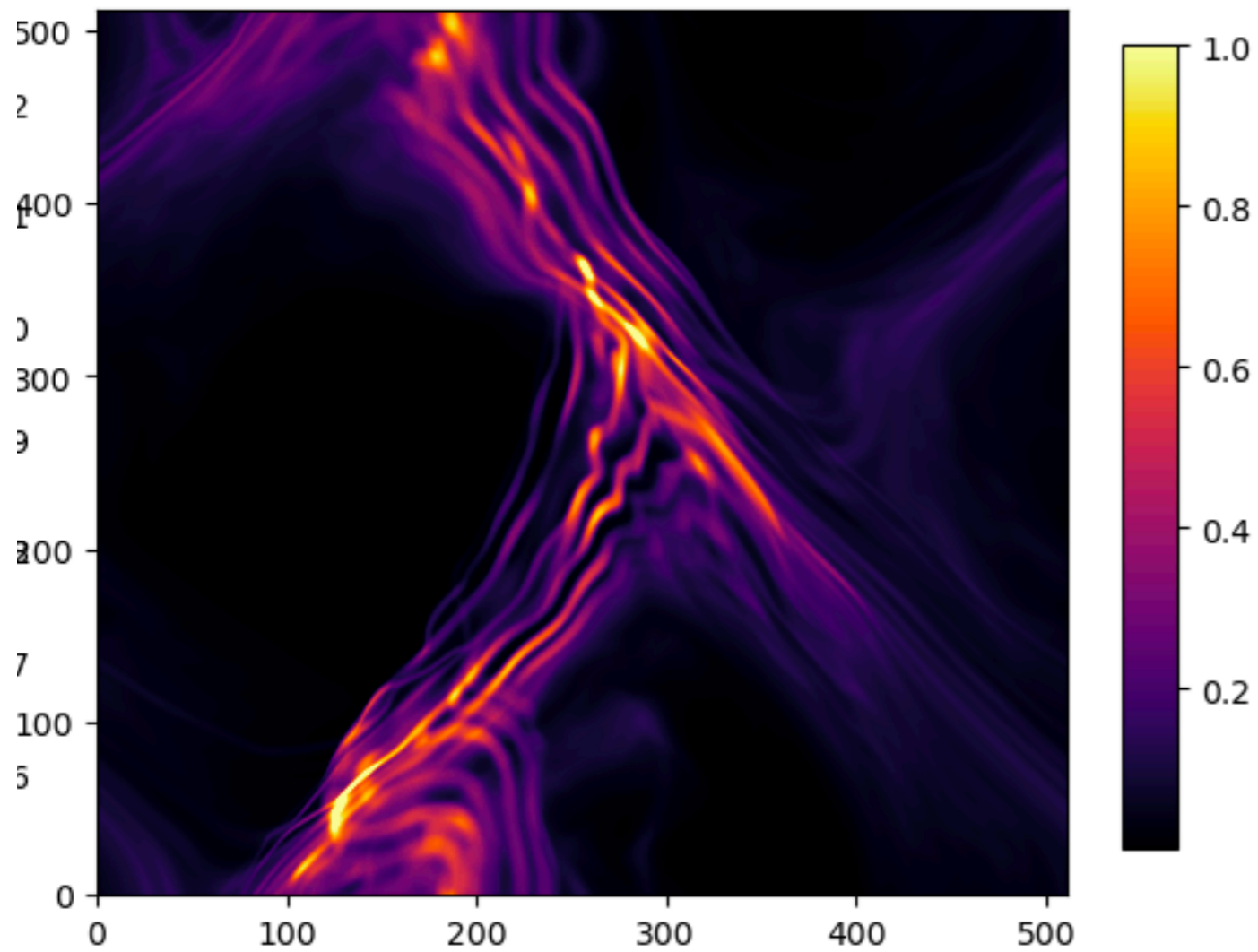
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Polydisperse Results:

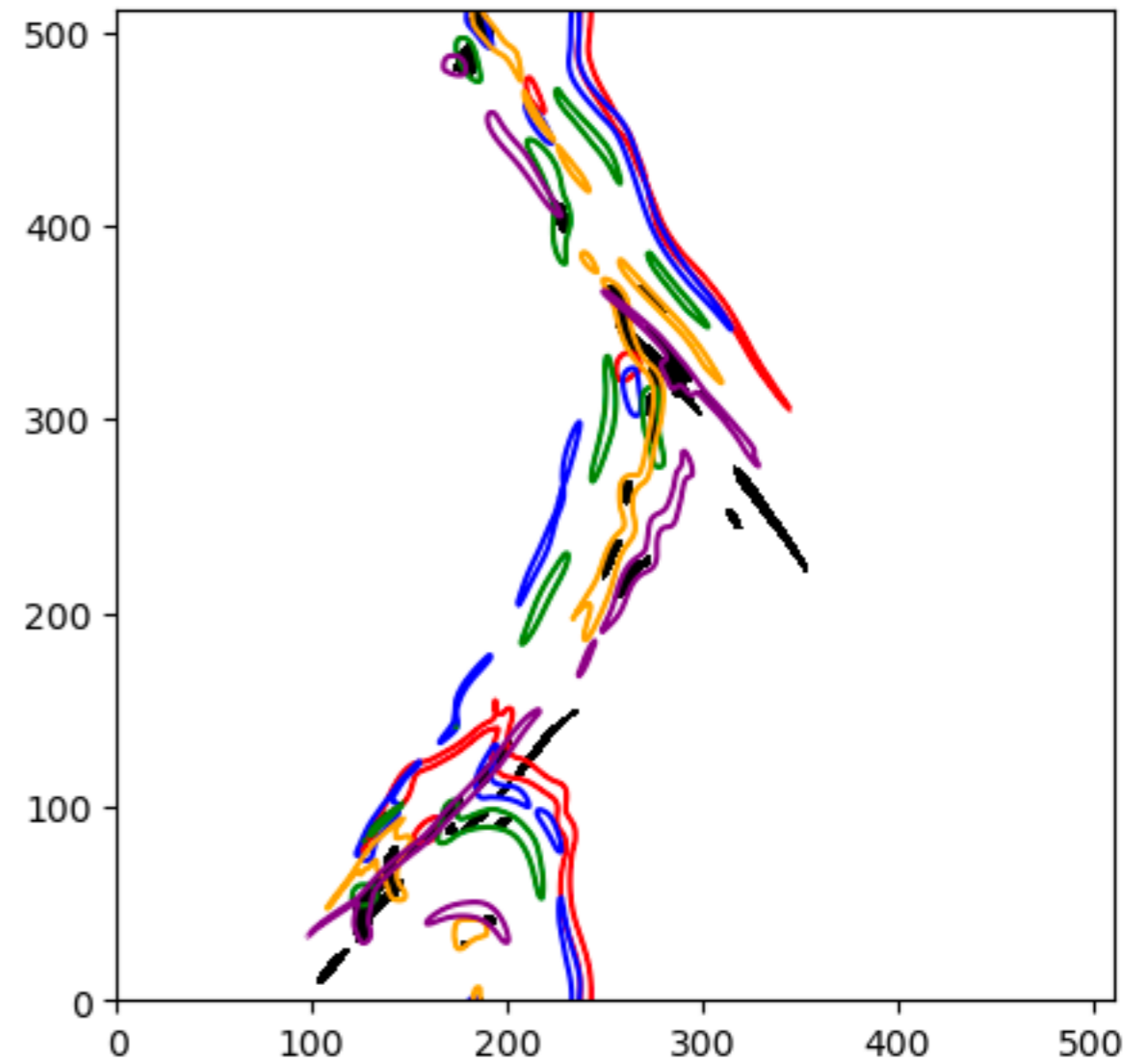
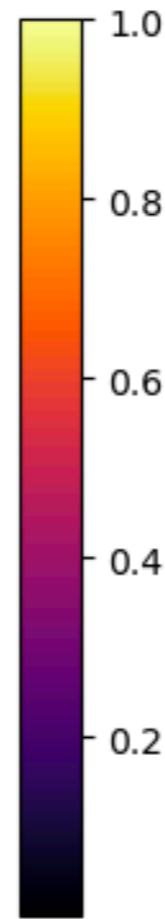
