Komplexe Systeme

Institut für Ionenphysik und Angewandte Physik

Leitung: Alexander Kendl

- Theorie und numerische Simulation
- nichtlineare Dynamik, Turbulenz und Strukturbildung
- komplexe Fluide und ionisierte Vielteilchen-Systeme

- Aktuelle Schwerpunkte:

  # Turbulenz und Transport in Plasmen

  # Fusionsforschung (Tokamak, Stellarator)

  # Elektron-Positron-Laborplasmen

Komplexe Systeme

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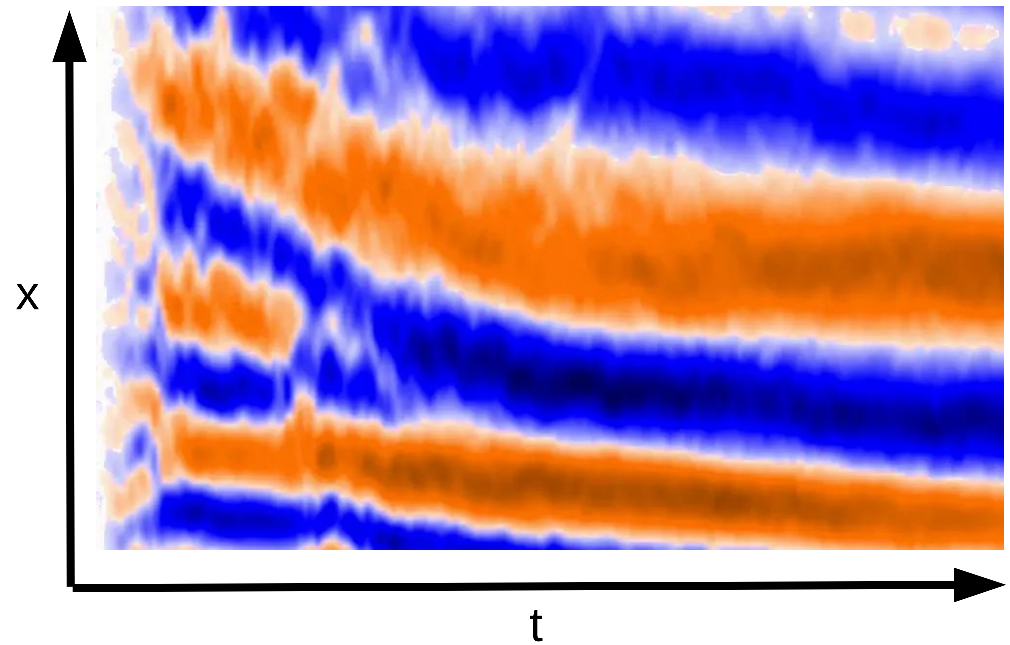
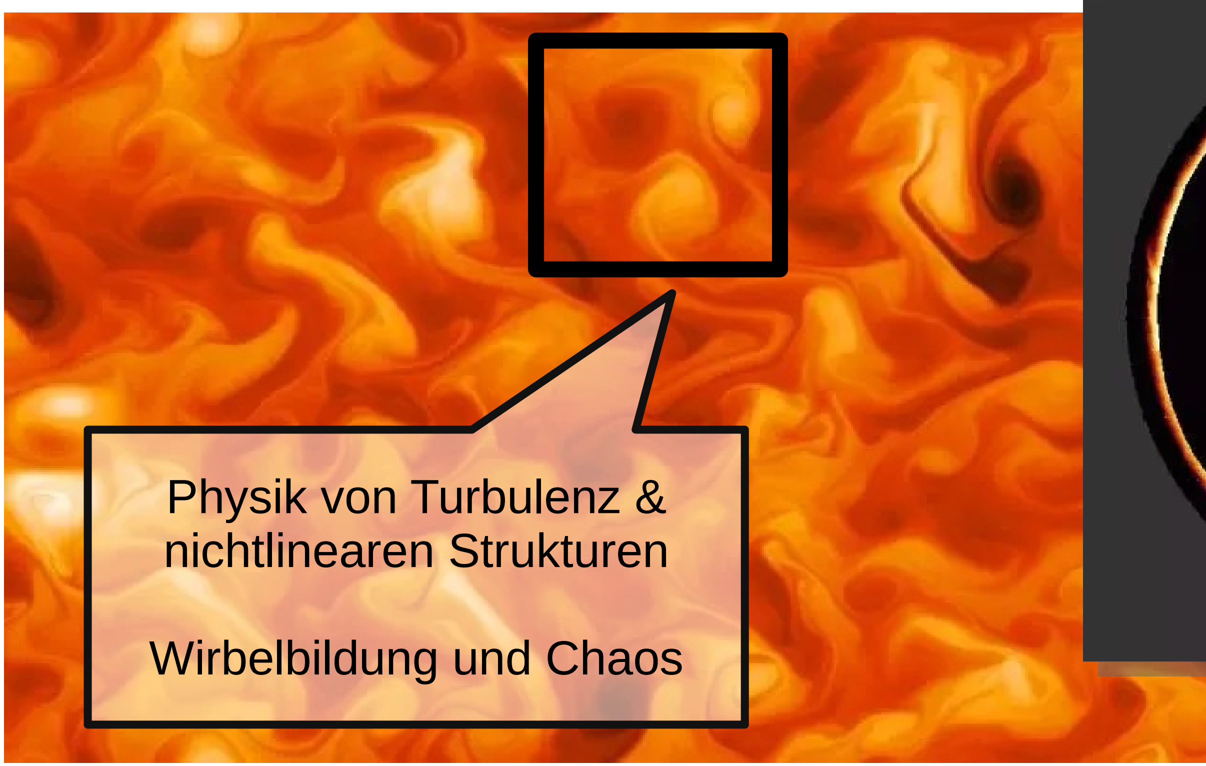
Entstehung von Strömungen
⟨v(x,t)⟩ aus starker Turbulenz
in einem Fusions-Plasma

