RESEARCH INTERESTS & POTENTIAL SYNERGIES

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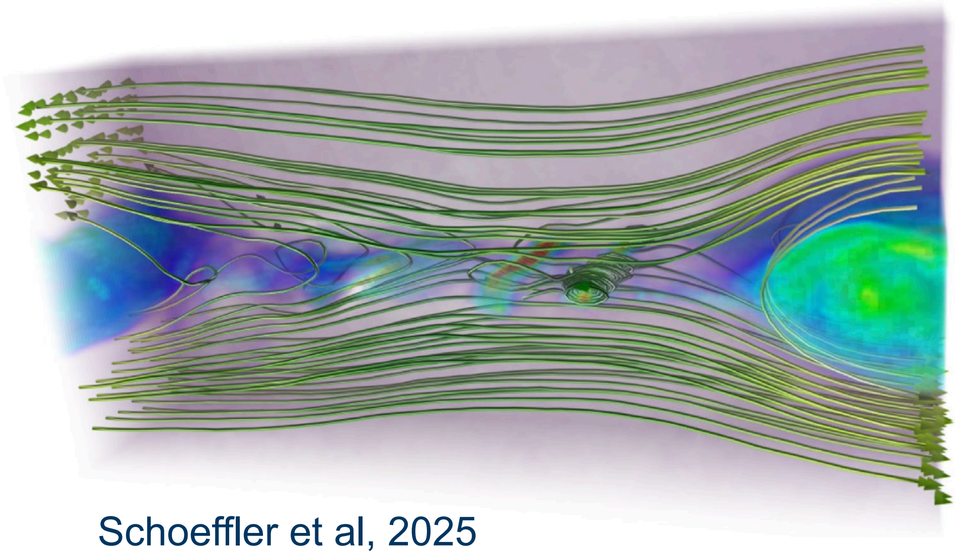
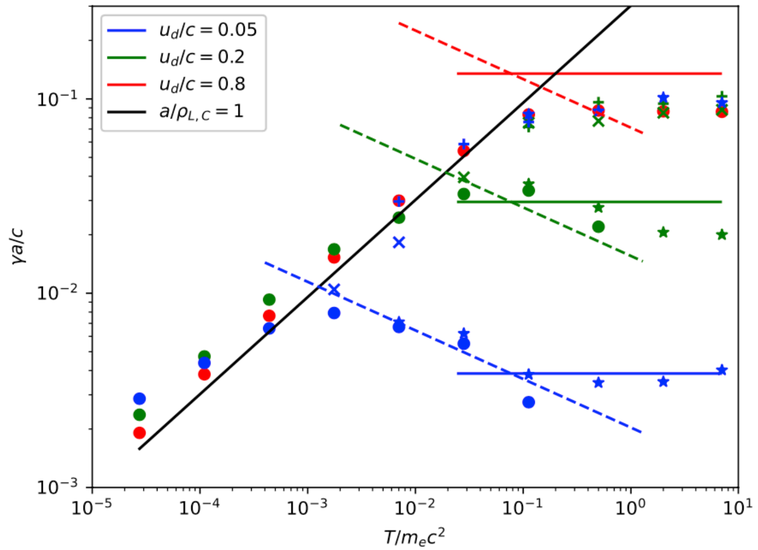
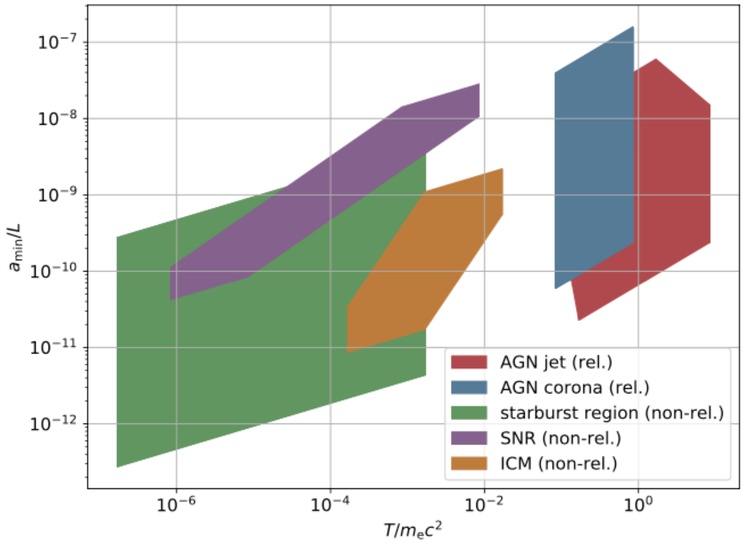
RESEARCH INTERESTS