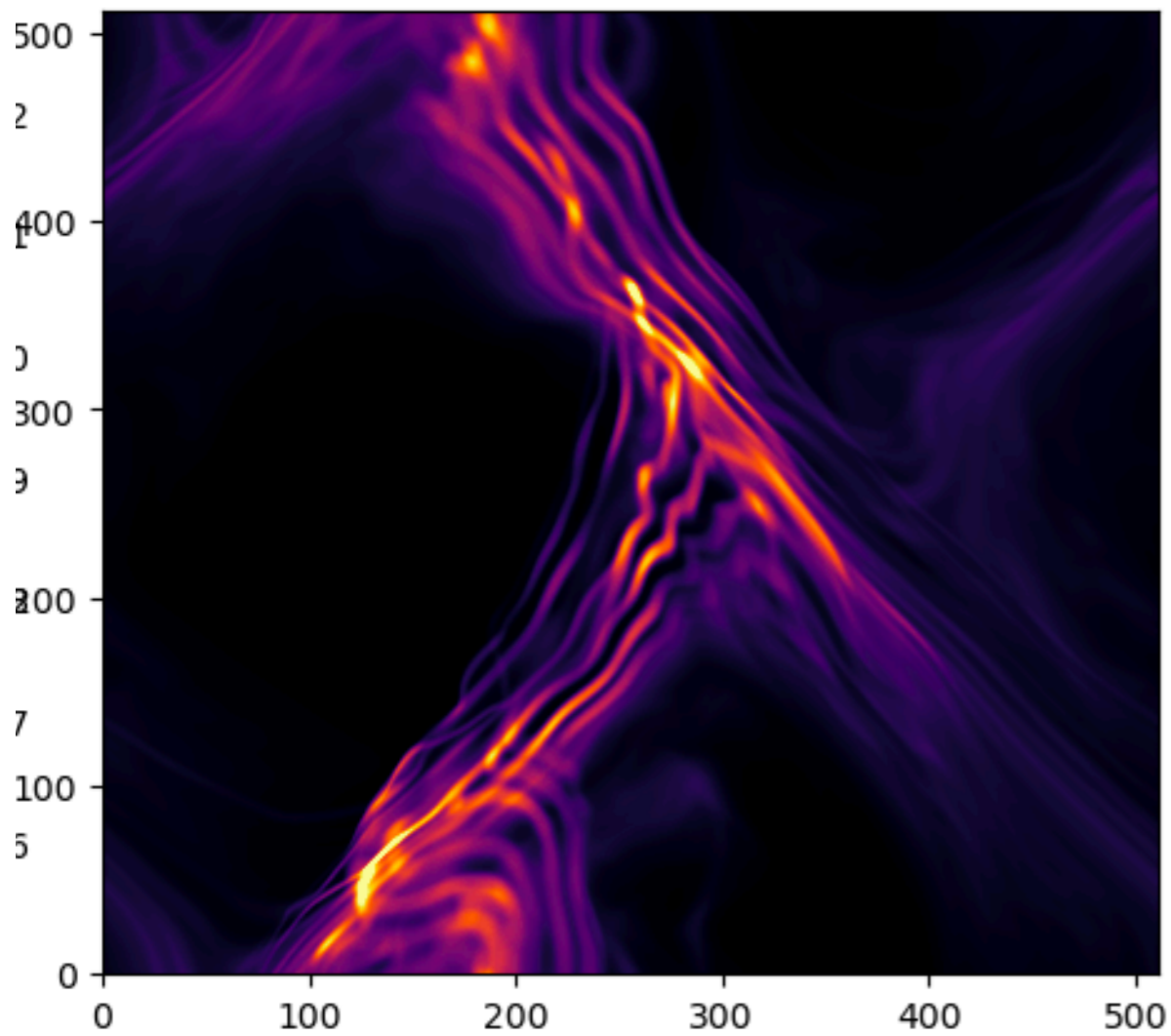




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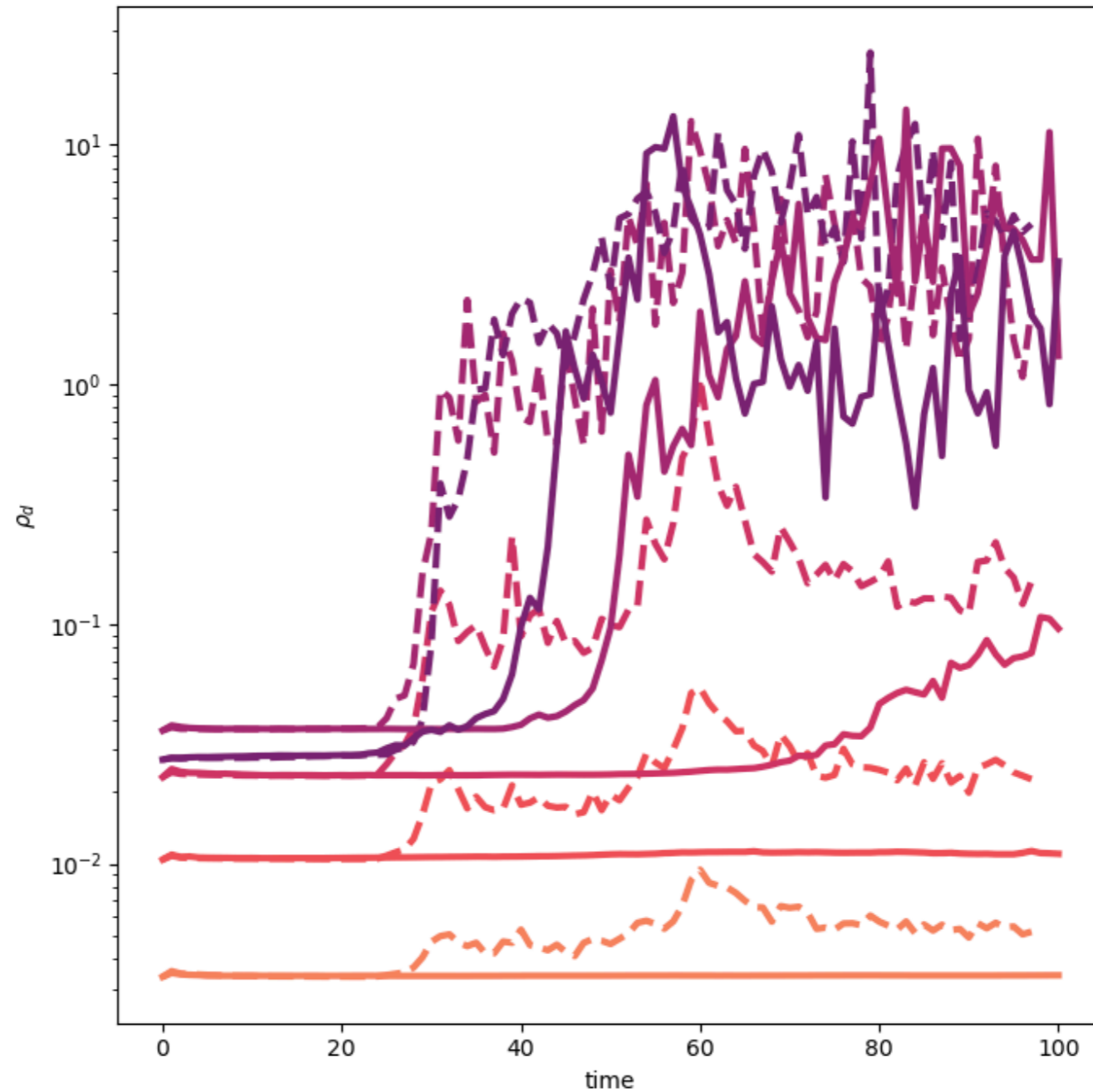
Polydisperse Results:



