Seminar/Proseminar Plasma Physics winter semester 2023/24

Dr. Philipp Lauber, Dr. G. Birkenmeier

- https://pwl.home.ipp.mpg.de/tum/2023_WS.html
- please choose a topic from the list below according to your level: pro-seminar/first contact students have priority on introductory topics
- contact us (philipp.lauber@ipp.mpg.de, gregor.birkenmeier@ipp.mpg.de) by Oct 31st via email with your preferred topic and one alternative (first come first serve basis);
- you are encouraged to choose your own topic (e.g. bachelors, masters, interns) related to your thesis/work

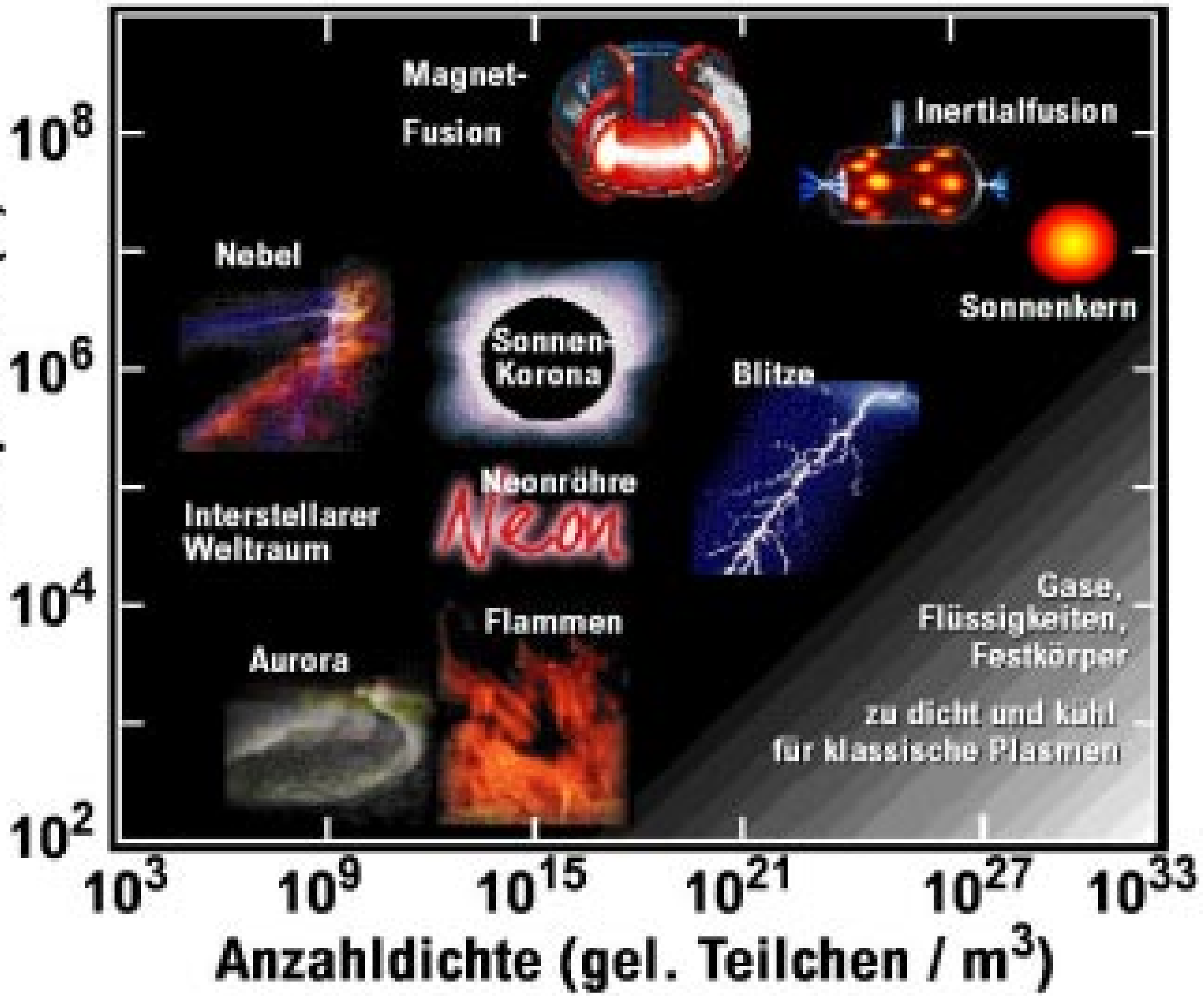
aim:

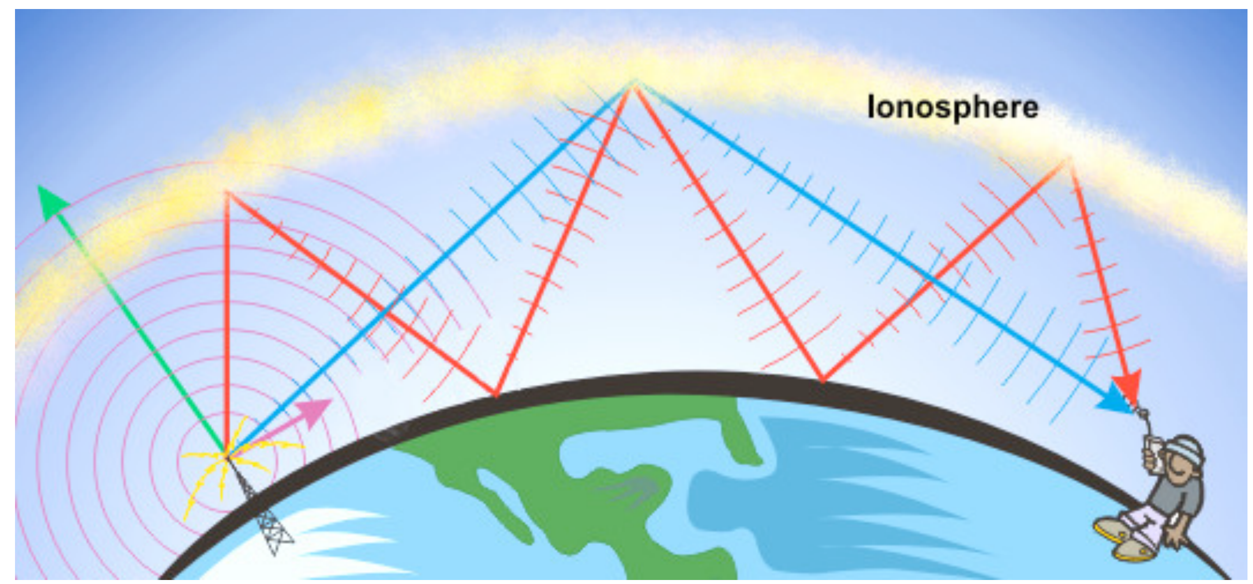
- introductory/deeper knowledge about some aspects of plasma physics
- train presentation skills:
  - preparation of scientific material (reading/understanding)
  - combine and present material in your own style/words/slides
  - explain and ‘teach’ your material in class, answer questions

style:

- duration 25+15 mins, language English
- discussion: all attendants should try to ask questions
- prepare slides (and/or blackboard)
- slides to be discussed and iterated with Gregor/Philipp before the presentation (a couple of days before)

Basic Plasma Properties

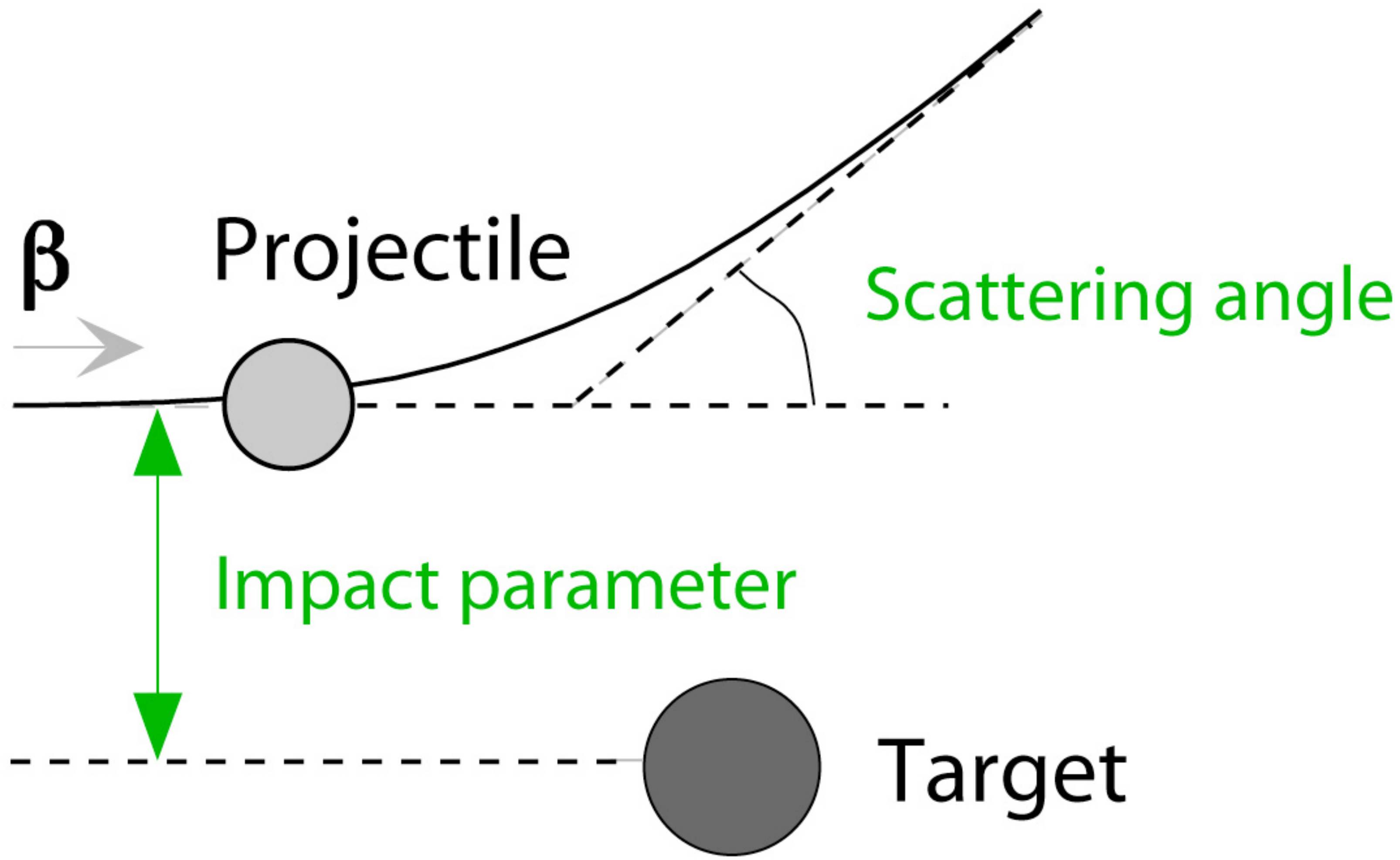




classification of plasmas,
Debye theory

derivation, consequences,
application to ionosphere

Coulomb collisions



cross section, Coulomb logarithm, friction force

models for describing plasmas: fluid - kinetic

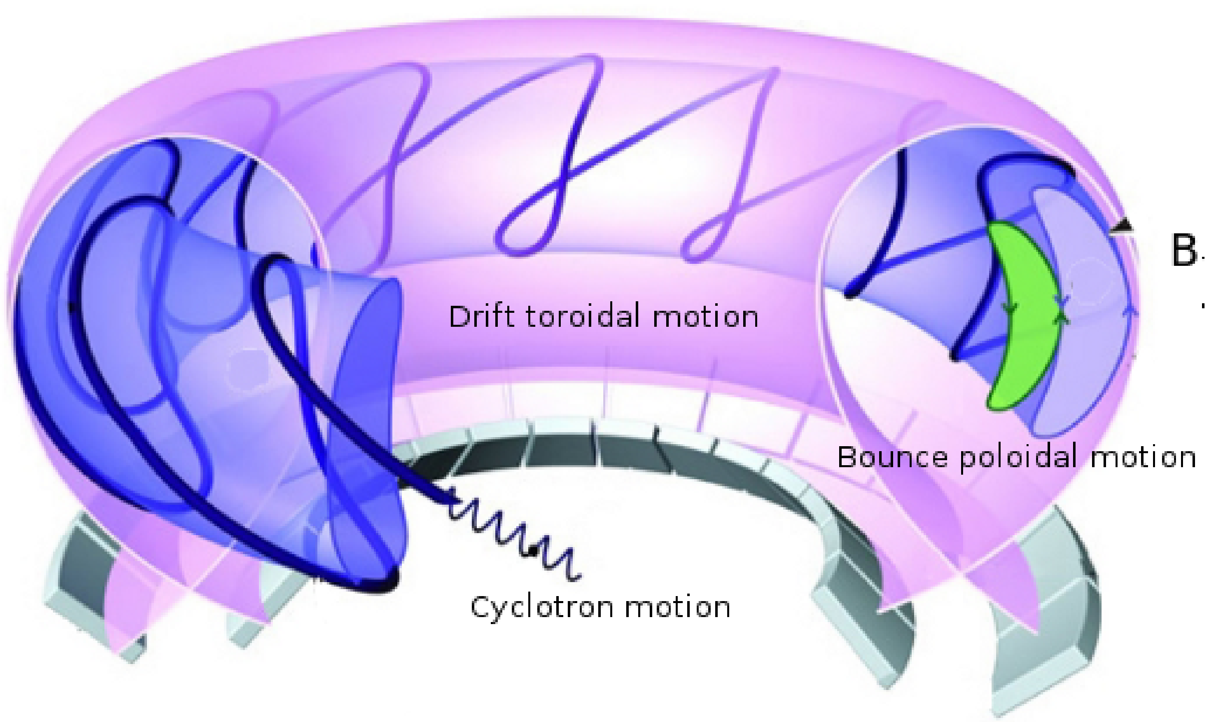
$$\frac{d\rho}{dt} + \rho \nabla \cdot \mathbf{V} = 0,$$

