A Snowflake Divertor - an Attempt to Solve the Heat Load Problem for Future Tokamaks

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The snowflake divertor [1] exploits a tokamak geometry in which the poloidal magnetic field null approaches second order; the name stems from the characteristic hexagonal, snowflake-like, shape of the separatrix for an exact second-order null.

The proximity of the poloidal field structure to that of a second-order null substantially modifies edge magnetic properties compared to the standard X-point geometry; this, in turn, affects the edge plasma behavior. Modifications include: 1) The flux expansion near the null-point becomes 2-3 times larger. 2) The connection length between the equatorial plane and divertor plate significantly increases. 3) Magnetic shear just inside the separatrix becomes much larger. 4) In the open-field-line region, the squeezing of the flux-tubes near the null-point increases, thereby causing stronger decoupling of the plasma turbulence in the divertor legs and in the main SOL [2]. All these effects can be used to reduce the power load on the divertor plates and to suppress the "bursty" component of the heat flux.

It is emphasized that the snowflake divertor can be created by a relatively simple set of poloidal field coils situated beyond the toroidal field coils. Analysis of the robustness of the proposed divertor configuration with respect to changes of the plasma current distribution is presented and it is concluded that, even if the null is close to the second order, the configuration is quite robust. Analysis of the drift orbits of particles for the flux surfaces just inside the separatrix is presented and it is shown that there is no significant increase of the neoclassical transport compared to the standard X-point configuration.

It is concluded that the snowflake configuration can have a significant favorable effect on the divertor performance. Prepared by LLNL under Contract DE-AC52-07NA27344.

1. D.D. Ryutov. Phys. Plasmas, **14**, 064502 (2007); D.D. Ryutov. Paper D1.002, 34th EPS Conf. on Plasma Phys, Warsaw, 2007 (http://epsppd.epfl.ch/Warsaw/start.htm).
2. R.H. Cohen, et al. Nucl. Fusion, **47,** 612 (2007); D.D. Ryutov, R.H. Cohen. Contrib. Plasma Phys., **48**, 48 (2008).