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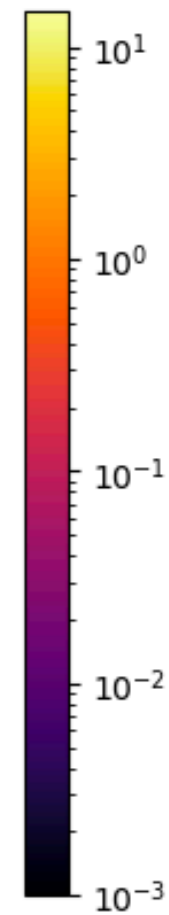
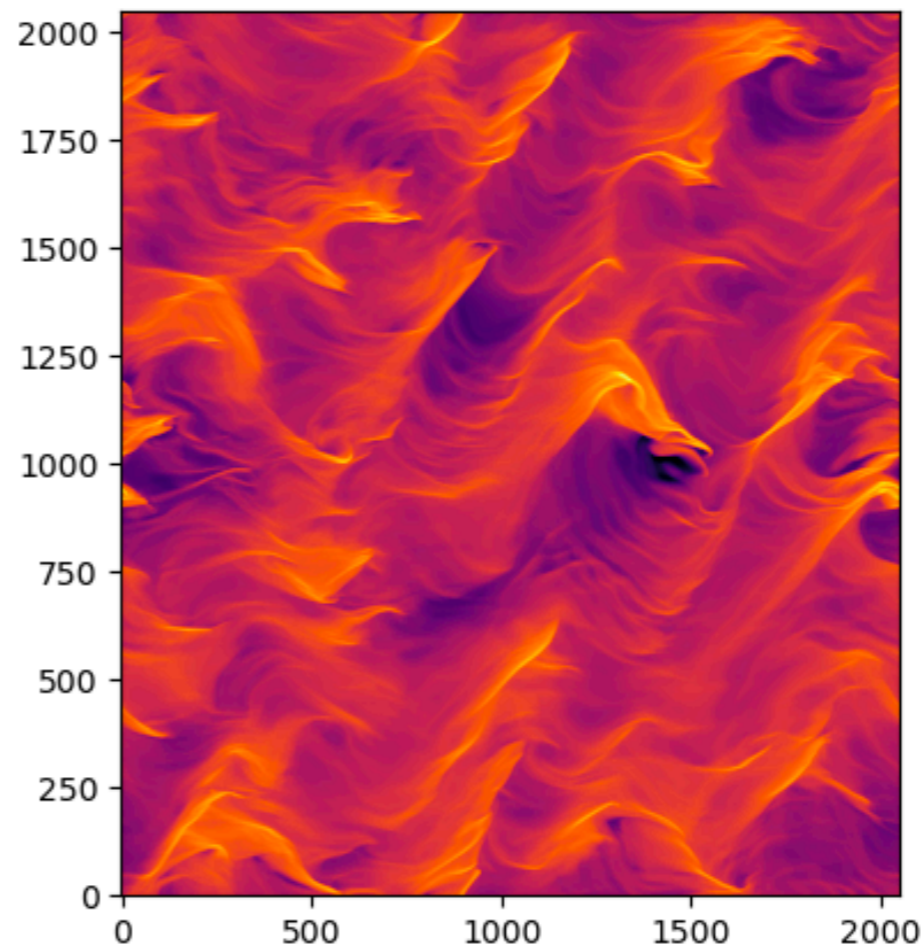
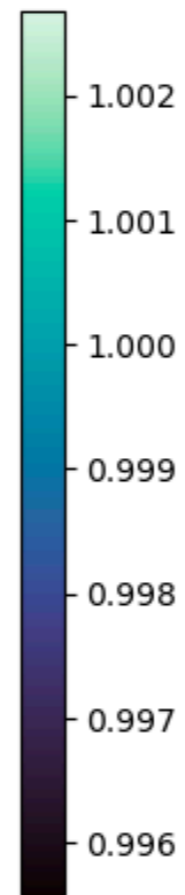