$$\rho \frac{d\mathbf{V}}{dt} + \nabla p - \frac{(\nabla \times \mathbf{B}) \times \mathbf{B}}{\mu_0} = 0,$$

$$-\frac{\partial \mathbf{B}}{\partial t} + \nabla \times (\mathbf{V} \times \mathbf{B}) = 0,$$

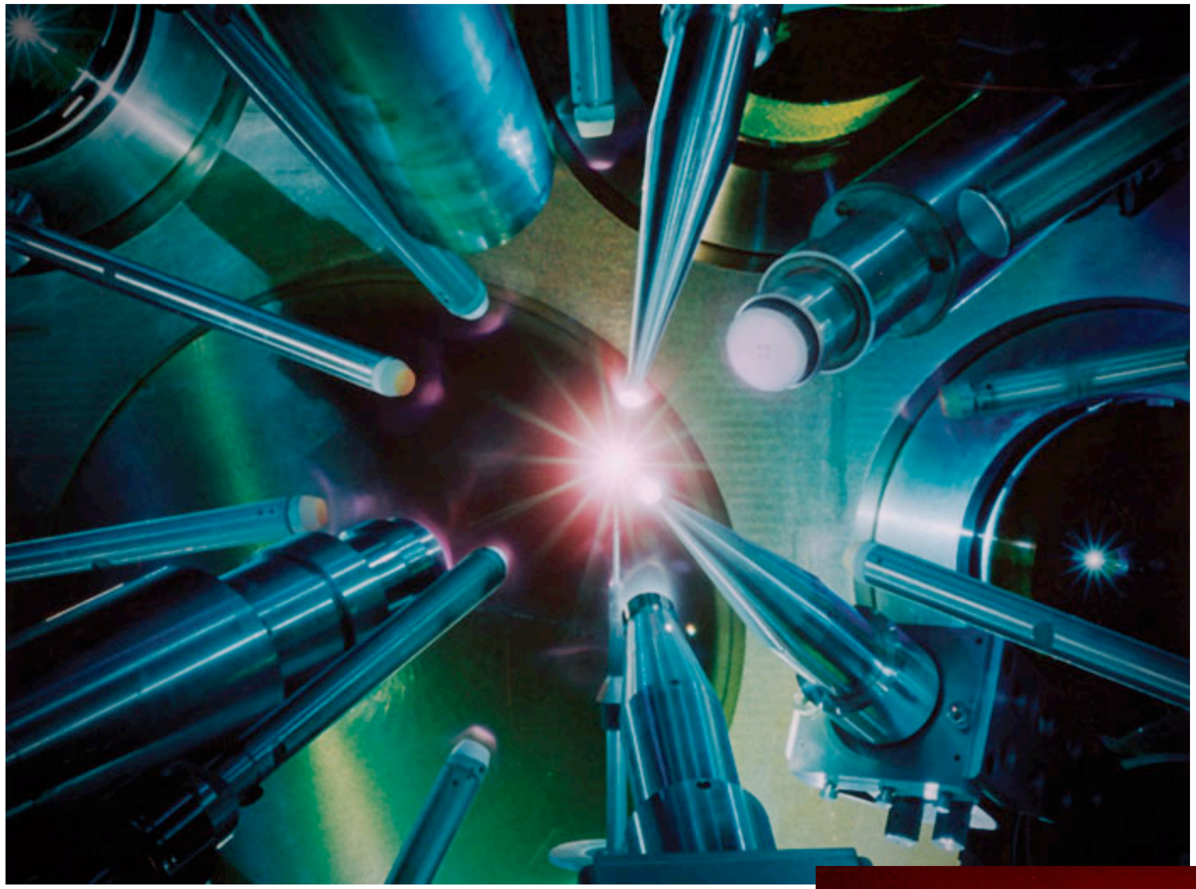
$$\frac{d}{dt}\left(\frac{p}{\rho^{\Gamma}}\right) = 0,$$

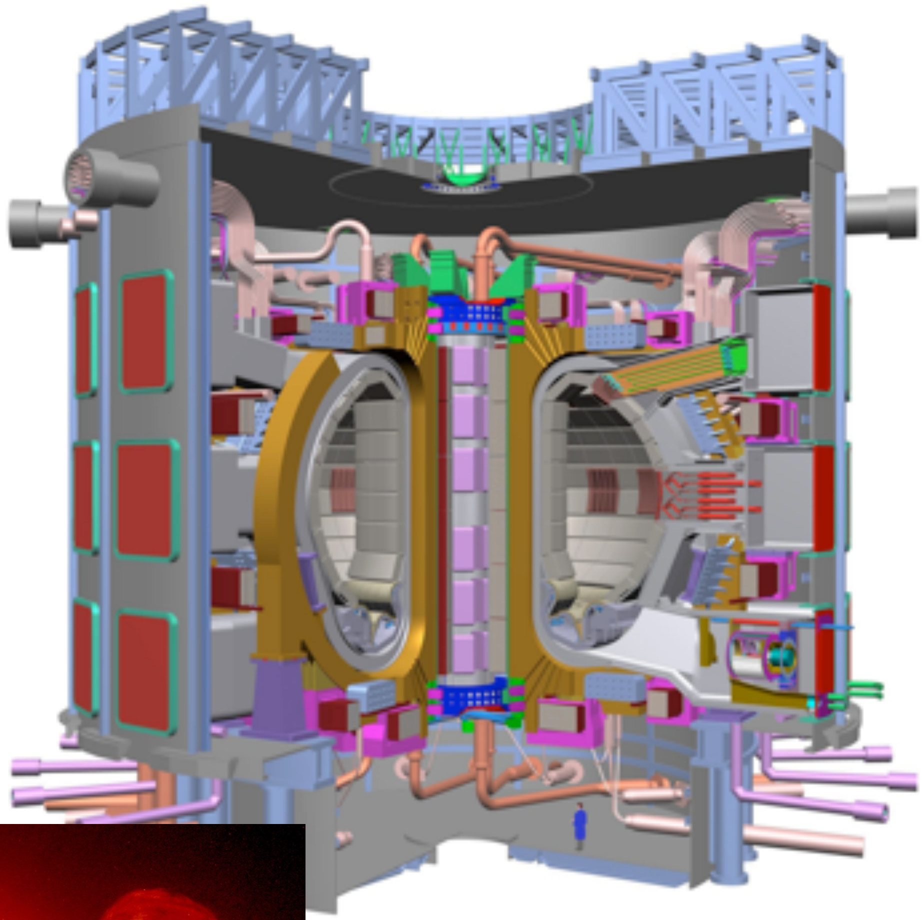
Charged particle motion in inhomogeneous magnetic fields

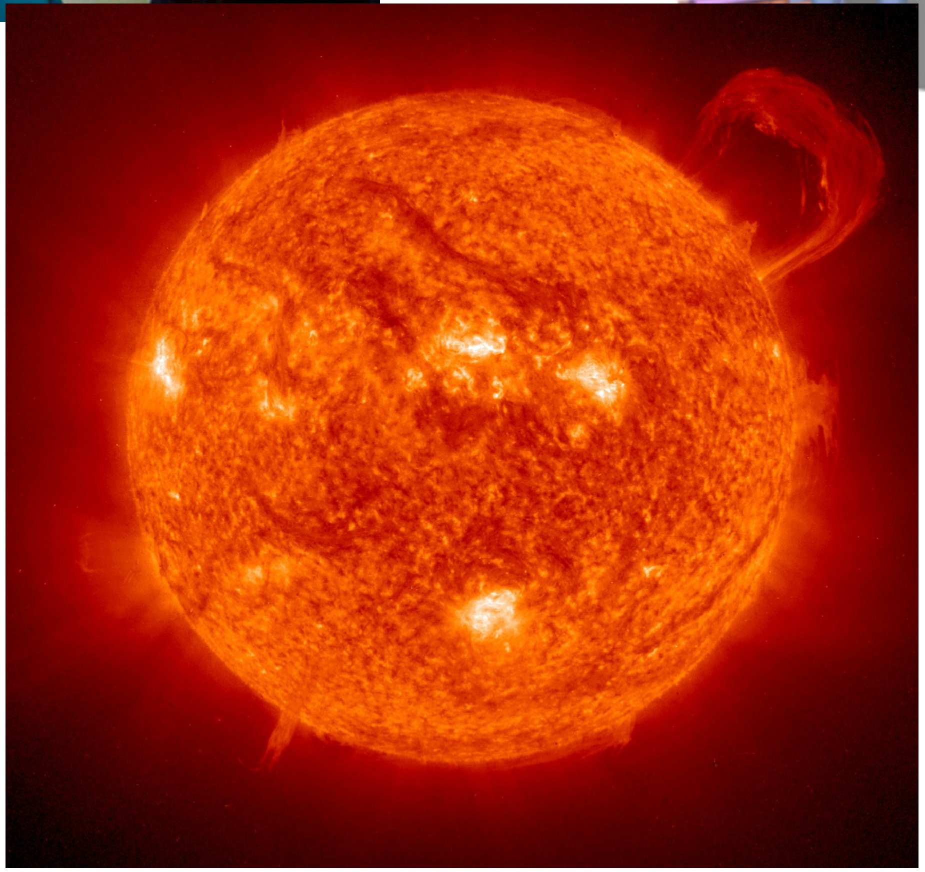


drifts, guiding centre description
(numerical approaches: implicit, explicit, symplectic)

