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Developing Physics Basis for the Radiative Snowflake Divertor at DIII-D

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Recent DIII-D results using the snowflake (SF) divertor configuration demonstrate that the SF geometry enables significant manipulation of divertor heat transport for power spreading in attached and radiative divertor regimes, between and during edge localized modes (ELMs), while maintaining good H-mode confinement. Enhanced heat transport through the low poloidal field null-point region and divertor legs resulting in increased scrape-off layer (SOL) width and heat flux spreading over additional strike points (SPs) were observed. Direct measurements of divertor null-region poloidal beta, using a unique DIII-D divertor Thomson scattering diagnostic, support the theoretically proposed mechanism of additional heat redistribution between strike points due to fast convection, especially efficient during ELMs. The measured divertor β_p ~ 50–100 was about 2–3 orders of magnitude higher the midplane β_p, and the high beta region was broader in the SF configuration. During an ELM, the β_p was increased up to an order of magnitude. Type I ELM heat transport was significantly affected by the SF divertor geometry. While the pealing-ballooning mode stability in the H-mode discharges was not significantly affected, the ELM frequency and size were changed by 10%-20%. The stored energy lost per ELM was reduced. In gas-seeded radiative regimes, SF geometry led to a significant reduction of peak heat fluxes between and during ELMs, while maintaining good H-mode performance. The results complement the initial NSTX and DIII-D SF divertor studies and contribute to the physics basis of the SF divertor as a promising concept for high power density tokamaks.

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