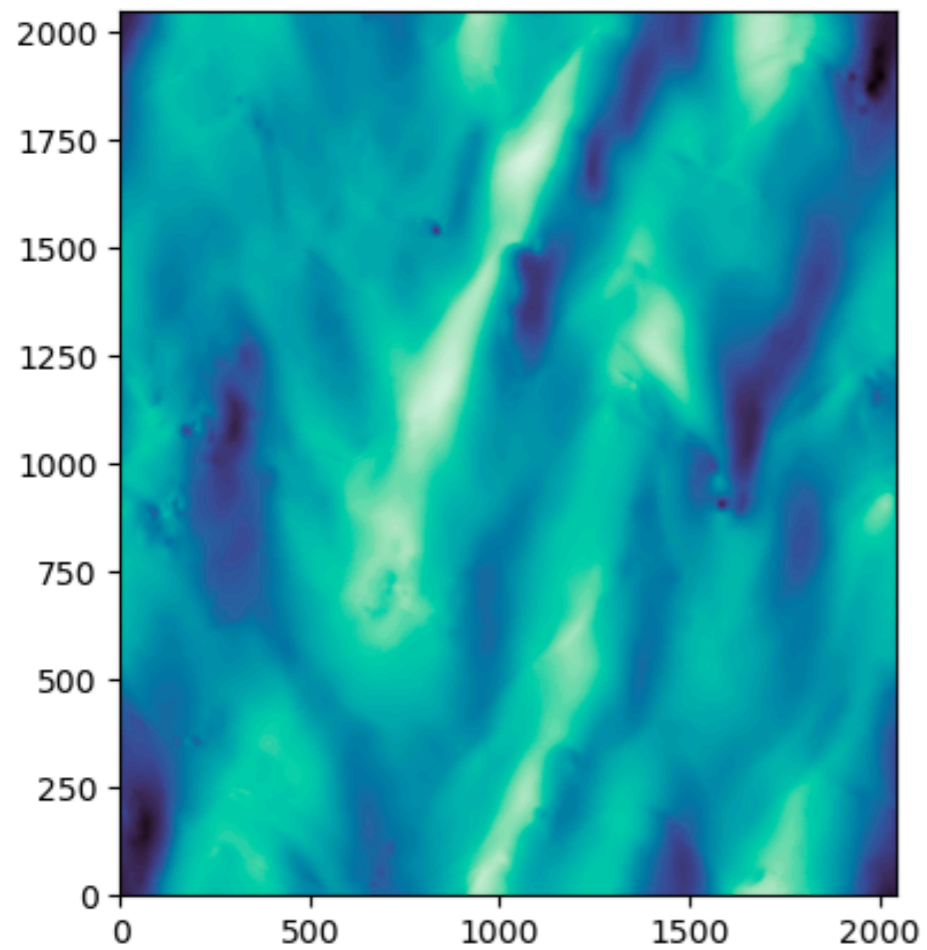
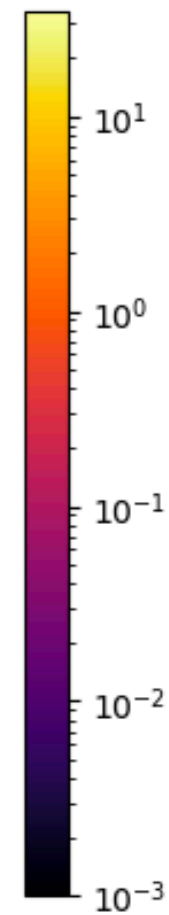
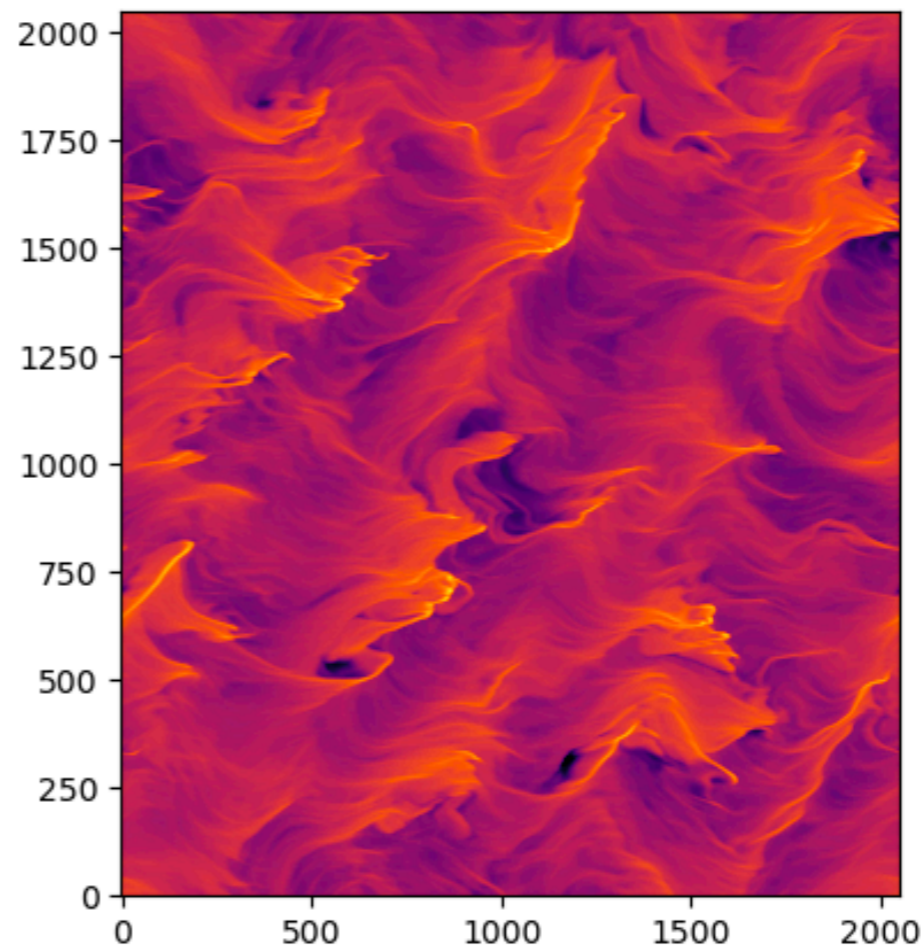
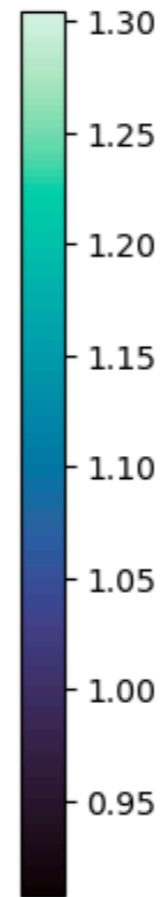