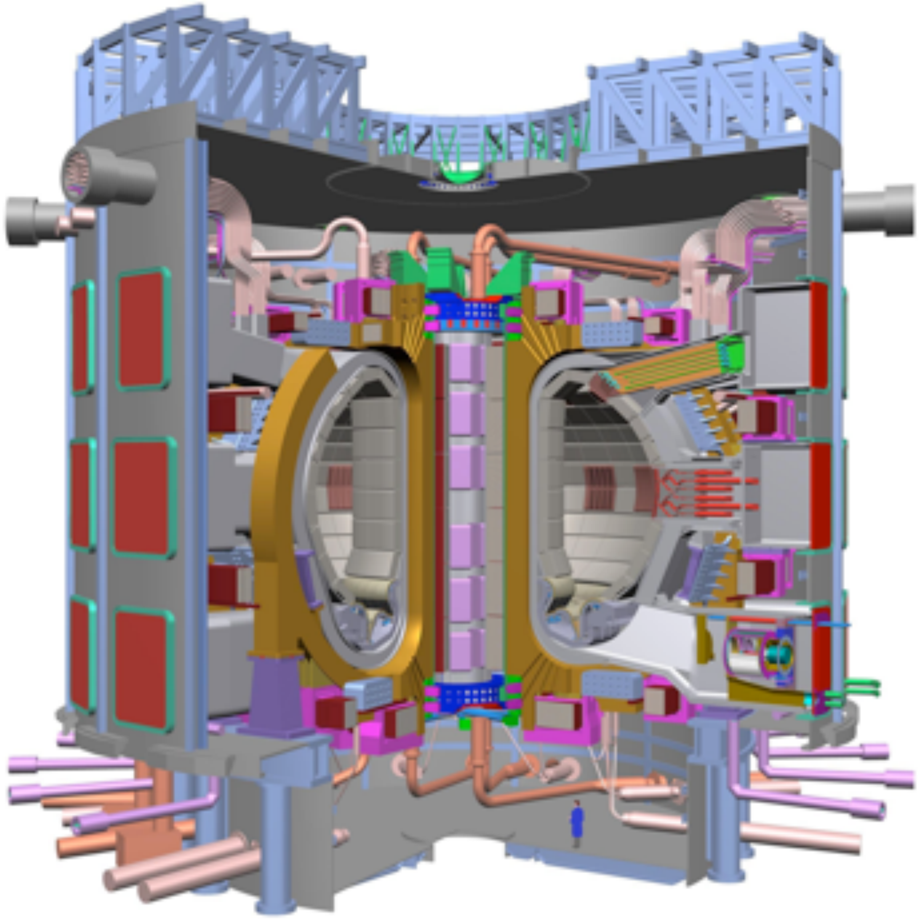
Confinement concepts





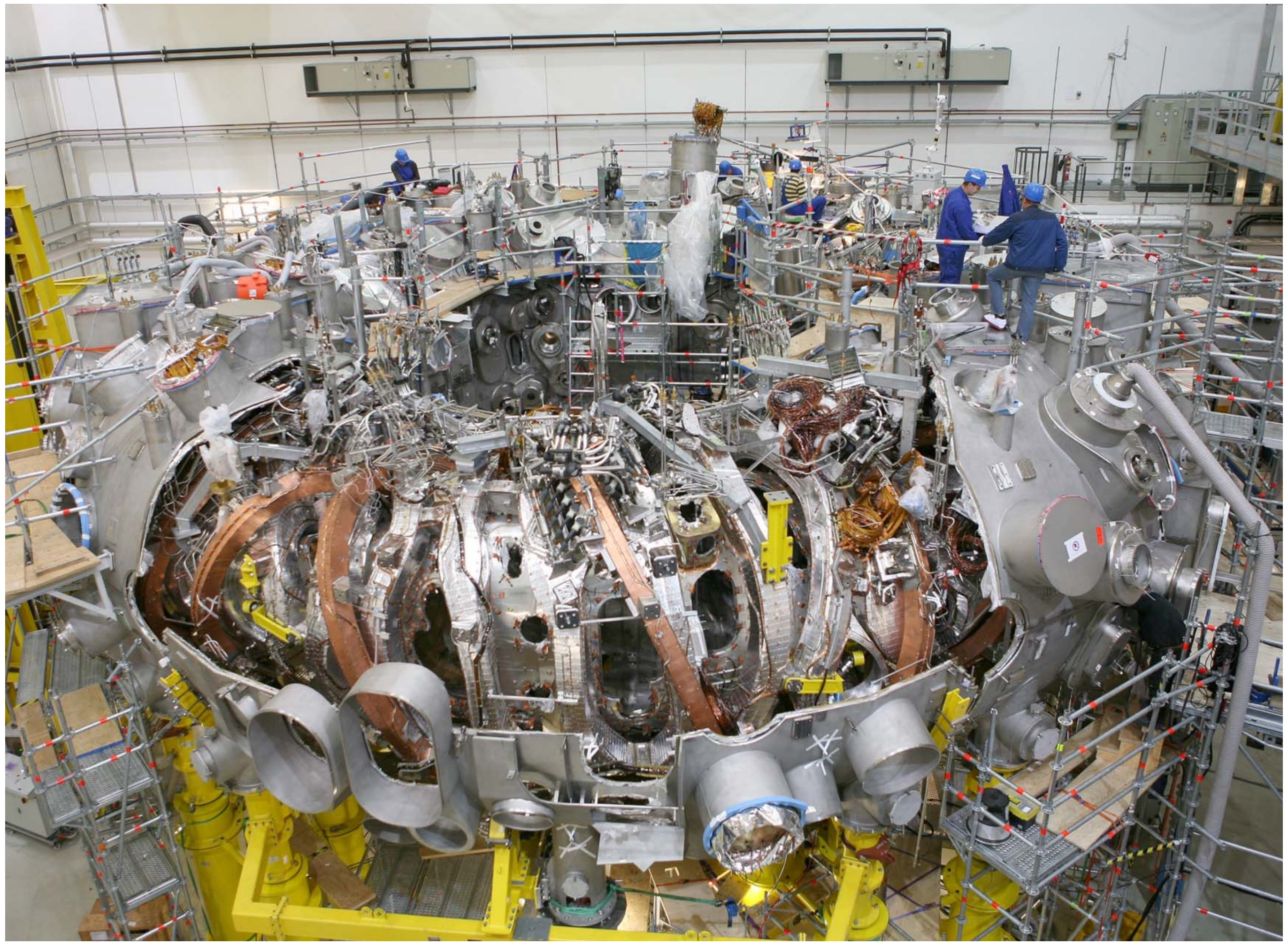


Tokamaks (JET/AUG/JT60SA/ITER/DEMO)