- Wave/ particle interaction processes: **magnetic reconnection**, kinetic instabilities
- Cross-scale coupling in plasmas
- Modelling aspects: kinetic vs fluid models



Schoeffler et al, 2025





Schoeffler et al, 2024

Possible synergies:

- Use simulation results to constrain “astro” properties

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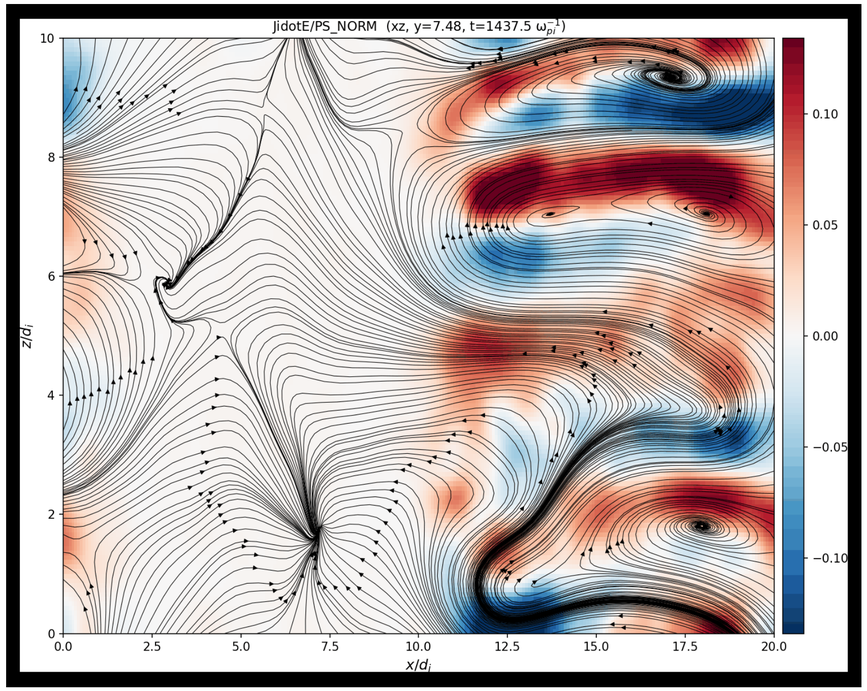

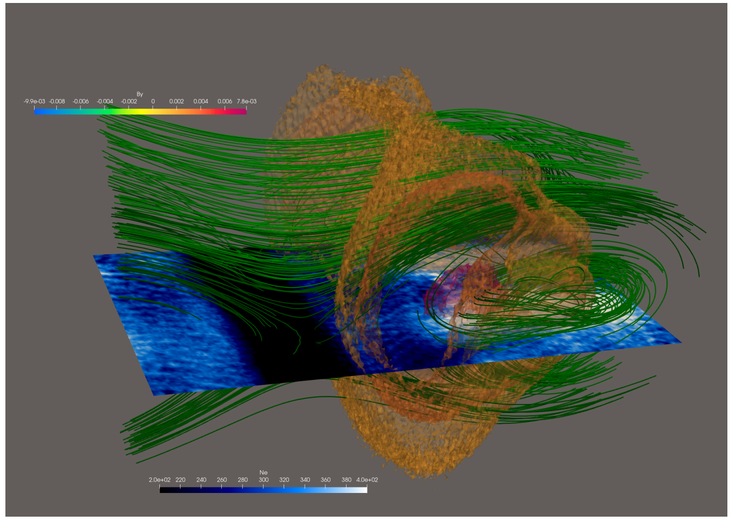

Aravindakshan et al, in prep

Research questions:

- How is energy converted and partitioned between species by magnetic reconnection as a function of reconnection ‘flavor’ and plasma parameters?
- Which processes heat preferentially heavier particles (protons, alphas), and how?

