# Ballooning mode stability in negative triangularity plasmas

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The negative triangularity shape has shown the potential to operate tokamaks with good confinement ($H_{98y,2}$>1.2) and high normalized pressure ($\beta_N$<~2.8) while staying in L-mode, thus avoiding ELMs that are unacceptable in reactor conditions [1-3]. The analysis of the n= ∞ ideal MHD ballooning modes using HELENA and BALOO codes of a pair of DIII-D negative triangularity discharges shows that a small decrease of the top triangularity can have a dramatic effect on the access to 2$^{nd}$ stability for the n= ∞ ideal MHD ballooning modes in the pedestal region, and this change coincides exactly with the L-mode plasma being unable to transition to the H-mode, even when the heating power is increased significantly The discharge with the top triangularity ($\delta_u$) of –0.18 transitions to H-mode at 4MW heating power, while the discharge with $\delta_u$ = –0.36 stays in L-mode even at 13MW of heating. When varying numerically the pedestal profiles from the L- to H-mode and analysing the resulting self-consistent equilibria, the $\delta_u$ = –0.18 case is stable throughout the transition, while the $\delta_u$ = –0.36 case reaches the ballooning stability limit that stops the pedestal pressure gradient from increasing at the halfway point between the L- and H-mode profiles. It is therefore likely that the ballooning mode stability limit is preventing the H-mode access in the $\delta_u$ = –0.36 case.

While such an L-mode scenario is very attractive to a conventional tokamak operating at moderate $\beta_N$, the degraded ballooning stability in the core makes it possibly unfeasible for a high-beta ($\beta_N$>5) spherical tokamak (ST) to operate with negative triangularity shape even if the good core confinement could be achieved. The reduced ballooning mode stability strongly restricts the achievable global $\beta_N$ in such an ST for the triangularities required to keep the pedestal in the L-mode.

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[2] M E Austin et al. Phys. Rev. Lett. 122 115001 (2019)
[3] A Marinoni et al., Phys. Plasmas 26, 042515 (2019)

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