(„A highlight of the year 2018“
in *Nuclear Fusion*)





Instabilitäten und Transport

Komplexe Systeme

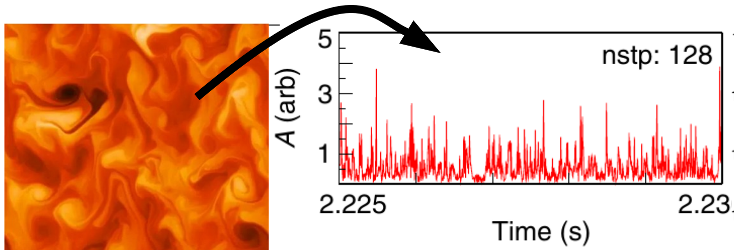
BSc

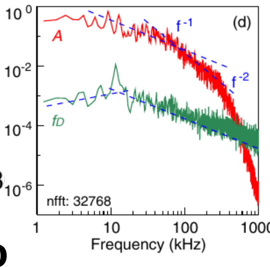
Aktuelle Themenvorschläge für Bachelor-Arbeiten

im 744087 SE Seminar mit Bachelorarbeit am Institut für Ionenphysik und Ang. Physik

Alle Themen beinhalten eigene praktische Arbeiten (und nicht nur Literatur-Review)

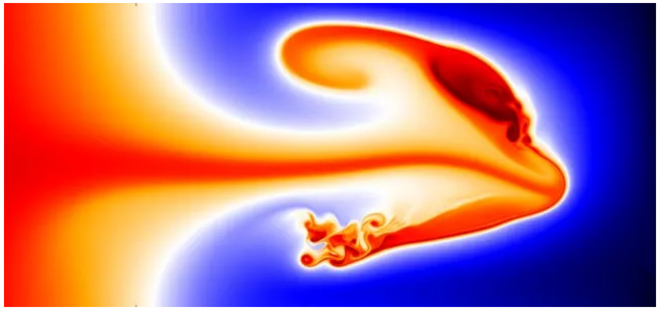
(1) Statistische Analyse von Zeitserien aus Simulation und/oder Messung von Turbulenz in Fusionsplasmen





FFT, PDF, ACF & Co

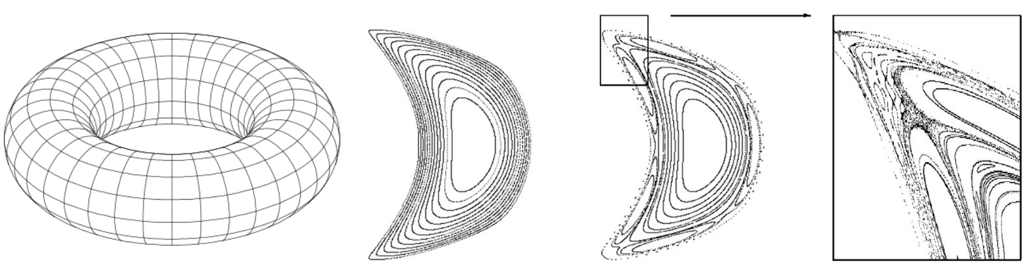
(2) Theorie: Dispersionsrelation der Austausch-Instabilität in Mehrkomponenten-Plasmen



Elektron + Positron + Ion

Elektron + Proton + Ionen

(3) Hamiltonsches Chaos, KAM-Tori und symplektische Abbildungen: von gekoppelten Pendeln zu Inseln in Fusionsplasmen



Komplexe Systeme

MSc

Aktuelle Themenvorschläge für Master-Arbeiten

Zuordnung in den Curricula:

Studienschwerpunkte (MSc Curriculum bis 2019/20):

- (2b) Ionen-, Plasma- und angewandte Physik : Theoretischer Zweig (ITH)
- (4) Computational Physics

Vertiefungsrichtungen (MSc Curriculum NEU voraussichtlich ab 2020/21):

- Ion physics and applied physics
- Many-body theory

Wünschenswerte Voraussetzungen:

