Polarimetric Thomson Scattering for high electron temperature measurements: perspectives and challenges

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Polarimetric Thomson Scattering (PTS) is a technique that allows for accurate measurements of electron temperature (T_e) in a hot plasma environment. Future high-power tokamaks, such as ITER, are expected to regularly achieve T_e > 10 keV. In these conditions, a reliable reconstruction of Thomson scattered spectra is hindered by their widening. Here, in fact, the spectral region spanned by the TS spectrum is large and extends to low wavelengths, where the transmission of the collection optics decreases, available detectors are less efficient and the high level of plasma background light perturbs the measurements [1]. A PTS system, instead of performing a spectral analysis, relies upon the depolarization of scattered light to probe T_e. When T_e increases, part of the scattered light is progressively depolarized due to a relativistic effect. Eventually, the depolarized light becomes a significant fraction of the output signal when T_e exceeds 10 keV [2, 3, 4]. Under certain conditions, that depend upon the scattering angle and the polarization characteristics of the input light (Fig. 1), the degree of depolarization increases monotonically with temperature [5], and this relationship can be exploited to measure T_e. This work presents an overview of recent progresses in the development of such technique, challenges that should be addressed for future system design, as well as perspectives for next-generation, high-temperature tokamaks.

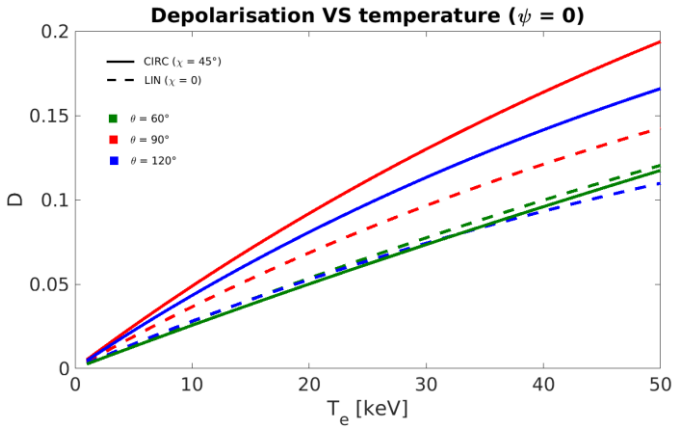

Figure 1. Degree of depolarization (D) as a function of electron temperature (T_e), showing the strong dependence of D upon the input polarization state and collection optics scattering angle. Here, the orientation angle of the polarization ellipse ψ was set to 0. Different colors indicate a different scattering angle θ. The D- T_e curves corresponding to circularly and horizontal (χ = 0) linearly polarized light are shown, respectively, with continuous and dashed lines.

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