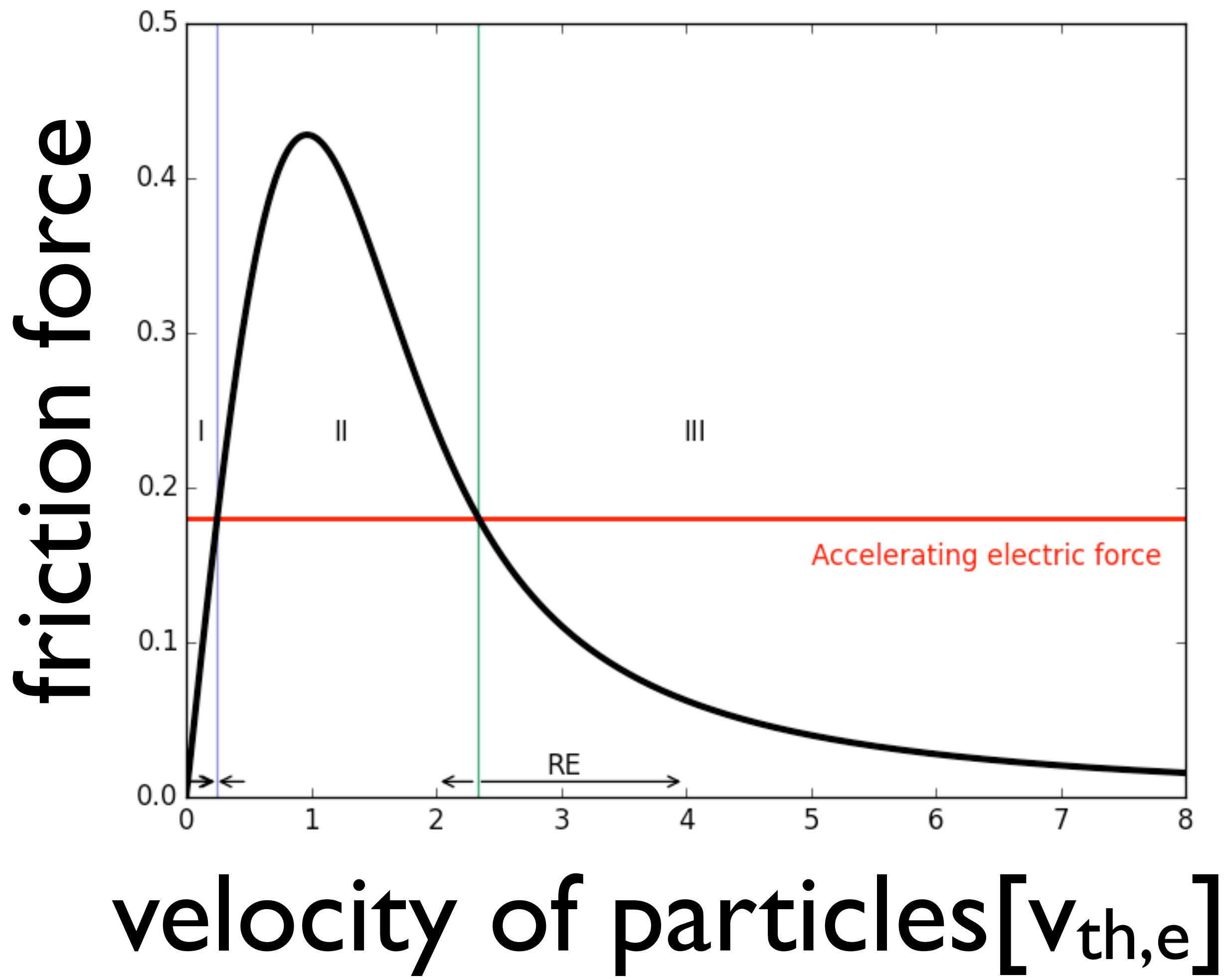


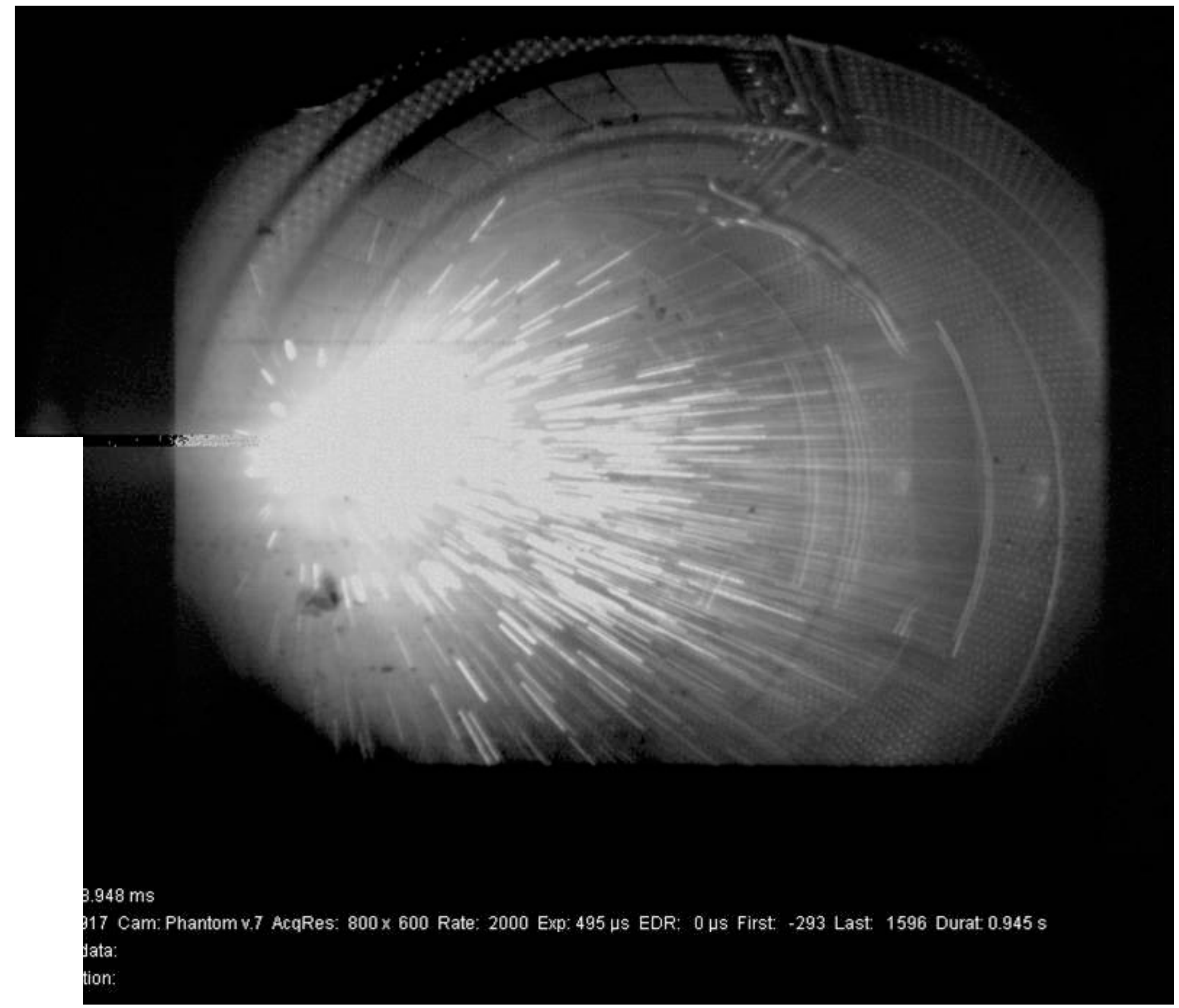
Stellarators

basic concepts
confinement
experiments

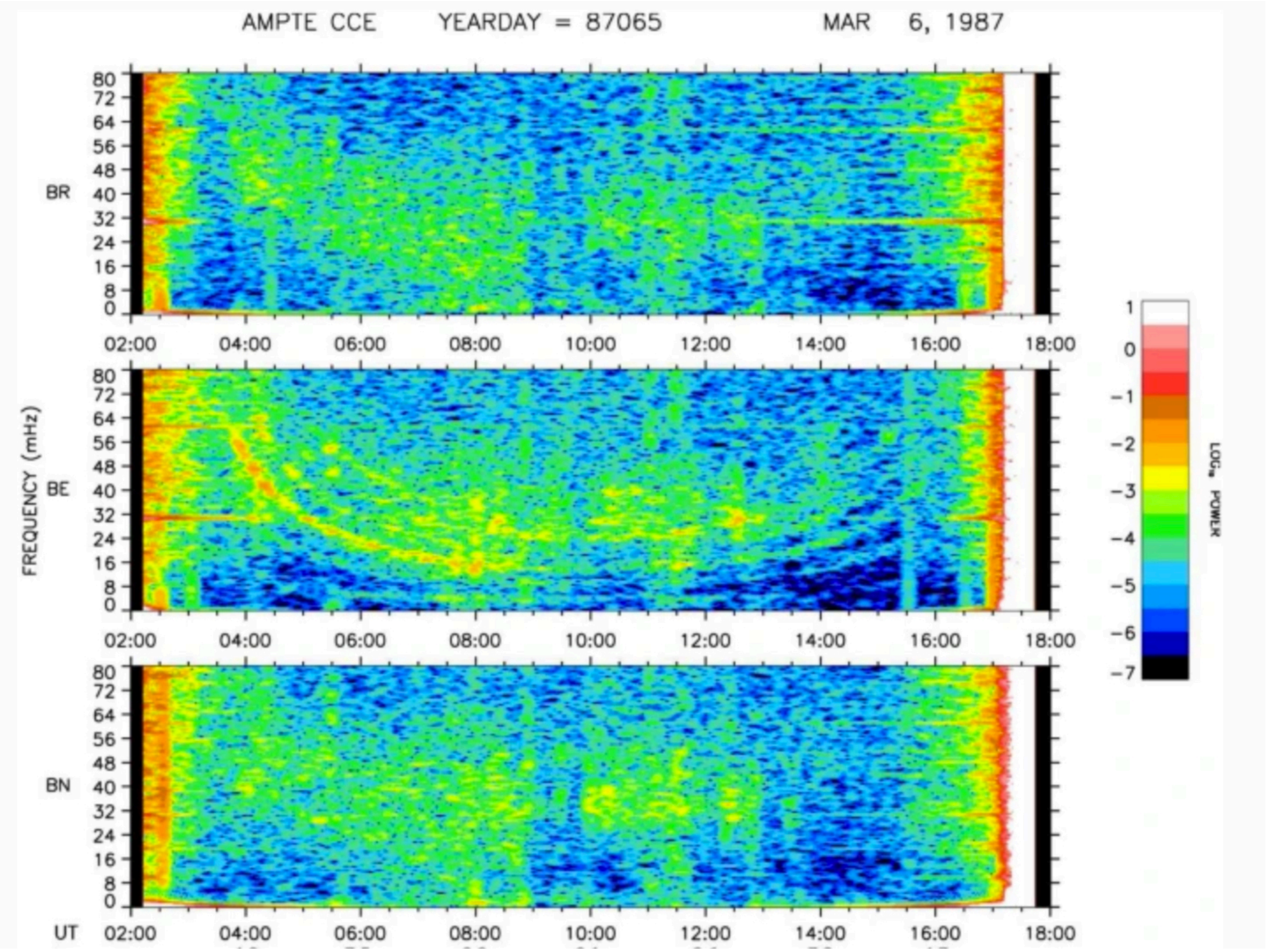


Runaway electrons



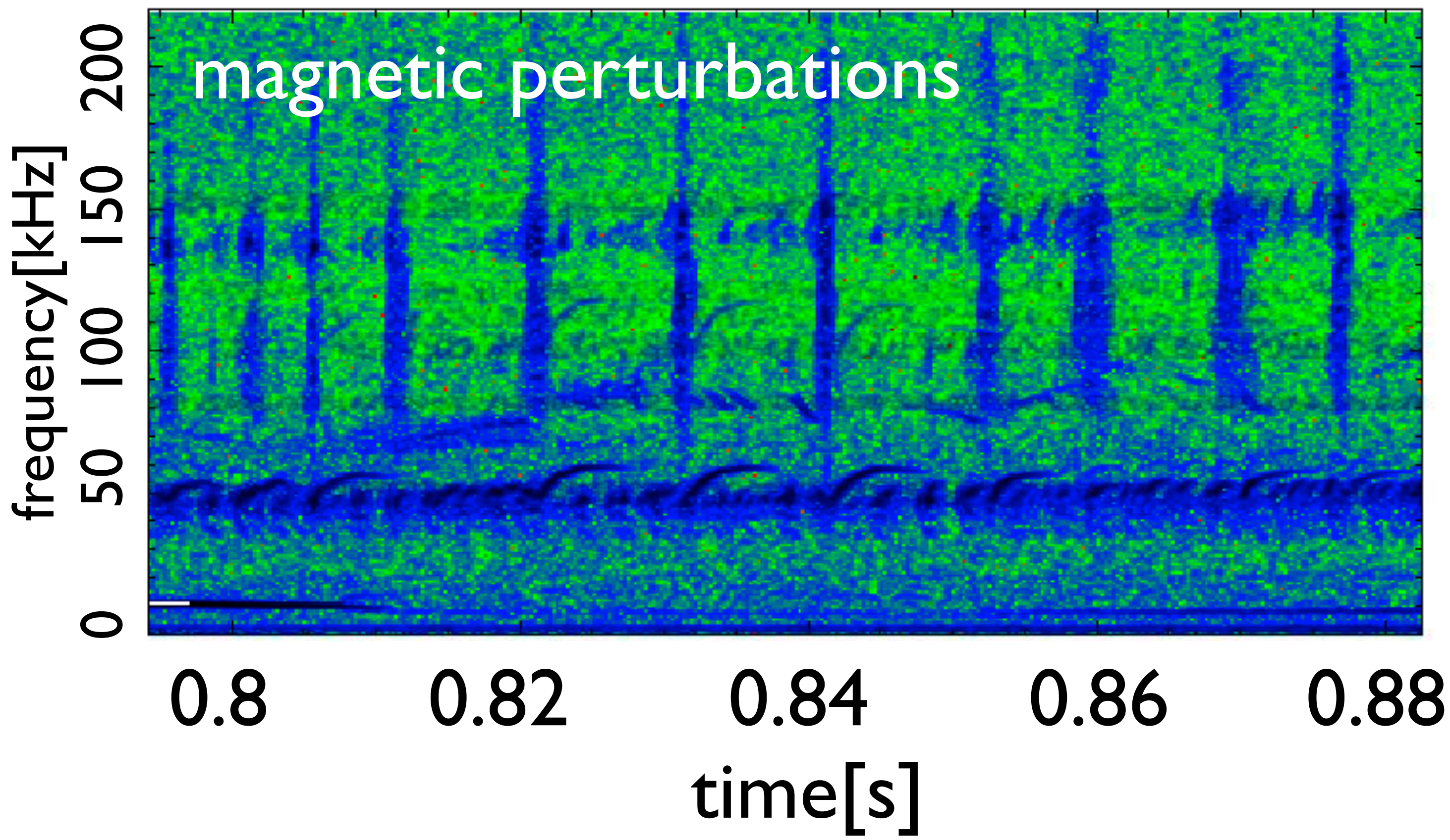


Kinetic Alfvén waves: theory, applications in space/astro/fusion



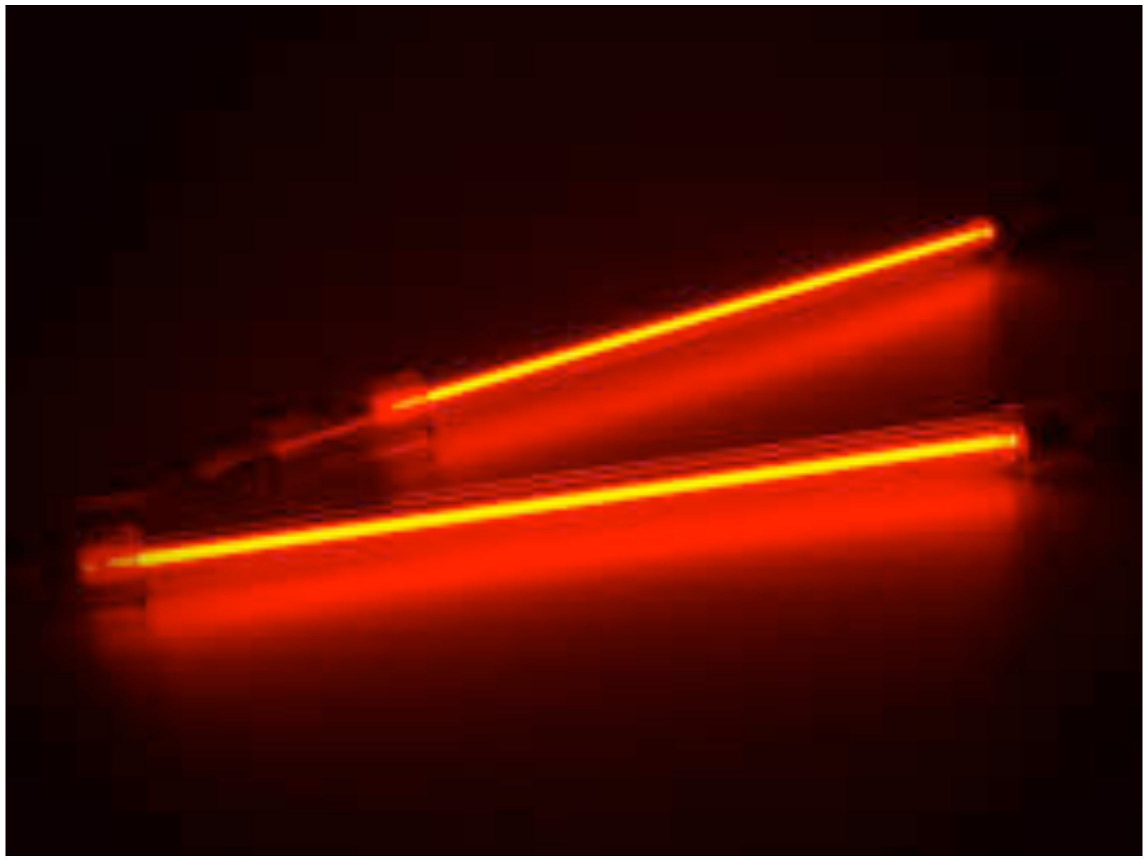
Energetic Ions in Tokamaks

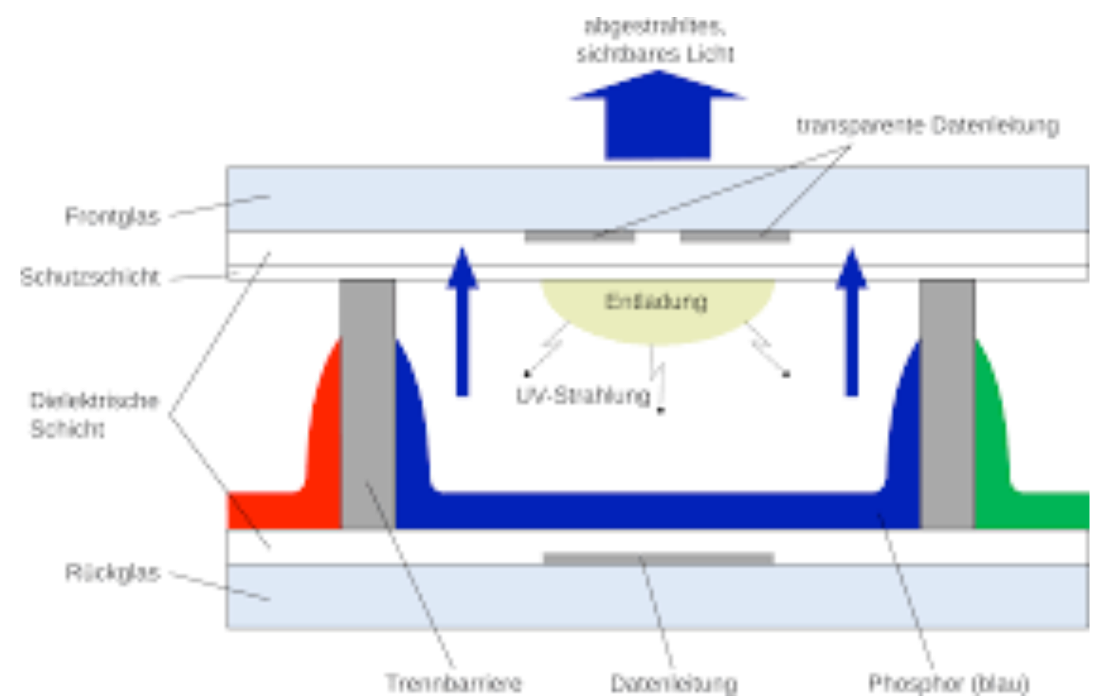
Alfvén waves, resonant interaction, non-linear saturation

