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Planned contributions of KUL to TSVV5 – Neutral Gas Dynamics in the Edge

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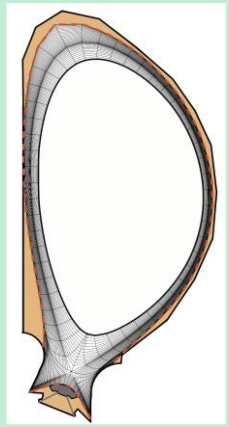
Main focus: development hierarchy of neutral models

Advanced fluid neutral models

- Efficient (direct) coupling to plasma equations, no MC noise
- Basis for hybrid methods
- Good accuracy in highly collisional regimes

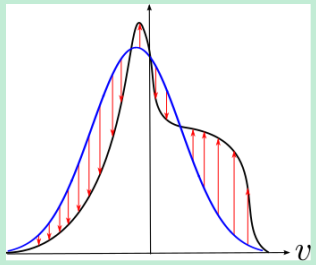
Hybrid fluid-kinetic models

Spatially (SpH)



- F-K transition based on location
- User-defined transition criteria

micro-Macro (mMH)



$$f_{\mathrm{n}}(v) = f_{\mathrm{n,f}}(v) + f_{\mathrm{n,k}}(v)$$

- Decomposition in velocity space
- Can be made **fully equivalent** to kinetic model

Kinetic model

- Most complete physical description
- Flexibility w.r.t. geometry, collisional processes, sources, boundary conditions,…
- Very expensive in highly collisional regimes

Model accuracy

Computational efficiency

CPU × 1/10?

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Spatially hybrid approach

- Planned work (WD, WVU, MB, TB)
  - Further development of Advanced Fluid Neutral AFN models (n-n collisions, drifts, mixed H/D/T plasmas)
  - Optimization of SpH parameters, combination with (evaporation/)condensation approach
  - Application cases: ITER + DEMO, slab + realistic geometry
  - Investigation of fluid/hybrid approach for molecules
- First milestones / deliverables

	Description	Target date
D2.a, 1	AFN with drifts and n-n collisions	6/2022
D2.a, 2	AFN for H/D/T mixed plasmas	6/2023
D2.a, 3	Optimization SpH interfacing scheme	6/2024
D5.c, 1	Application/assessment of FKH for slab DEMO	6/2023
D5.c, 2	Application/assessment of FKH for realistic DEMO	6/2024

micro-Macro hybrid approach and KDMC

- Planned work (BM, WD, VM, GS; NH)
  - mMH:
    - implementation of projection techniques + combination with SpH approach to reduce cancellation errors;
    - rejection sampling to eliminate modeling error
  - KDMC:
    - bias reduction through use of multilevel Monte Carlo
    - implementation of basic scheme + estimators in EIRENE
  - Performance assessment for ITER + DEMO
- First milestones / deliverables

	Description	Target date
D2.b, 1	Assessment of techniques for error reduction (bias, cancellation, modeling)	6/2022
D2.b, 2	Implementation basic KDMC scheme in EIRENE	6/2023
D2.b, 3	Performance assessment FKH schemes	12/2023

Code sensitivities through Algorithmic Differentiation

- Planned work (WD, SC, MB, TB)
  - Interfacing of EIRENE with TAPENADE tool
  - Application in forward and adjoint modes
  - Testing + identification of bottlenecks

- First milestones / deliverables

	Description	Target date
D4.e, 1	Interfacing EIRENE with Tapenade, forward mode	3/2022
D4.e, 2	Interfacing EIRENE with Tapenade, backward mode	3/2023
D4.e, 3	Assessment bottlenecks for use AD with EIRENE(-CFD)	3/2024

Cooperation with ACH

- Link with IM-hub:
  - Algorithmic improvement; optimal particle tracing schemes for ‘regular’ and hybrid simulations