Alpha-particle velocity-space diagnostic in ITER - DTU Orbit (14/03/2019)

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We discuss α-particle velocity-space diagnostic in ITER based on the planned collective Thomson scattering (CTS) and γ-ray spectrometry (GRS) systems as well as ASCOT simulations of the α-particle distribution function. GRS is sensitive to α-particles with energies MeV at all pitches \( p \), and CTS for MeV and \( p \). The remaining velocity space is not observed. GRS and CTS view the plasma (almost) perpendicularly to the magnetic field. Hence we cannot determine the sign of the pitch of the α-particles and cannot distinguish co- and counter-going α-particles with the currently planned α-particle diagnostics. Therefore we can only infer the sign-insensitive 2D distribution function by velocity-space tomography for MeV. This is a serious limitation, since co- and counter-going α-particle populations are expected to have different birth rates and neoclassical transport as well as different anomalous transport due to interaction with modes such as Alfvén eigenmodes. We propose the installation of an oblique GRS system on ITER to allow us to diagnostically track such anisotropy effects and to infer the full, sign-sensitive for MeV. α-particles with MeV are diagnosed by CTS only, which does not allow velocity-space tomography on its own. Nevertheless, we show that measurements of the α-particle energy spectrum, which is an ITER measurement requirement, are now feasible for MeV using a velocity-space tomography formalism assuming isotropy in velocity space.

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