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Thermal Quench in DIII-D locked mode disruptions

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The cause of the thermal quench (TQ) in tokamak disruptions has not been well understood.
Recent work identified the TQ in JET locked mode disruptions with
a resistive wall tearing mode (RWTM) [1].
New research finds a similar instability in DIII-D locked mode shot 154576 [2]. The instability is studied with simulations, theory, and comparison to experimental data. Linear theory and simulations show the mode is stable for an ideal wall, and unstable with a resistive wall.
Its growth rate γ scales asymptotically as the resistive wall
time τ_{wall} to a negative fractional power,
$\gamma \propto \tau_{wall}^{\alpha}$, which varies between $-4/9 \geq \alpha \geq -1$.
The scaling depends on the tearing stability parameter Δ', with and without an ideal wall.
The growth rate increases as the edge safety factor approaches $q = 2$.
The growth time is consistent with the experimental thermal quench time.
Nonlinear simulations show that the mode grows to large amplitude, causing a thermal quench.
These results could be important for ITER [3], greatly mitigating the effects of disruptions.
The ITER thermal quench time could be
much slower, because the wall resistive penetration time is
50 times longer than in JET and DIII-D.

[1] H. Strauss and JET Contributors,
Effect of Resistive Wall on Thermal Quench in JET Disruptions,
Phys. Plasmas 28, 032501 (2021)

[2] R. Sweeney, W. Choi, M. Austin, et al.
Relationship between locked modes and thermal quenches in DIII-D, Nucl. Fusion 58, 056022 (2018)

[3] H. Strauss, Thermal quench in ITER disruptions,
Phys. Plasmas 28 072507 (2021)

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