Ion temperature clamping in electron heated plasmas

In electron heated L-mode plasmas of ASDEX Upgrade and Wendelstein7-X, the ion temperature clamps at T_i ~ 1.5 keV, independent of magnetic configuration:

- The ions are heated by energy exchange $p_{ei} \sim n_e^2 (T_e - T_i)/T_e^{3/2}$, which offers a broad ion heating profile only where $T_e/T_i > 1$.
- Heat transport due to ITG/TEM turbulence is strongly exacerbated as $T_e/T_i > 1$ even at small positive ε with $T_e/T_i = 1 + \varepsilon$
- The resulting "stiff" core transport leads to T_i-clamping.

To remedy the impact of clamping, tokamaks and stellarators either feature:

1. an **H-mode** with a strong **edge pedestal** to lift the "stiff" core T_i profiles
2. **suppressed or reduced core turbulence** by means of:
   i. Fast ions stabilisation (tokamaks and stellarators)
   ii. Enhanced density gradients (stellarators and negative-magn.-shear-tokamak)
   iii. Designing turbulence-resilient-configurations with e.g. negative triangularity tokamaks or e.g. low elongation in stellarators.

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