Particle transport via gas puff modulation experiments in JET

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New JET experiments utilising gas puff modulation technique [1-4] have been carried out in L- and H-mode plasmas to study particle sources and transport both in the plasma core and in the pedestal region. The electron density response to the gas puff modulation was measured at 10 kHz sampling rate using a recently upgraded multi-band reflectometry system [5] capable of measuring full radial profiles that extend well across the separatrix down to densities ~$2\text{x}10^{17}$ m^{-3}.

In L-mode a 3-point dimensionless collisionality scan was performed. A simple analysis valid for a source free region is consistent with the earlier experimental database studies on JET [6] where density peaking showed virtually no collisionality dependence. Gyrokinetic quasi-linear analysis by QuaLiKiz confirms the result from the scan. However, it is noted that weak collisionality dependence can be found with QuaLiKiz when using artificial parameters nulling the small, unavoidable, Te/Ti changes in the experimental scan.

The first proof-of-principle gas modulation in JET H-mode proved highly successful, showing clear modulation (1-2% in the core) in electron density. Various gas injection locations and frequencies were tested and the strongest electron density modulation for a given gas rate was obtained with an outboard midplane injection, with a modulation that is a factor of 1.5-3 larger than the one obtained with injection from the top or from the divertor. Since the SOL width is narrowest at the midplane this would seem to indicate that the direct fuelling (or possibly "convection assisted direct fuelling") could be responsible for a significant part of the total fuelling also in JET H-mode plasmas. This is quite interesting as the common understanding is that most of the fuelling is expected to be due to recycling, especially in the X-point region.

This contribution presents the recent experimental data together with modelling of particle transport and sources using ASTRA and SOLEDGE2D to clarify the possible existence of convection (inward particle pinch) at the edge of H-mode plasmas. The influence of ELMs in the analysis will be discussed.

[1] K.W. Gentle et al 1992 NF 32 217
[2] J O'Rourke et al 1993 PPCF 35 585
[3] K. Nagashima et al 1993 NF 33 1677
[4] D.R. Baker et al 1998 NF 38 485
[5] A. Sirinelli et al 2010 RSI 81 10D939
[6] H. Weisen et al 2005 NF 45
* *F. Romanelli et al, Fusion Energy 2012 (Proc. 24th IAEA Conf., San Diego, 2012) IAEA Vienna*