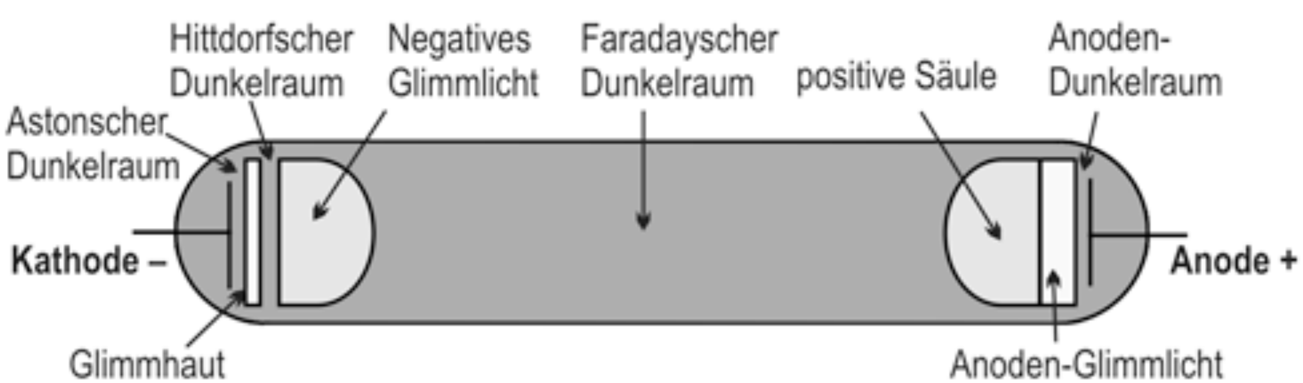


1. theoretical framework
2. experiment

Low temperature plasmas: principles and applications







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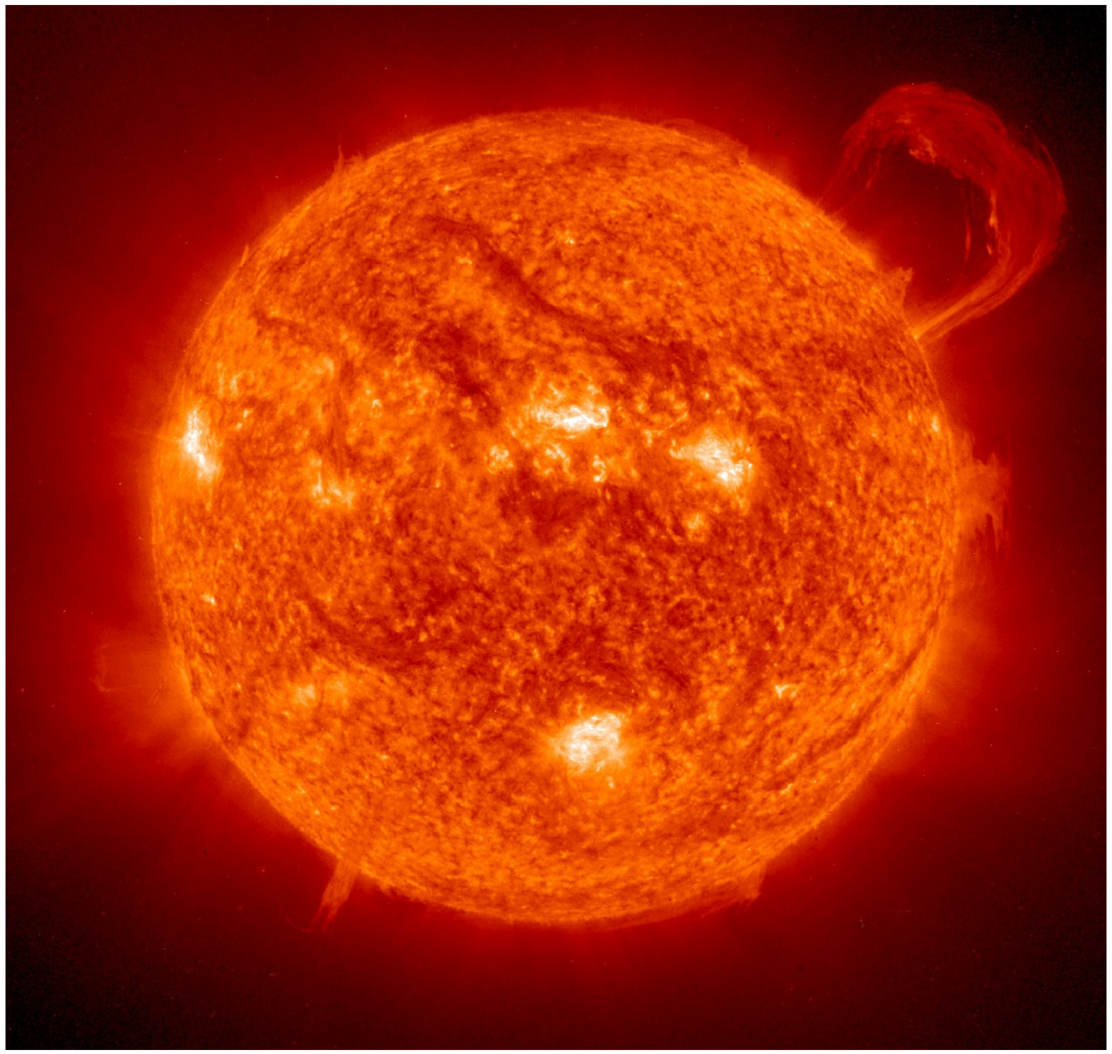
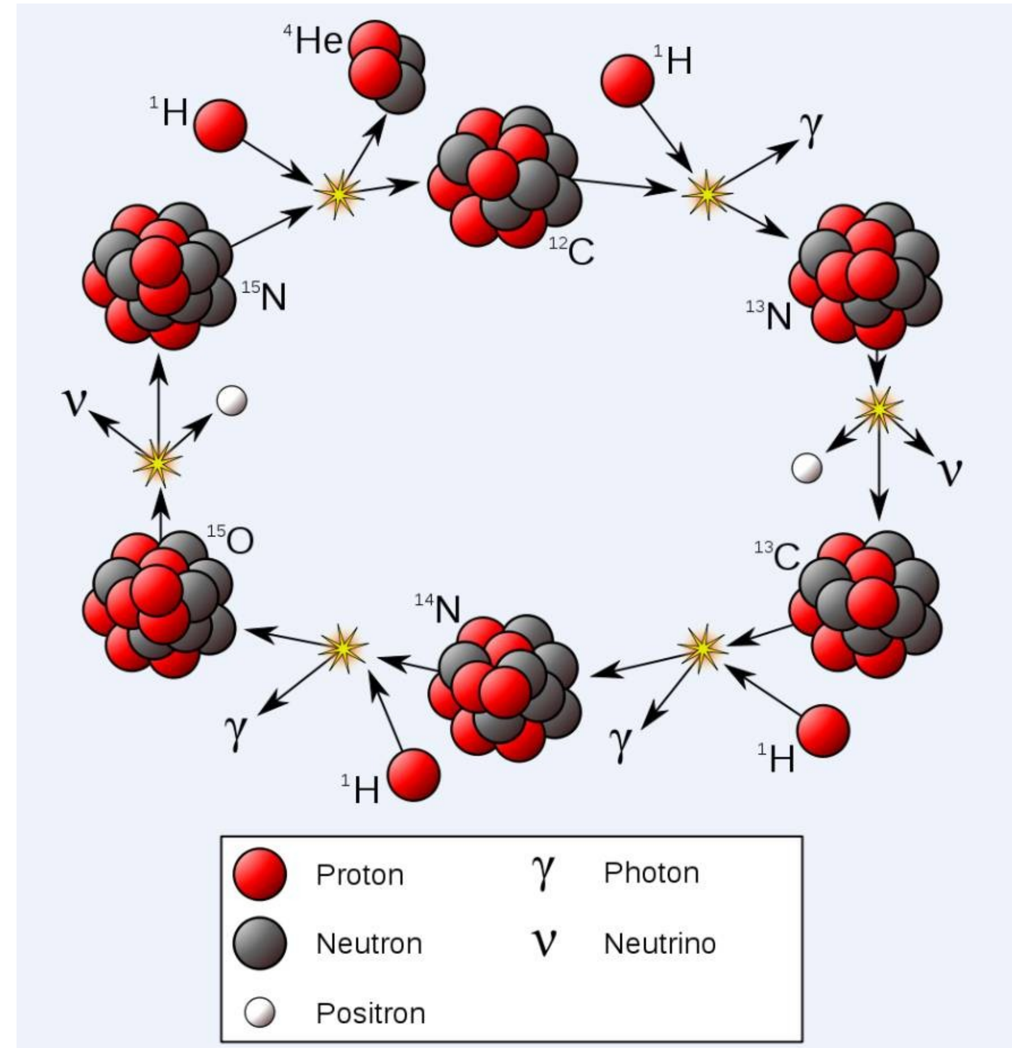
Plasma Thrusters

