COLLISIONAL-RADIATIVE MODELLING OF NEUTRAL BEAM ATTENUATION AND EMISSION

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Abstract

In addition to heating tokamak plasmas, neutral beam injection can also be exploited as a quantitative diagnostic to investigate the concentration of impurities in the plasmas via charge exchange spectroscopy. For this use, a detailed knowledge of the beam attenuation or alternatively the neutral beam density in the plasma is required. There are two methods which may be employed to determine the neutral beam density. The first approach involves modelling the rate at which the beam neutrals are ionised as they traverse the plasma. The second and in principle more accurate method, involves the direct measurement of the intensity of the spectral lines emitted from the excited beam neutrals. Then with the use of atomic modelling the neutral beam density can be recovered. This is the basis of beam emission spectroscopy.

The work in this thesis, which addresses the issue of modelling and measuring the neutral beam density, can be separated into two distinct parts. The first concerns the deduction of the neutral deuterium beam density at JET Joint Undertaking using both the theoretical and experimental approach. The second part of this thesis involves developing a Bundled-nlSL collisional-radiative model to predict the attenuation and emission associated with a fast neutral helium beam. The model is then used to explore the attenuation and the behaviour of the excited state population structure of the beam atoms as a function of typical plasma parameters.

Experimental aspects associated with beam emission spectroscopy at JET are summarised and a detailed description of the atomic modelling required to support the diagnostic exploitation of fast neutral deuterium and helium beams is given. The modelling codes used and developed during the course of this work form part of the Atomic Data and Analysis Structure, ADAS.

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