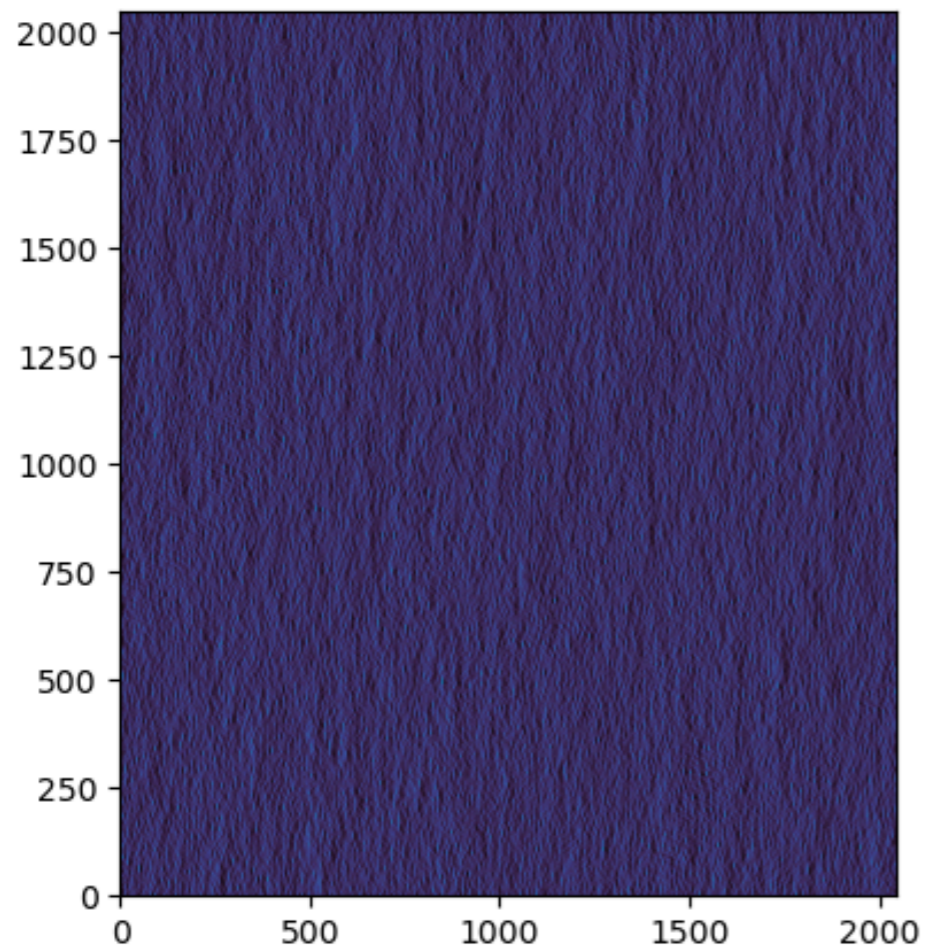
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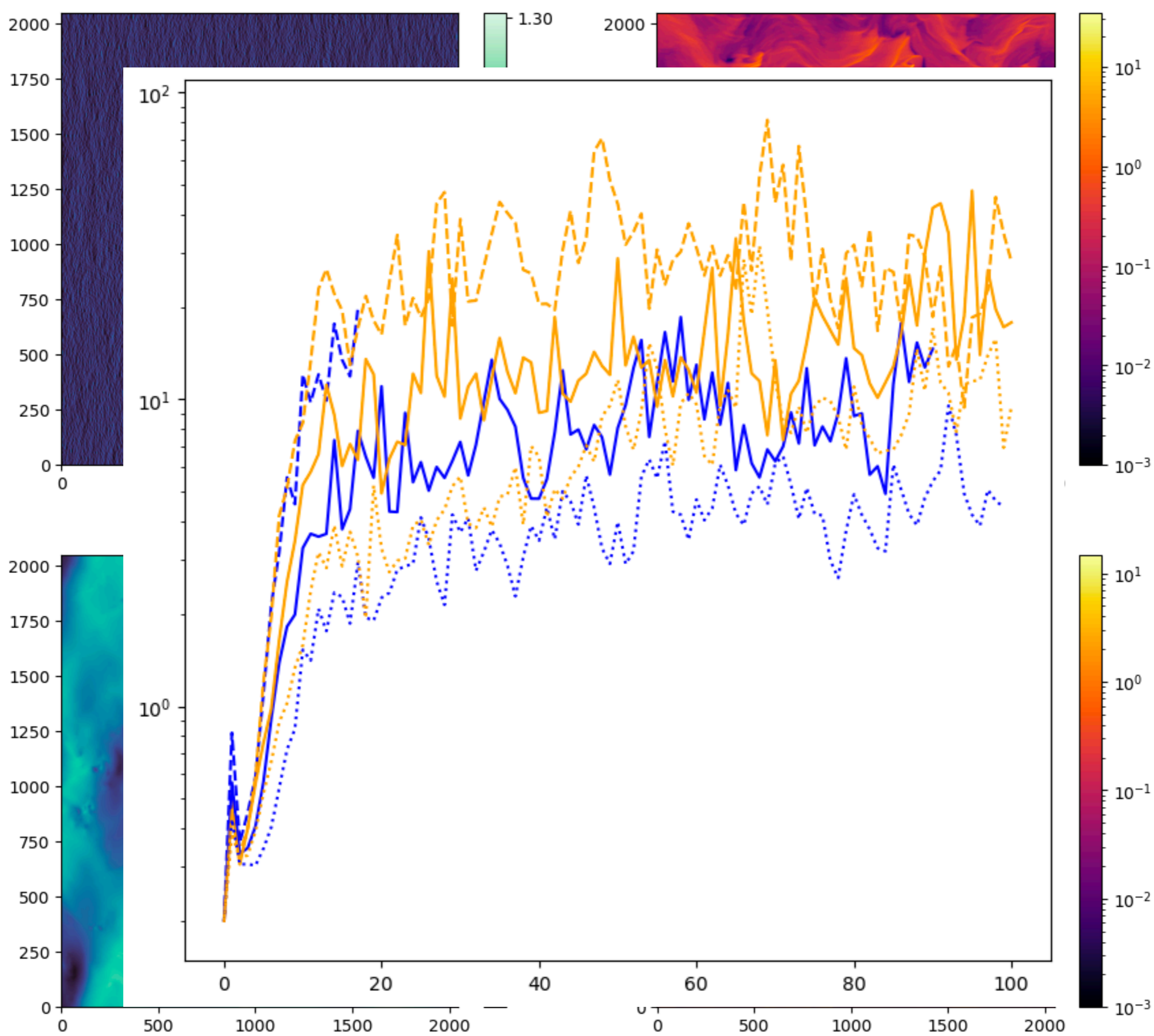
Polydisperse Results:



# Streaming Instability Comparison

BA