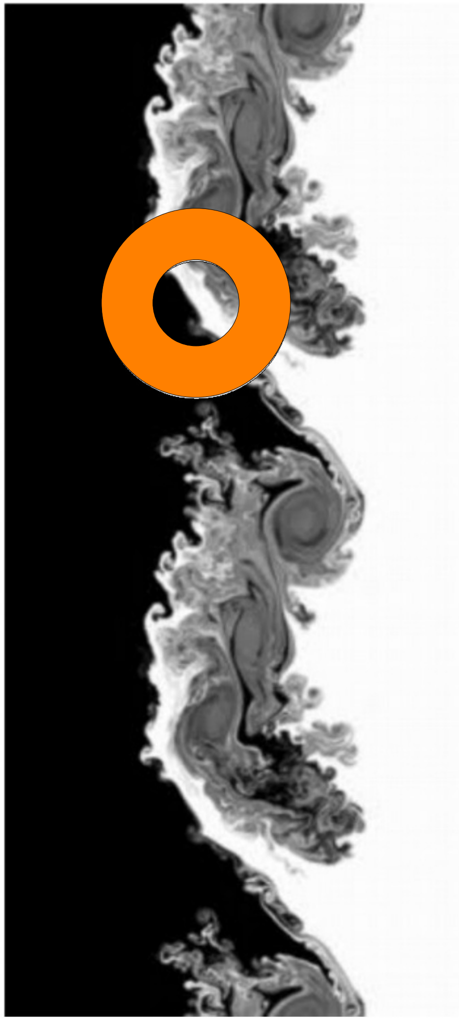
- Grundkenntnisse in Programmierung (C/C++) sehr hilfreich
- Grundkenntnisse in Plasmaphysik und / oder Fluiddynamik (Vorlesungen im MSc)

Komplexe Systeme

MSc

Aktuelle Themenvorschläge für Master-Arbeiten

(1) Finite Larmor radius effects on the Kelvin-Helmholtz instability in magnetised plasmas



An existing **2D gyro-fluid turbulence code** (written in C++) in magnetised plasmas shall be prepared for simulation of the Kelvin-Helmholtz (shear flow) instability.

The **gyro-fluid model** consistently includes effects of a finite Larmor (gyration) radius (FLR), which gets relevant when vortices have spatial extensions in the order of an ion gyration radius.

(1) Review the present status of literature on simulations including FLR effects on the KH instability;

(2) Prepare the code for simulations;

(3) Plan parameter studies for a series of simulations;

(4) Apply or further develop post-processing diagnostics of the simulations;

(5) Characterise the influence of FLR effects on mode numbers, growth rates, and transition to turbulence;

(6) Discuss possible relevance of the effect for applications (fusion, space).

Starting literature:

Faganello, J. Plasma Phys. 83, 535830601 (2017);

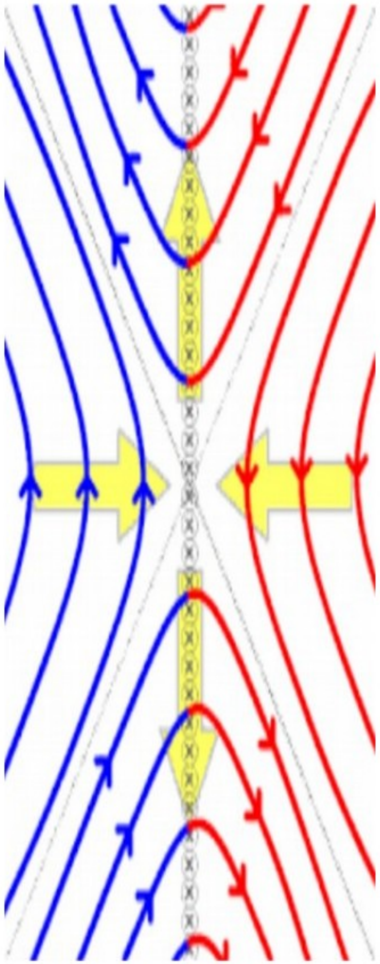
Kendl, Plasma Physics and Controlled Fusion 60, 025017 (2018).

Komplexe Systeme

MSc

Aktuelle Themenvorschläge für Master-Arbeiten

(2) Full-f gyrofluid simulations of reconnection in magnetised plasmas



The **reconnection of magnetic field lines** in turbulent magnetised plasmas is of high interest both in astrophysical and fusion plasmas.

Previously, reconnection has been studied with delta-f gyrofluid models, which only treat small fluctuations of the relevant quantities.

(1) Implement already formulated nonlinear equations in the context of a **full-f model** (which treats the full quantities, and thus allows for arbitrarily large fluctuation amplitudes) into an existing gyrofluid code.

(2) The model and equations so far implemented in the code have the same structure as those for reconnection, so that **some coding** but **no major new numerical developments** will be required.

(3) **Devise and run a series of simulation studies** in order to compare the reconnection rates and structure formation from simulations of the new code version developed within this thesis, with the delta-f results both in the literature and with the delta-f limit within our code.

Starting literature:

Comisso, Phys. Plasmas 20, 092118 (2013);

M. Held, Ph.D. (2017), http://diglib.uibk.ac.at/ulbtirolhs/download/pdf/1530595