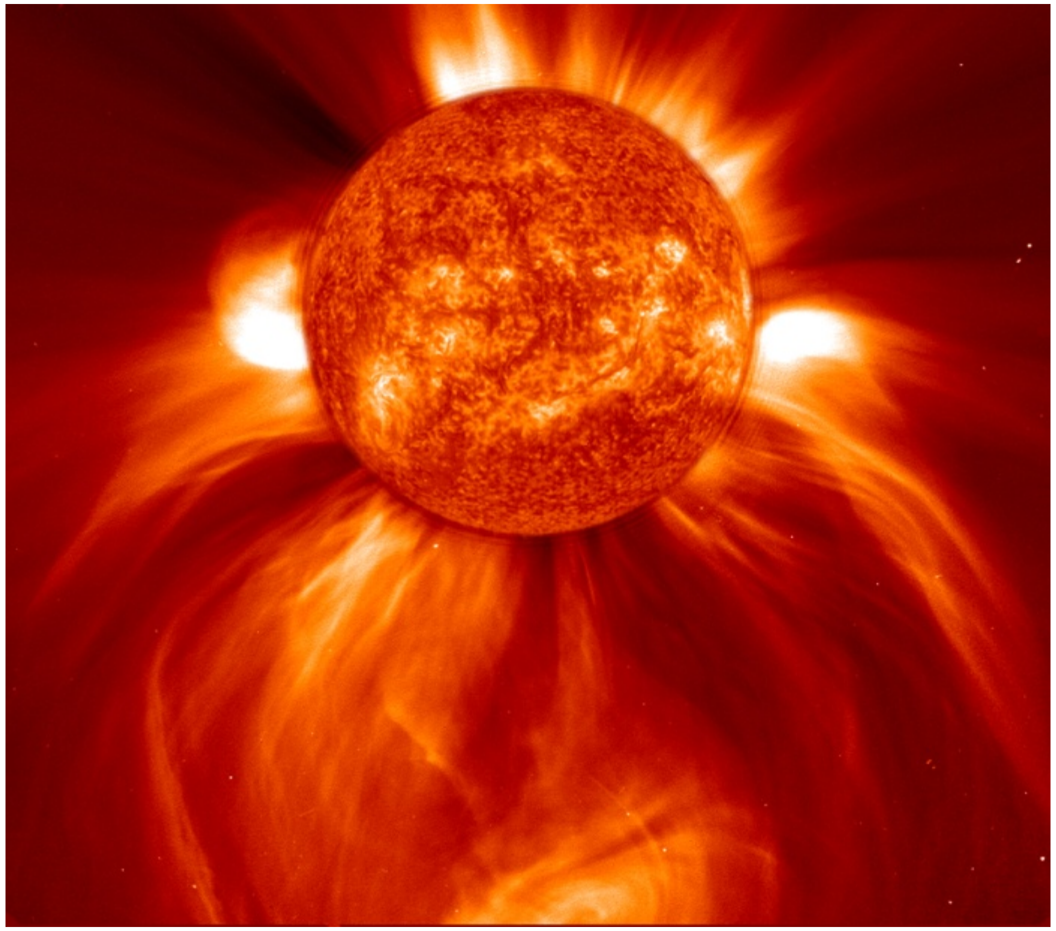
The Sun

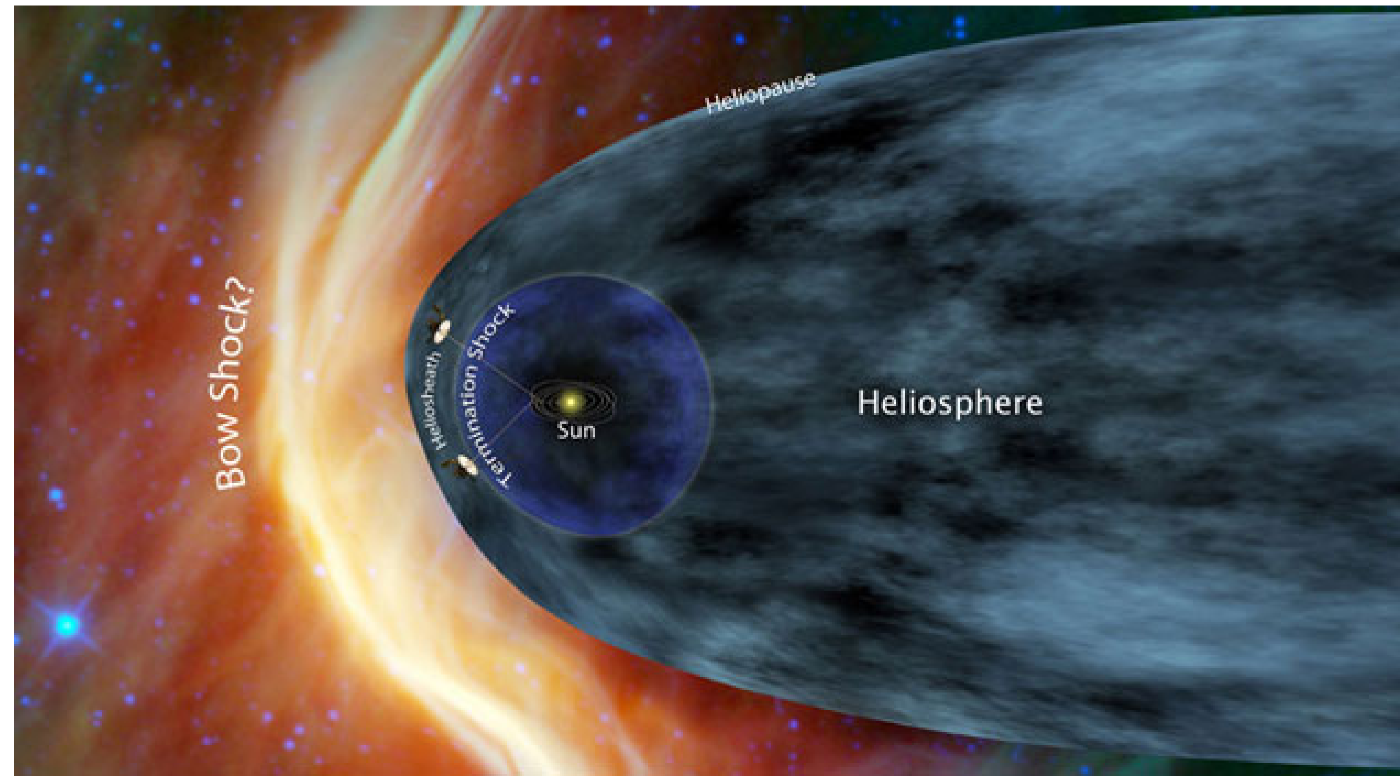




nuclear processes, solar structure, solar equilibrium and equations of state, radiation transport, convection

The solar Corona and the solar wind



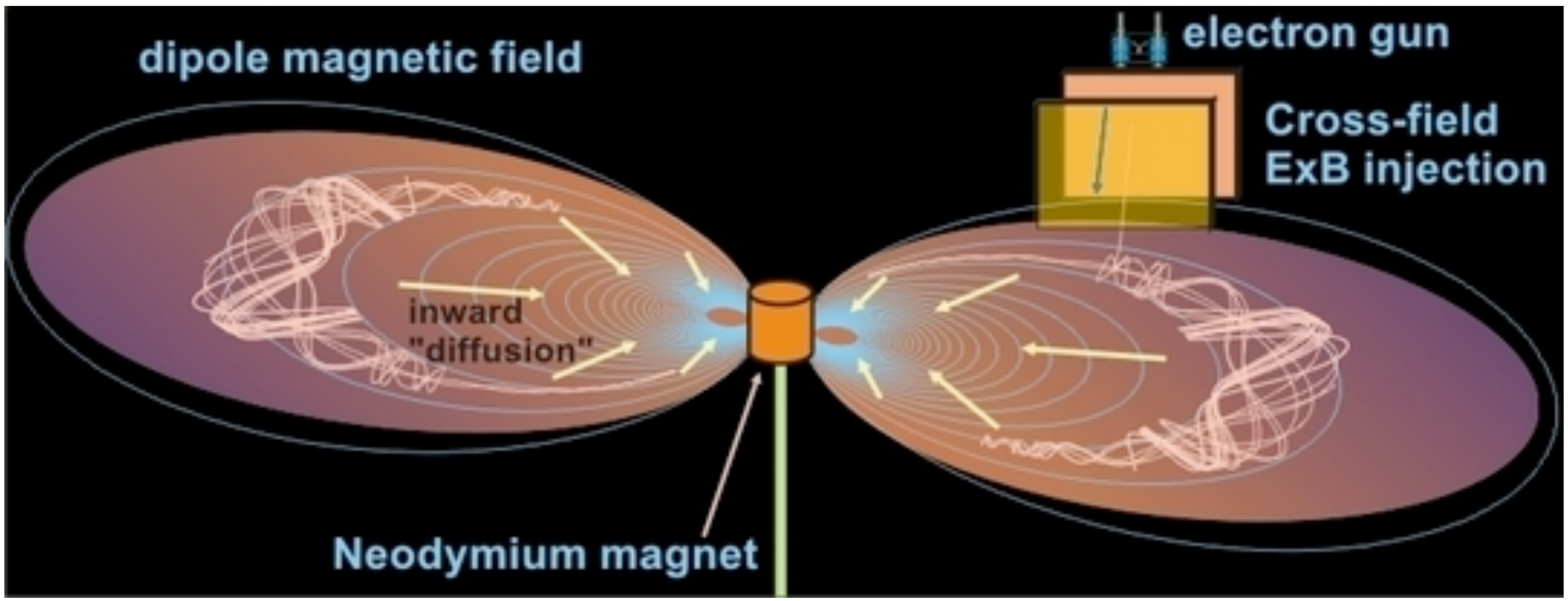


NASA, easa/SOHO

solar structure, magnetic fields in the sun(dynamo), solar spots, the corona heating problem

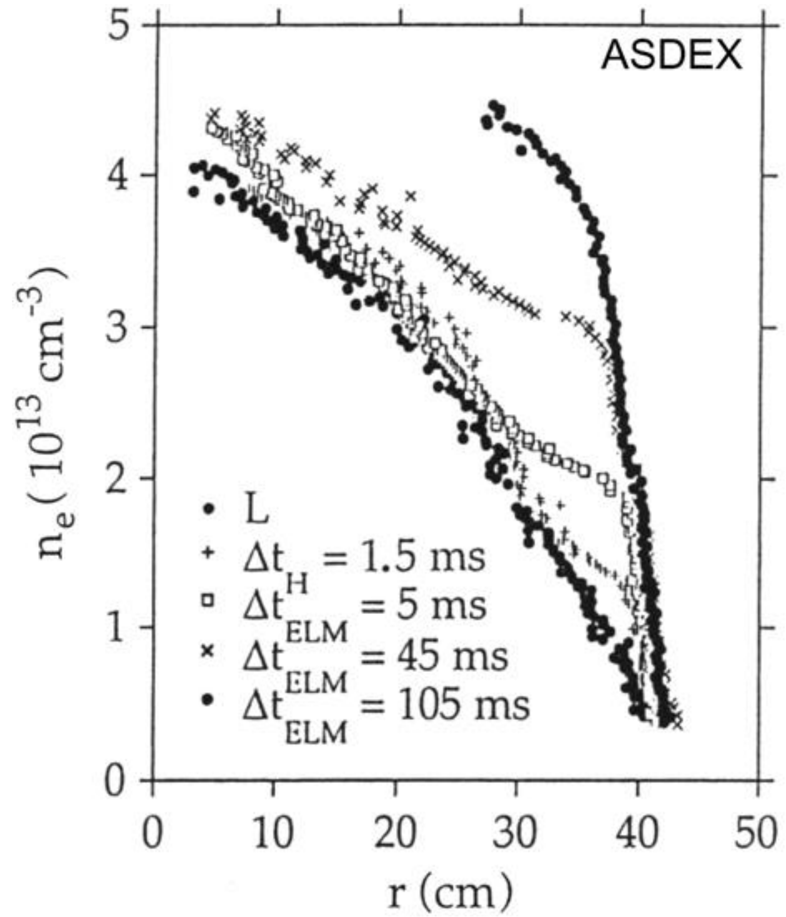
history, origin, Chapman model (static), Parker Model, interaction with earth magnetic field

