Effects of fast particles on plasma polarimetry in high performance fusion plasmas

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In Magnetic Confinement Fusion devices like the tokamaks , the plasma dielectric properties can be used for diagnostic purposes. In particular the plasma birefringence induced by the magnetic field, i.e. the difference between the refraction index parallel and perpendicular to the magnetic field has a strong effect on the polarization of a wave propagating inside the plasma. The Polarimeter is an instrument with lines of sights located in the poloidal plane of a tokamak. The Polarimetry measurements, i.e. Faraday Rotation(FR) and Cotton-Mouton Phase Shift (CM), are useful as constraint for the determination of the plasma equilibrium and for the measurement of the plasma density, respectively. The modelling tool for polarimetry, is the Stokes model where FR and CM are calculated using the spatial profile of the magnetic field components Br and Bz (radial and vertical in the poloidal plane) of the plasma magnetic field(B) determined by the equilibrium code EFIT [1,2]. It is important to note that in high performance fusion plasmas the fast particle (alpha particles and fast ions produced by heating systems) pressure can be a substantial part of plasma pressure, having strong effects on plasma equilibrium. This implies that the components of the magnetic field determining the plasma birefringence are determined by the fast particle pressure. The paper presents a theoretical treatment of these effects using the Stokes model in a simplified geometry of circular plasma. It is demonstrated that the Faraday rotation induced by the fast particle pressure can be substantial.

1. F P Orsitto et al , Analysis of Faraday rotation in JET polarimetric measurements , Plasma Phys Contr Fusion 53(2011) 035001
2. F P Orsitto , S E Segre and JET Contributors , Plasma Phys Contr Fusion 61(2019)055008