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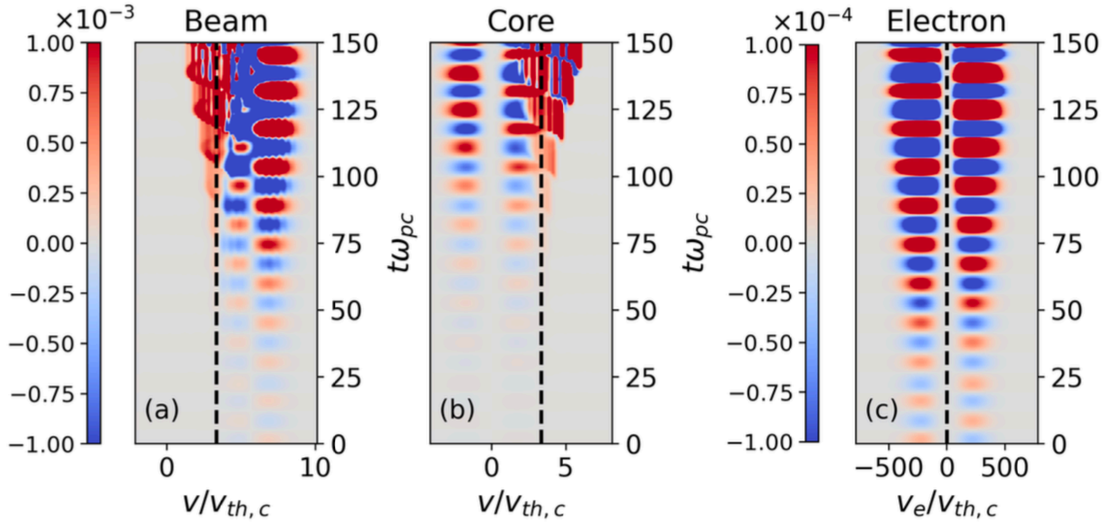
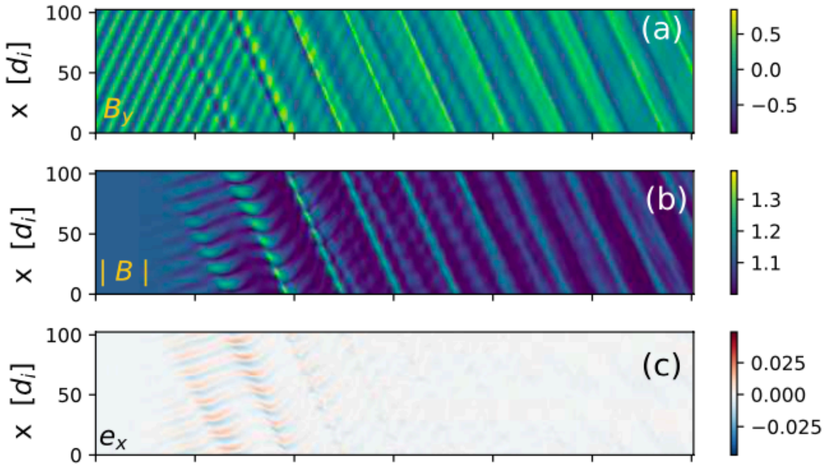


Afify et al, 2026



González et al, 2022

Possible synergies and research questions:

- Fusion, lab & astro plasmas: kinetic instabilities due to multiple ion populations, e.g. Bell, energetic alpha instabilities
- What heats the solar wind?
- Do kinetic instabilities contribute to the ‘fluid-like’ behavior of collisionless plasmas (solar wind, astrophysical turbulence)?

