Role of electric field curvature in the formation of edge transport barrier

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The role of radial electric field curvature (i.e. 2\textsuperscript{nd} derivative of the radial electric field, $E_r$) has been examined experimentally, in the formation of the edge transport barriers (ETBs) during/across the L-H transition of JT-60U plasmas with high-resolution CXRS measurements \cite{1}. For this aim, theoretical formula has been proposed for experimental validation \cite{2}, taking into account for the normalized turbulence intensity, $I/I_0$, in the presence of non-uniformity $E_r$-effects for both its shear and curvature (as expressed by the parameter of $Z$) as follows;\begin{equation}
\frac{I}{I_0} = 1/\{1 + (k\rho_i)^{-2}Z\}, \quad (1)
\end{equation}
\begin{equation}
Z \equiv \left(\frac{\rho_i}{(V_d\theta)}\right)^2 \left(E_r'E_r' - E_r*E_r^*\right) \equiv Z_1 + Z_2. \quad (2)
\end{equation}

Here, $k$ is a typical wavenumber for the plasma turbulence, $\rho_i$ is the ion gyro-radius, $V_d$ is the diamagnetic velocity, $B$ is total magnetic field), and $E_r^*$ is the modified radial electric field subtracting the toroidal rotation component.

We found the decisive importance of $E_r$-curvature on the ETBs formation at which the normalized ion temperature gradient, $L_{T_i}^{-1} \equiv -\nabla T_i/T_i$, has a local peak value in the pedestal region. On the other hand, the role of the $E_r$-shear was newly understood as for the expansion of pedestal width, compensating an unfavorable effect of the $E_r$-curvature having its sign dependence on the transport reduction/enhancement, being expected by a theoretical model as $L_{T_i}^{-1} \propto Z^{0.5}$.

Based on these rapid progresses, the essential role of $E_r$-curvature is confirmed unambiguously, for the first time. These findings would shed more light on reviewing the paradigm of $ExB$ flow shear suppression of the turbulence, being thus expected to make a valuable contribution to a better prediction of the pedestal width/height in the future devices.

References
\begin{itemize}
\item \cite{1} K. Kamiya, K. Itoh, and S.-I. Itoh, Sci. Rep. 6, 30585 (2016).
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