What are we solving?

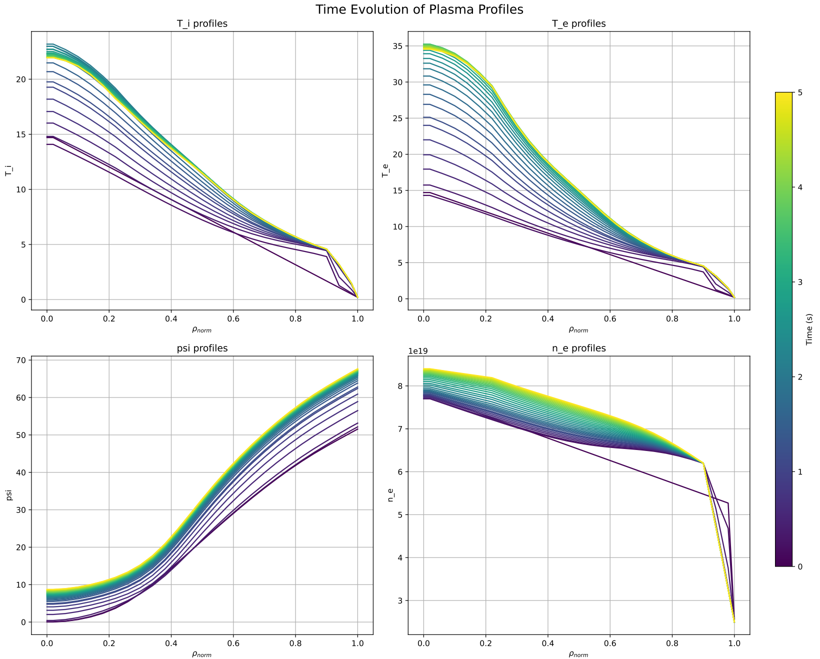
- A system of 1D transport equations for tokamak plasmas.
- Evolves profiles of:
  - Ion Temperature (T_i)
  - Electron Temperature (T_e)
  - Electron Density (n_e)
  - Poloidal magnetic flux (ψ)
- Self-consistently calculates:
  - Plasma geometry
  - Bootstrap current
  - Conductivity
  - Heating and particle sources

Core Physics Models

- **Plasma Geometry:** The magnetic equilibrium (the shape of the nested magnetic surfaces) is determined by the plasma pressure and the total current profile.
- **Bootstrap Current:** A self-generated current driven by the plasma's pressure gradient in the toroidal geometry. It is essential for achieving efficient operation in a reactor.
- **Conductivity:** The plasma's ability to carry current, which is the inverse of resistivity. It strongly on the electron temperature and the amount of impurities in the plasma (Z_{eff}).
- **Heating and Particle Sources:** These are user-defined profiles that model the injection of energy and particles that sustain the plasma.

Numerical Scheme

- **PDEs:** 1D (in ρ) coupled, nonlinear, second-order parabolic transport equations.
- **Spatial Discretization:** Finite Volume Method on a staggered grid.
  - Diffusion: Central differencing.
  - Convection: Upwind scheme with a Peclet number-dependent flux limiter.
- **Boundary Conditions:**
  - Core ($\rho = 0$): Zero-gradient (Neumann).
  - Edge ($\rho = 1$): Fixed value (Dirichlet).
- **Time Stepping:** Fully implicit backward Euler method.
  - A predictor-corrector or Newton-Raphson method solves the nonlinear system.
- **Coefficients & Sources:** Self-consistently calculated from physics models (e.g., QLKNN, Sauter).


Time Evolution of Plasma Profiles
T_i profiles
T_e profiles
psi profiles
n_e profiles
T_i
T_e
psi
n_e
ρ_{norm}
1e19
Time (s)

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