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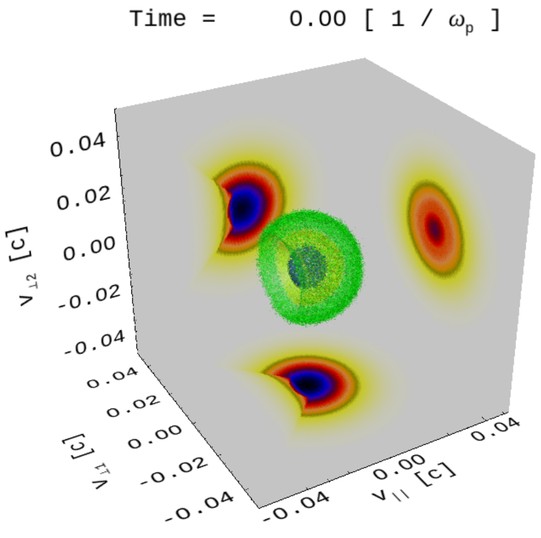
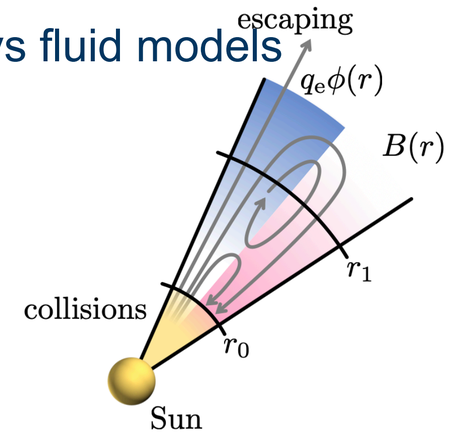
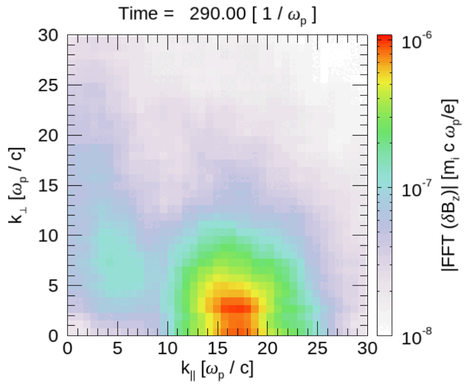
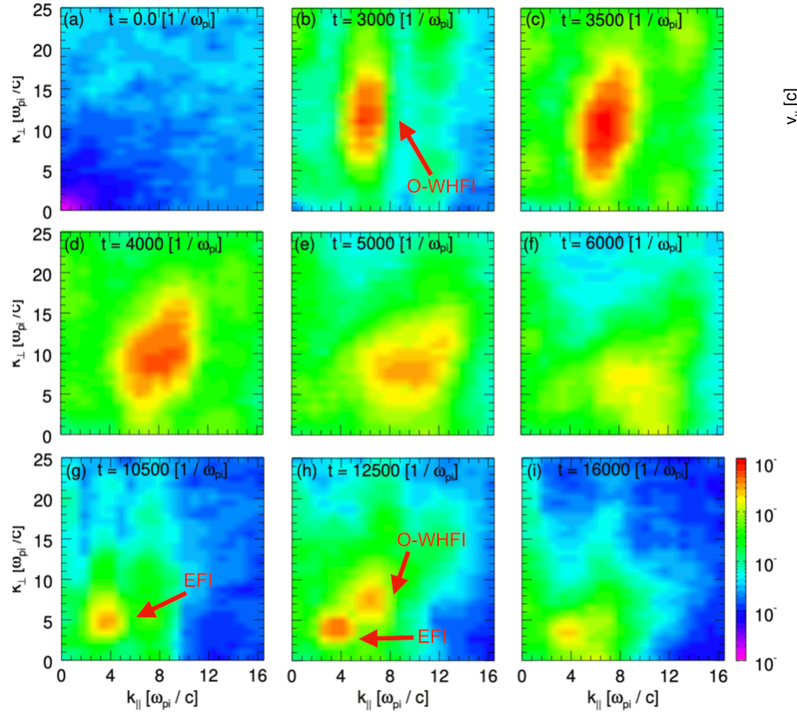


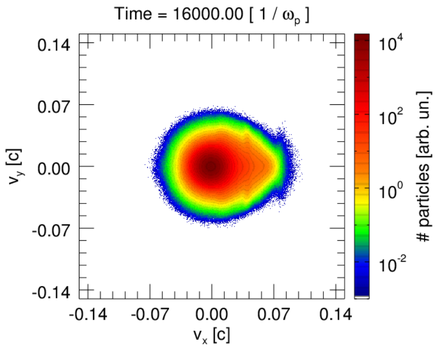
Micera et al, 2025

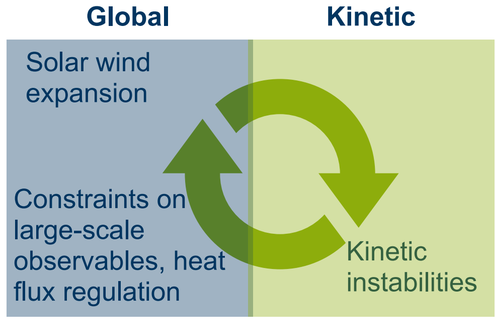




Micera et al, 2021







Possible synergies and research questions:

- Fusion/ laboratory & astrophysical plasmas: heat flux regulation due to whistler-type instabilities (Coburn et al, sub)
- Laboratory plasmas: electron core beam/ instabilities, especially **whistler heat flux instability**
- What regulates heat transport in collisionless/ semi-collisional plasmas?
- How do kinetic and global-scale processes influence each other?