test: FARGO3D vs Idefix





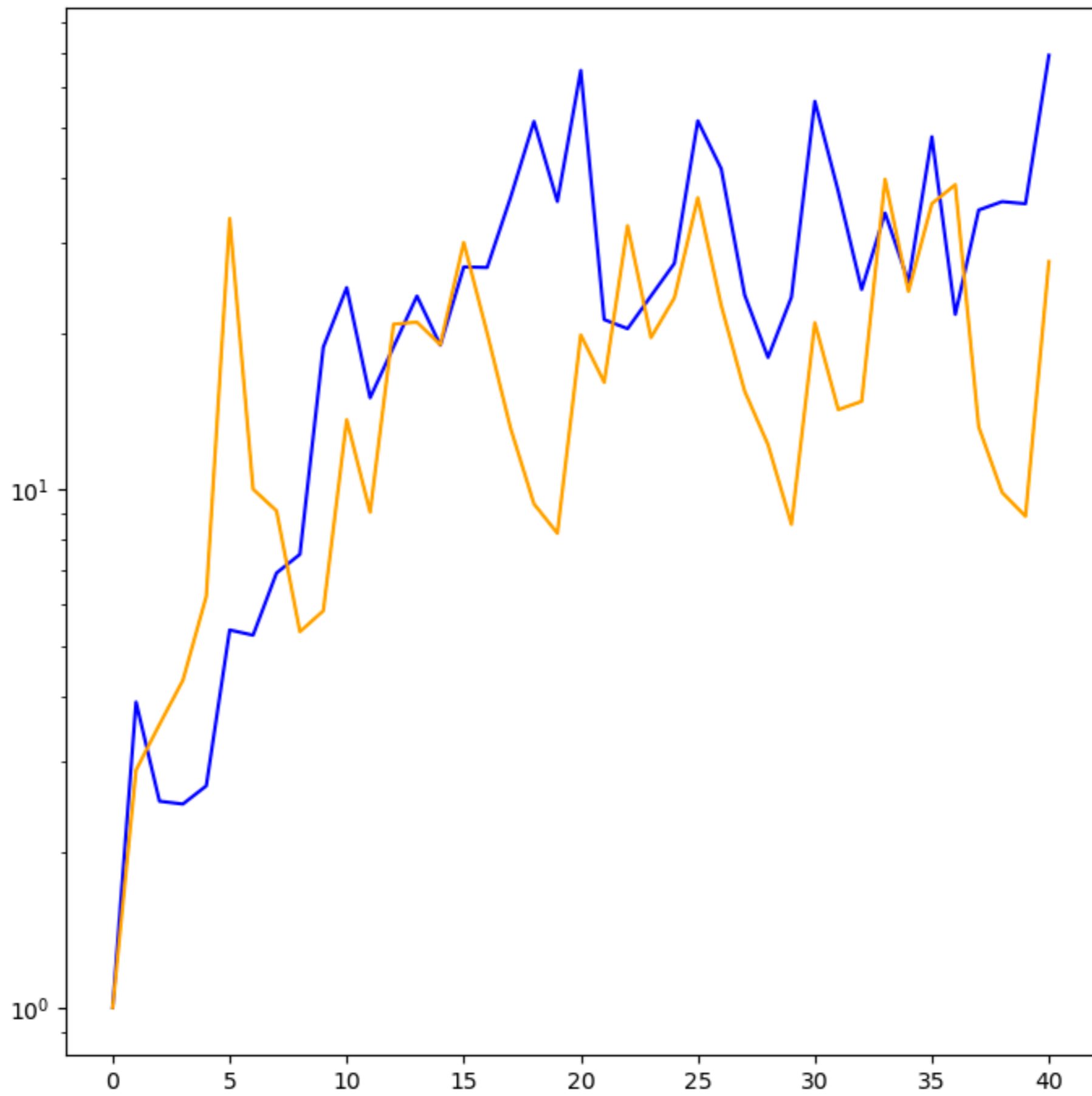
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AB test: FARGO3D vs Idefix

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AB t $\epsilon$





# Summary

Idefix solves gas artifacts and dust resolution problems in FARGO3D

Settling instability may lead to clumping. Polydisperse simulations show structure at very low  $St$

Polydisperse settling instability forms adjacent filaments for different  $St$

Early Christmas wishlist: Dust diffusion? Dust particles?