Analysis of Balmer alpha spectra in W7-X using FIDASIM

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Balmer-alpha spectroscopy allows important and versatile investigations of fusion plasmas. In particular active spectroscopy with lines of sight intersecting the paths of neutral beams has become an important diagnostic technique since it carries information on important plasma parameters such as the fast-ion density, the radial electric field, plasma rotation or the main-ion temperature.

However the complex shape of the spectra requires well developed models for its interpretation. Here we use for this purpose the Monte-Carlo based code FIDASIM [1], which is capable to predict the measured Balmer-alpha spectrum and was validated against axisymmetric cases from different tokamaks [2, 3]. The Monte-Carlo approach makes it possible to treat arbitrary 3D magnetic field geometry and full 5D fast-ion distribution thus to apply the forward modelling tool to stellarators as well.

For W7-X the capabilities of FIDASIM have been extended to the 3D magnetic field from VMEC [5] and 5D fast-ion distribution function from ASCOT [4]. During the 2018 experimental campaign of W7-X neutral beam injection has been applied for the first time. First comparisons between FIDASIM results and spectroscopic measurements show good agreement between the measured beam emission and halo emission. Moreover, the observed attenuation of the beam-emission is recovered, well. While good agreement is observed for the spectral shape of the fast-ion H-alpha emission, the absolute values do not match, possible reasons for this mismatch will be presented as well.

References

[1] W. Heidbrink et al., Communications in Computational Physics 10 716 (2011)