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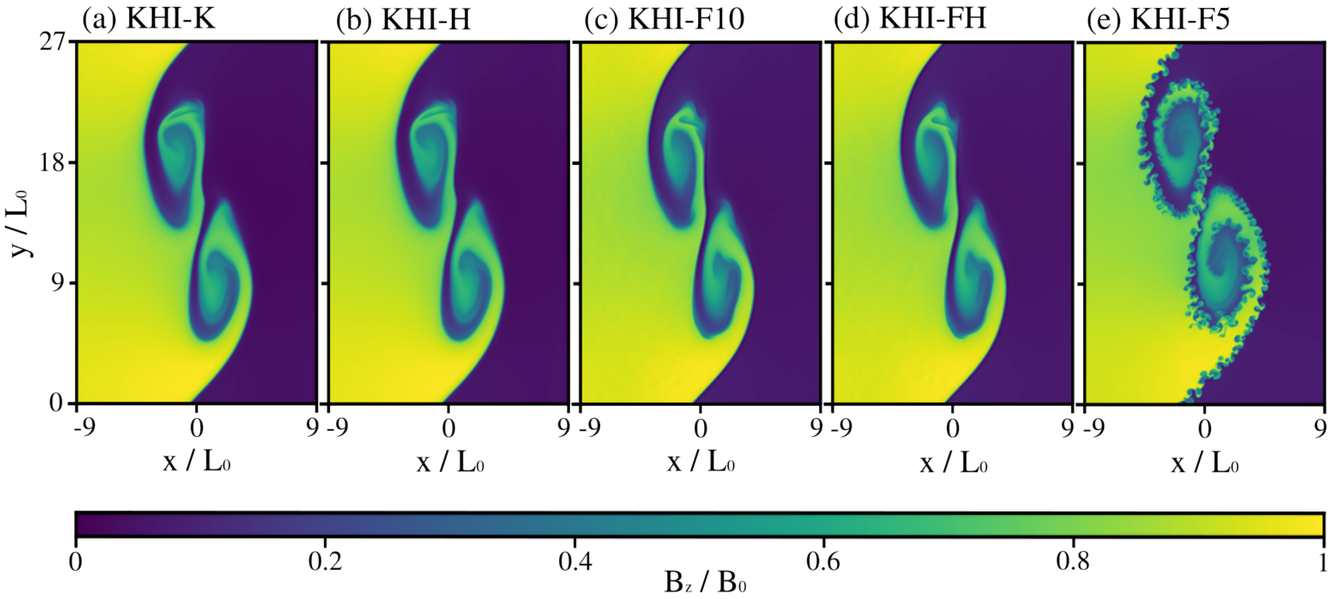
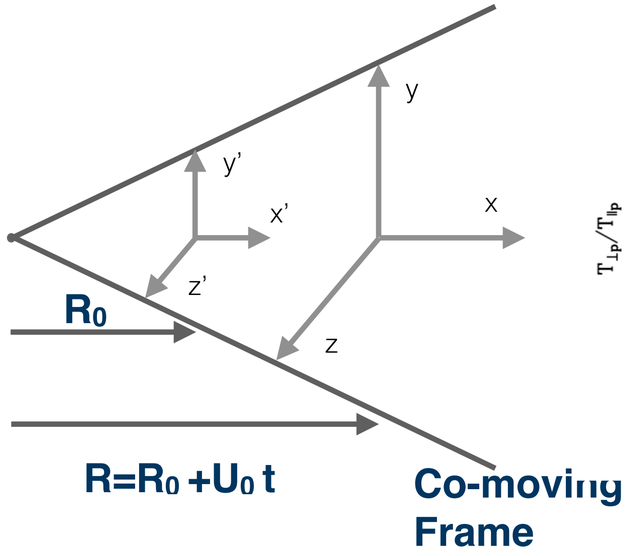
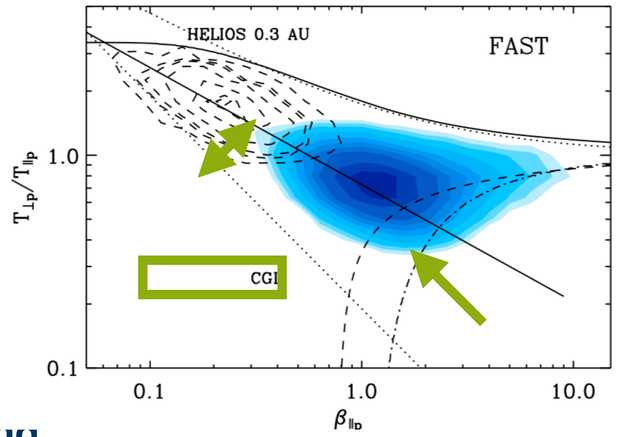