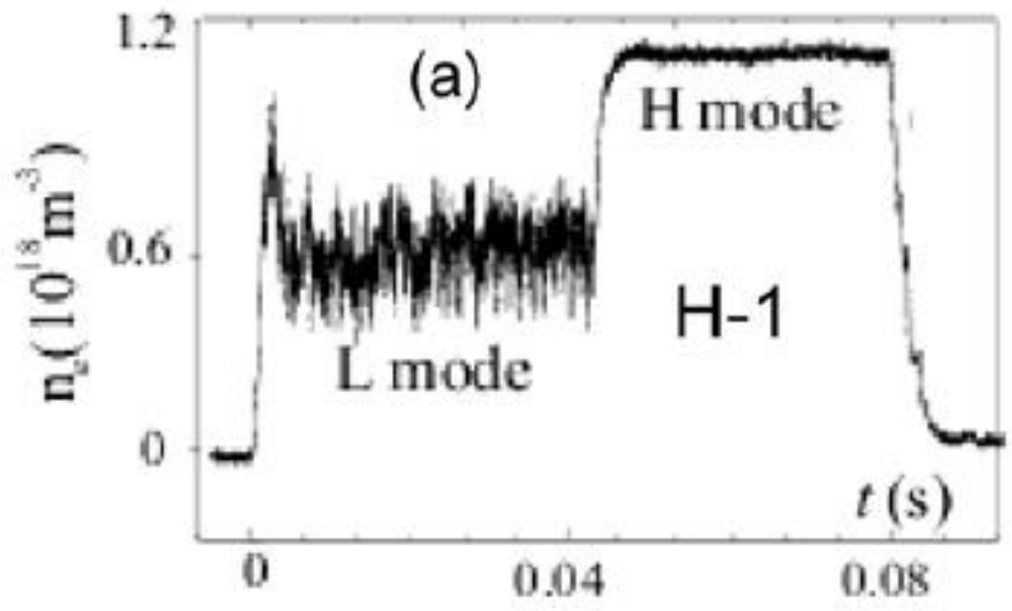
Electron-Positron Plasmas



theoretical properties, experimental setup

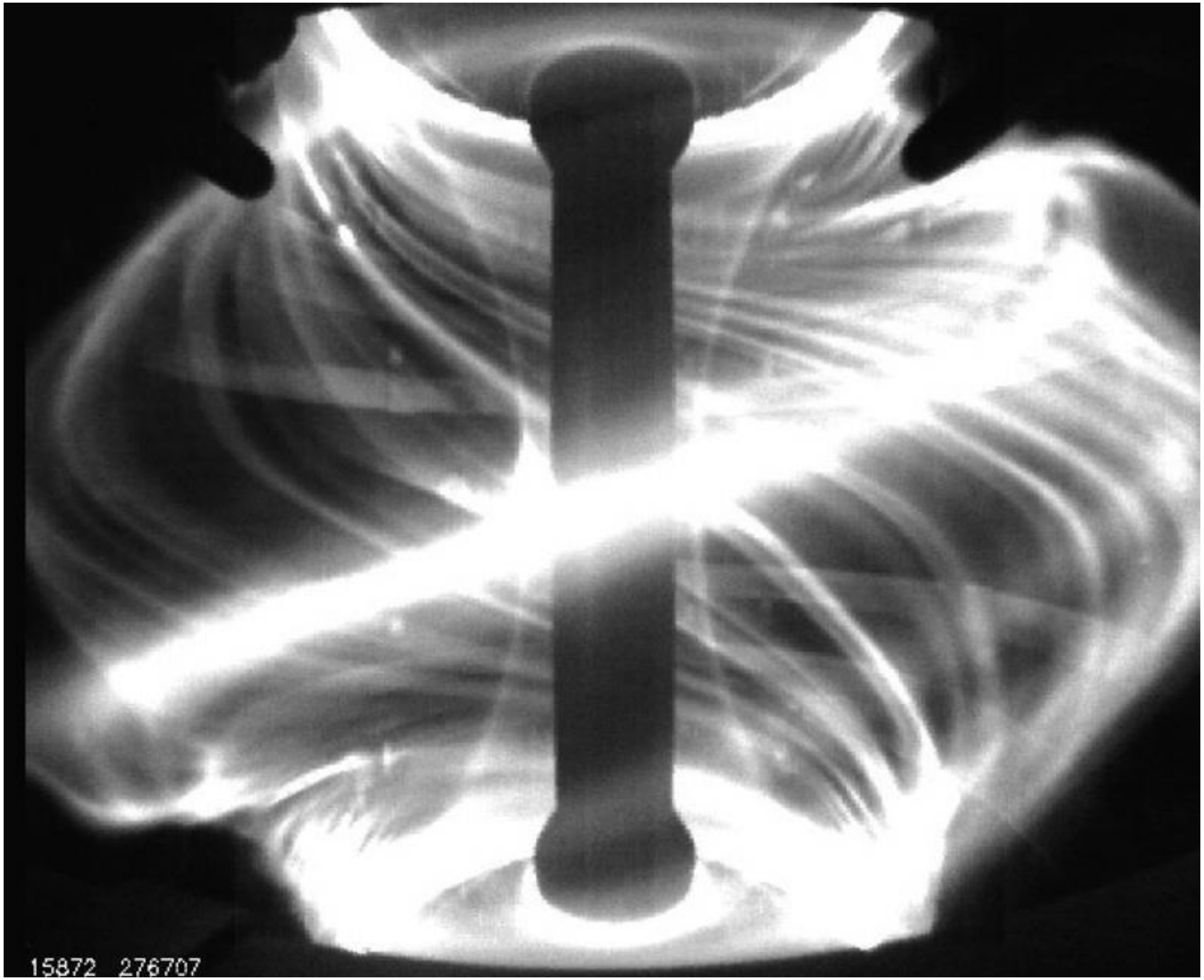
Confinement regimes



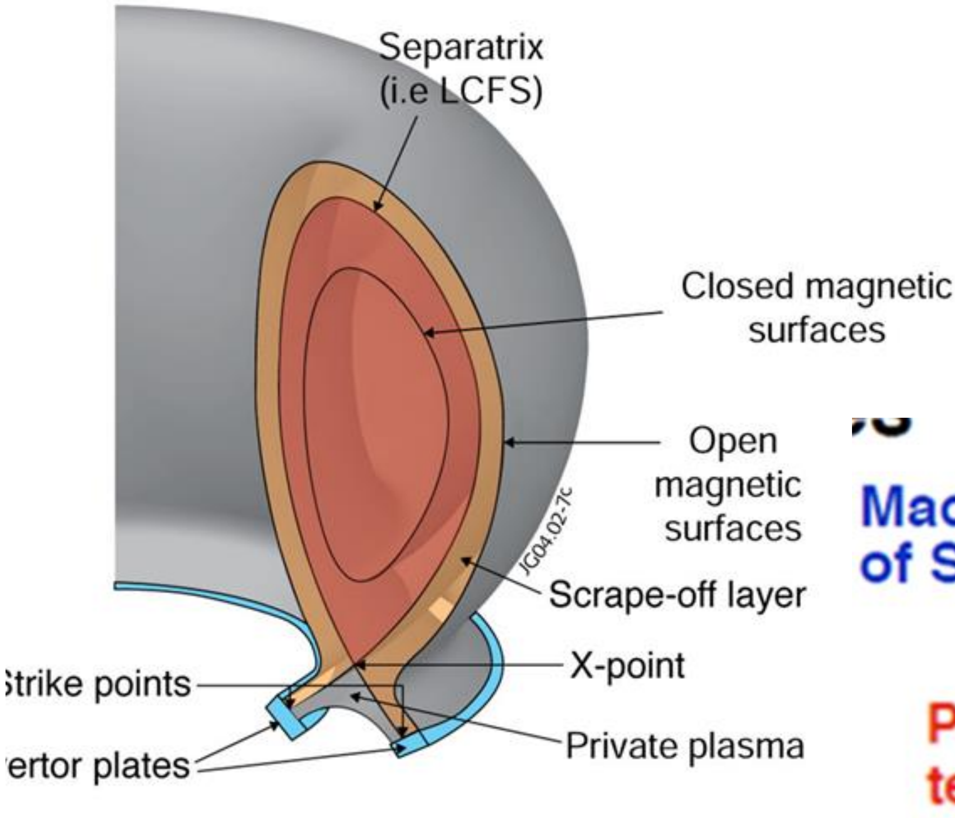


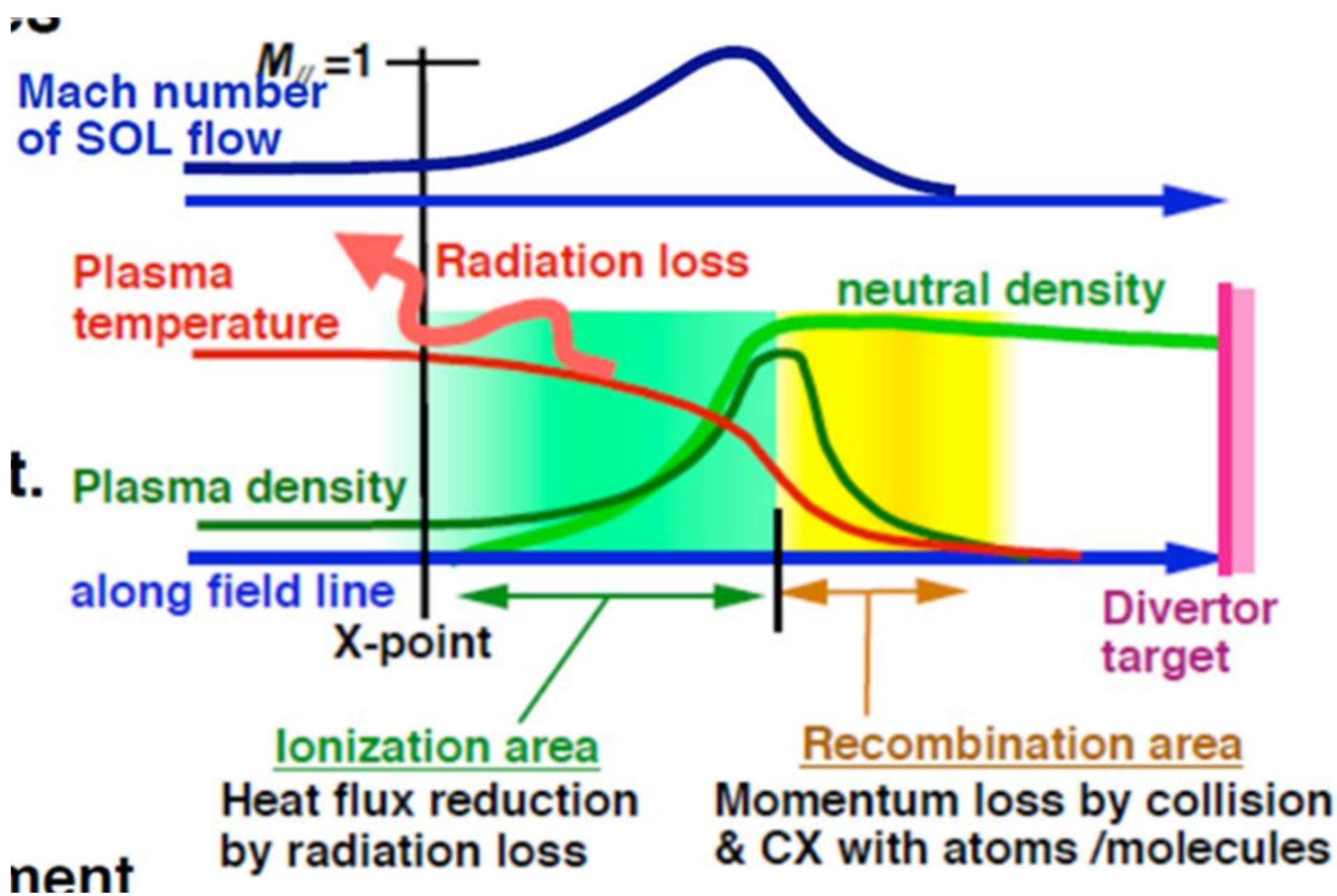
L-mode, H-mode, I-phase, I-mode, QH-mode, EDA-H-mode, Super-H-mode
turbulence, magnetic confinement, transport barriers