Lautenbach et al, 2026



Innocenti et al 2019, 2020



Matteini et al, 2013

Possible synergies and research questions:

- Kinetic scale processes in expanding/ contracting systems in astrophysical plasmas
- Groups requiring large-domain simulations with physical accuracy beyond MHD
- How do kinetic and global-scale processes influence each other?
- What is the minimal kinetic information we need, in simulations of a number of environments?

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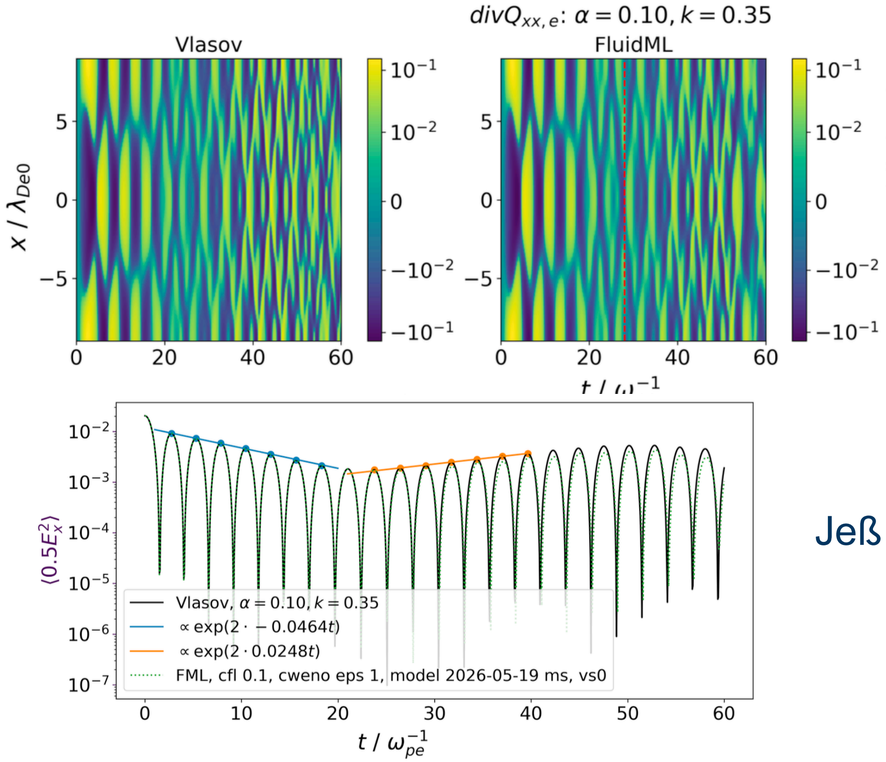
$$\frac{\partial f_s}{\partial t} + v_i \frac{\partial f_s}{\partial x_i} + \frac{q_s}{m_s}\left(E_i + \varepsilon_{abi} v_a B_b\right)\frac{\partial f_s}{\partial v_i} = 0$$

$$\frac{\partial \mu^{(k)}_{\mathrm{s;l,m,n\ldots i}}}{\partial t} = -\frac{\partial \mu^{(k+1)}_{\mathrm{s;l,m,n\ldots,i,j}}}{\partial x_j} + \frac{q_s}{m_s} \sum_{\substack{\text{cyclic perm.} \\ \text{of free indices}}} \left(\mu^{(k-1)}_{\mathrm{s;l,m,n\ldots}} E_i + \varepsilon_{ipq} \mu^{(k)}_{\mathrm{s;l,m,n\ldots,p}} B_q\right)$$

To close 10-moment fluid models (evolution of 1 eq. for n, 3 for V, 6 for P), we need a closure for the 6 div q terms in the P evolution equation



Jeß et al, in prep

Possible synergies and research questions:

- Groups that require large scale-simulations, which embed kinetic information in some form (reduced kinetic model, beyond Hammett-Perkins — example: Bell instability)
- Can we find (ML, analytical) reduced models for div q, at least in a subset of environments, for specific processes (e.g.: damping, turbulence, whistler instability)? Coburn et al, sub