H-mode ELMs

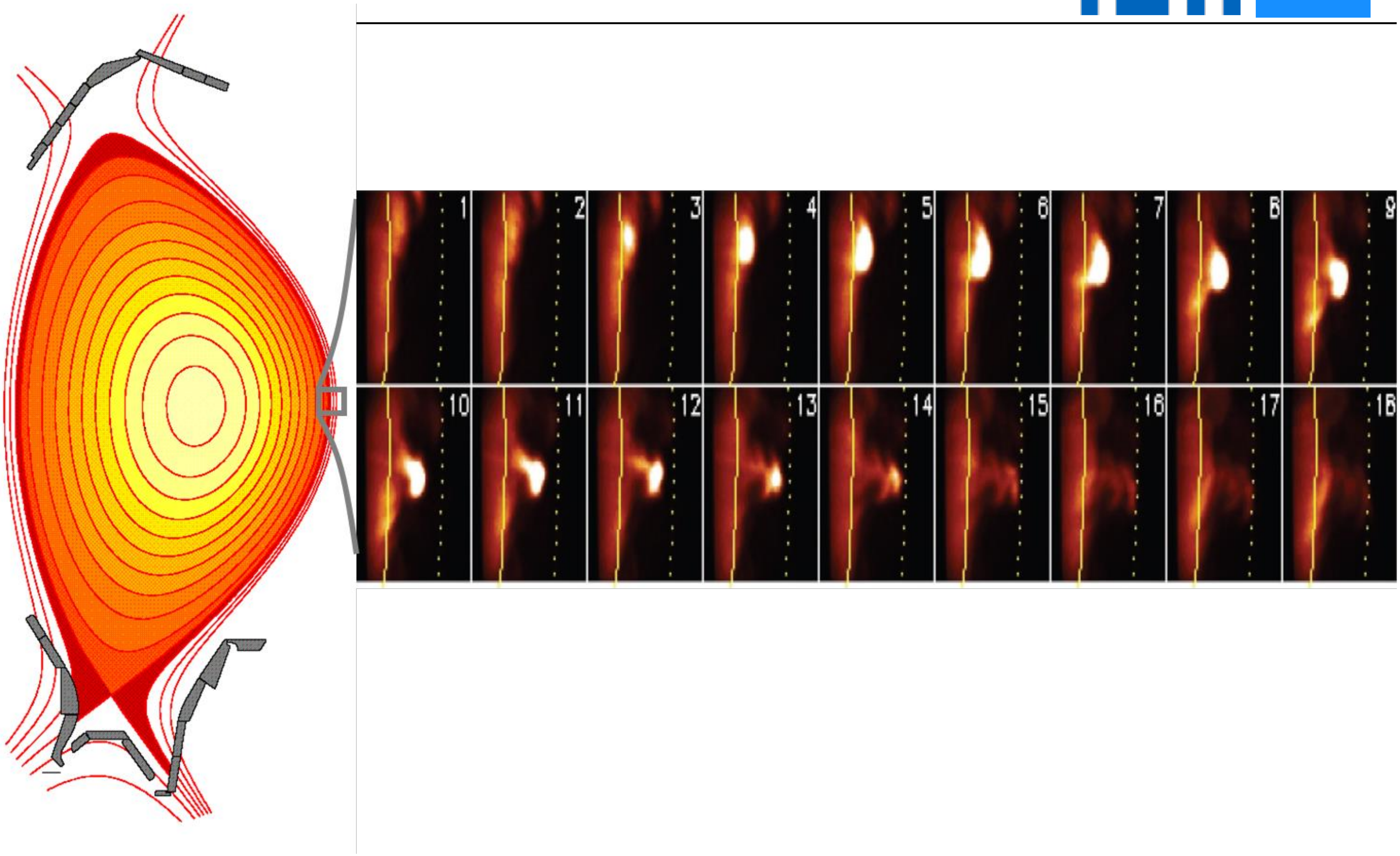


Divertor detachment





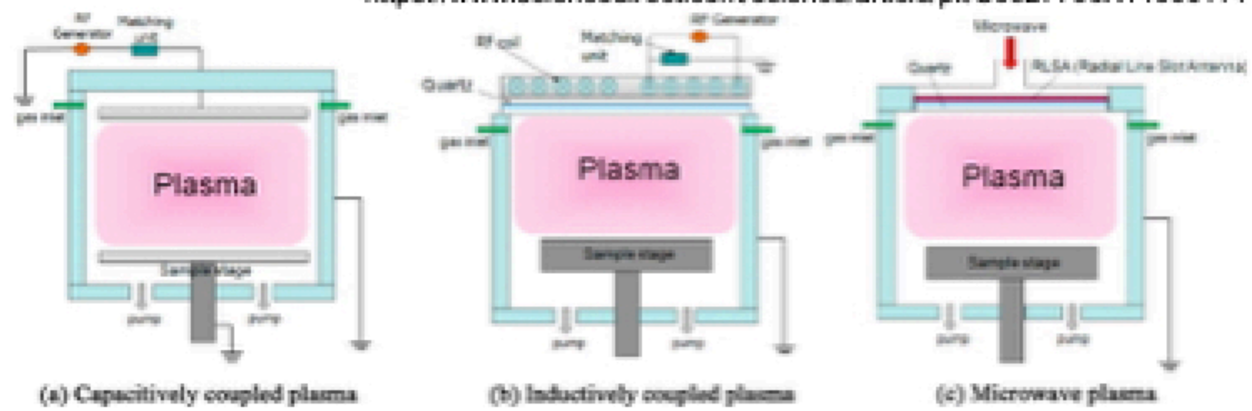
Plasma filaments in the scrape-off layer

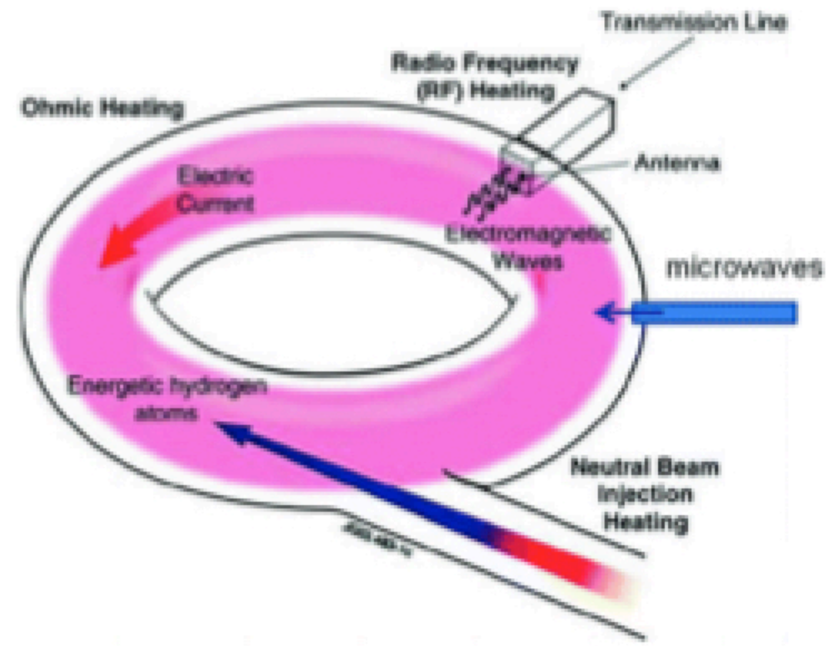


+ Plasmadiagnostiken…

Plasma Heating

https://www.sciencedirect.com/science/article/pii/S0927796X14000114





Dolan T.J. (2013) Plasma Heating and Current Drive. Springer, London.
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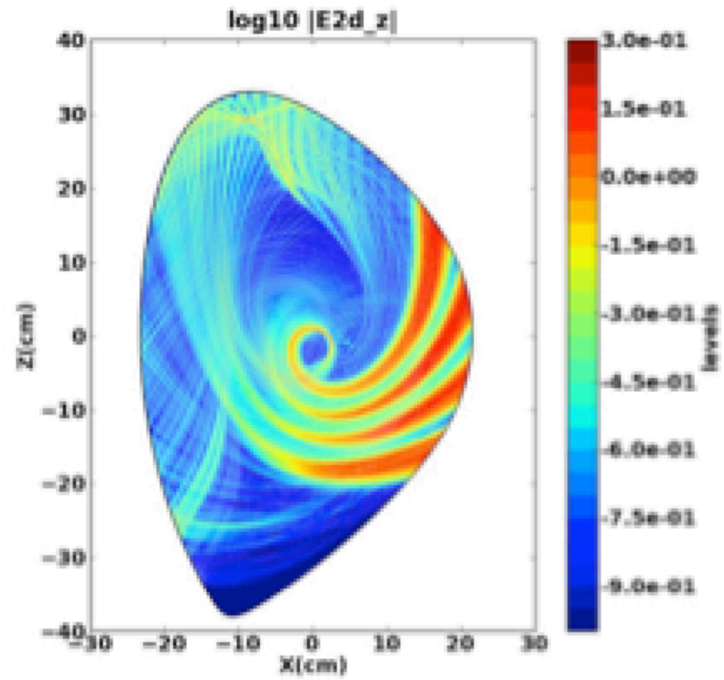
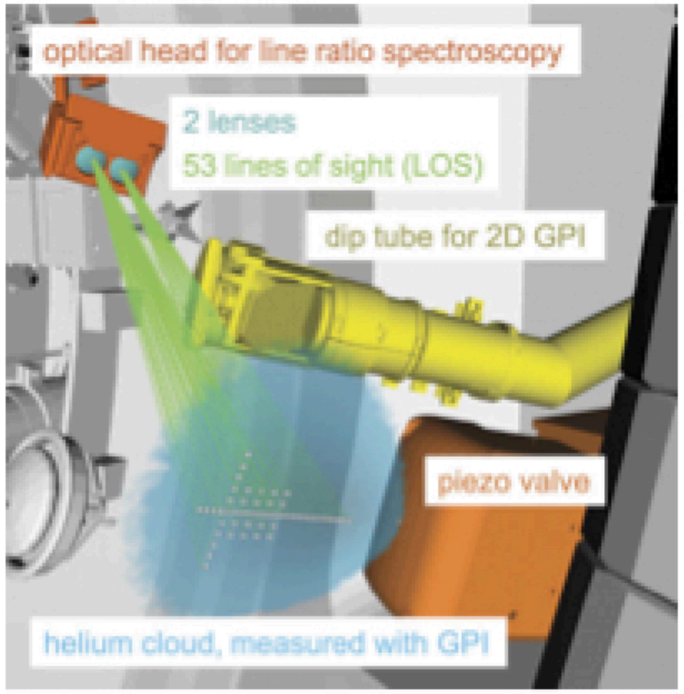
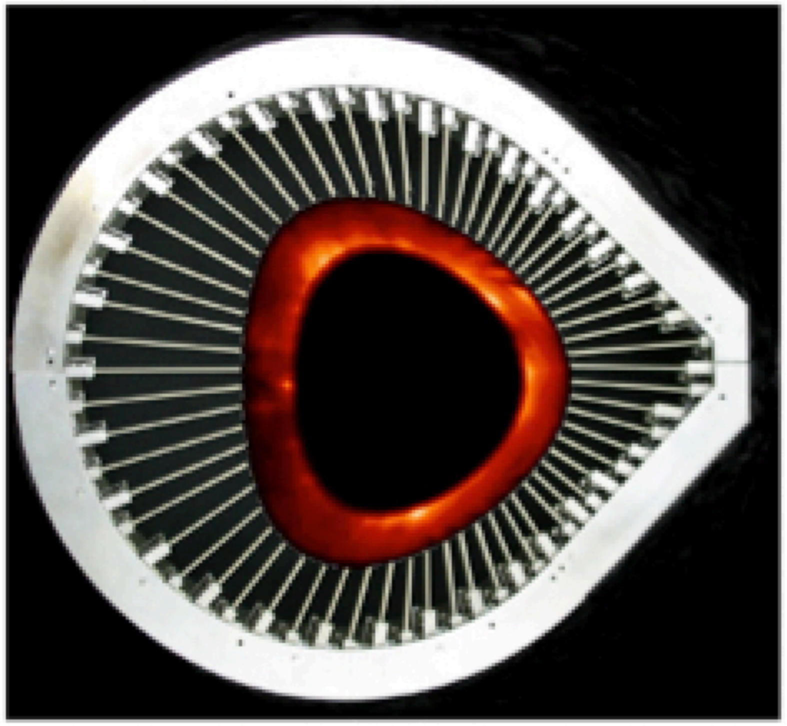
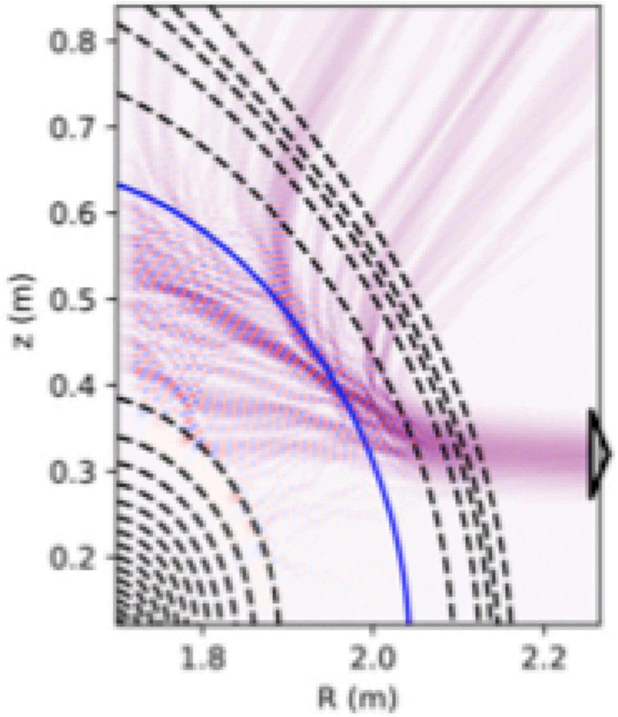


J.C. Wright, Phys. Plasmas 16, 072502 (2009)

Plasma diagnostics







C. Lechte *et al.*, 2020 *Plasma Sci. Technol.* **22** 064006

M. Griener et al., Review of Scientific Instruments **89**, 10D102 (2018); https://doi.org/10.1063/1.5034446