Charge exchange processing

The programs of series ADAS3 are associated with neutral beams of hydrogen or helium isotopes and there are two streams of modelling. The first stream is concerned with modelling and detailed spectral line emission from hydrogen-like impurity ions in a plasma following charge transfer from fast neutral beams. It commences with a collection of state selective charge transfer cross-section data at n, nl or nlm resolution (type ADF01) spanning an extended region of collision energies and n-shells and in some cases different sources. There are two processing options, namely for calculations in the *bundle-nl* (ADAS308) or *bundle-nlj* (ADAS306) approximations. The codes are specifically designed to assist in experimental data analysis and accept a number of experimental charge exchange line-of-sight integrated intensities from which they deduce an *emission measure* for the beam/plasma/viewing line intersection. They also allow some comparative assessment of theoretical charge exchange cross-sections with the experimentally implied ones, depending on the number of charge exchange lines presented. The programs also provide a detailed theoretical breakdown of the experimental charge exchange line intensities, together with plots of theoretical stick and Doppler broadened spectra. The programs include some capability for studying free-electron capture and electron impact driven line emission for these simple hydogenic systems and and also extend to lithium-like systems in fast beams, depending on the availability of fundamental data collections of type ADF01. Practical experimental data reduction requires effective emission coefficients for charge exchange lines as a function of relative collision energy for different plasma conditions. The programs ADAS308 and ADAS306 predict data for arbitrary lines at a fixed set of conditions. It is convenient to have available more automatic codes which generate look-up tables of these coefficients over ranges of plasma parameters without the intervening displays. This capability is provided by ADAS309 and ADAS307 for the bundle-nlj and bundle-nl pictures respectively. The latter are termed scanning versions of the codes and prepare directly data of type ADF18. The associated codes for interrogation of the fundamental state selective cross-section database and the effective charge exchange emission coefficient database are ADAS301 and ADAS303 respectively.

Ths second stream is concerned with modelling the attenuation of the beams and then the prediction of the emission spectrum of the beam atoms themselves. It commences with ion/atom collision cross-section data collections of type ADF02, stored separately for the hydrogen and helium beam reactants. Also electron collision data, type ADF04, first discussed in chapter 3 are utilised. There are separate processing programs for hydrogen and helium beams, ADAS310 and ADAS311 respectively. The primary calculations for the deuterium beam stopping coefficients are performed in a *bundle-nS* approximation and can generate extensive tabulations over plasma parameters (data type ADF21). ADAS304 is the interactive interrogation program for this data type. Additionally, the programs can generate detailed predictions of effective beam emission. The beam emission data is archived in data sets of type ADF22 which are interrogated interactively by the program ADAS304. In the case of the helium beam model, a *bundle-nlSL* approximation is adopted to calculate effective cross-coupling and beam emission coefficients. The cross-coupling coefficients describe the

rate at which the ground and the two metastable levels, i.e. He(2 ^{1}S) and He(2 ^{3}S) are populated and de-populated within a collisional-radiative framework. The main application of the coupling coefficients is to describe the beam attenuation

A schematic of the programs and data sets are shown in figures 4.0a and 4.0b below.

Figure 4.0a. Beam emission codes and data schematics.

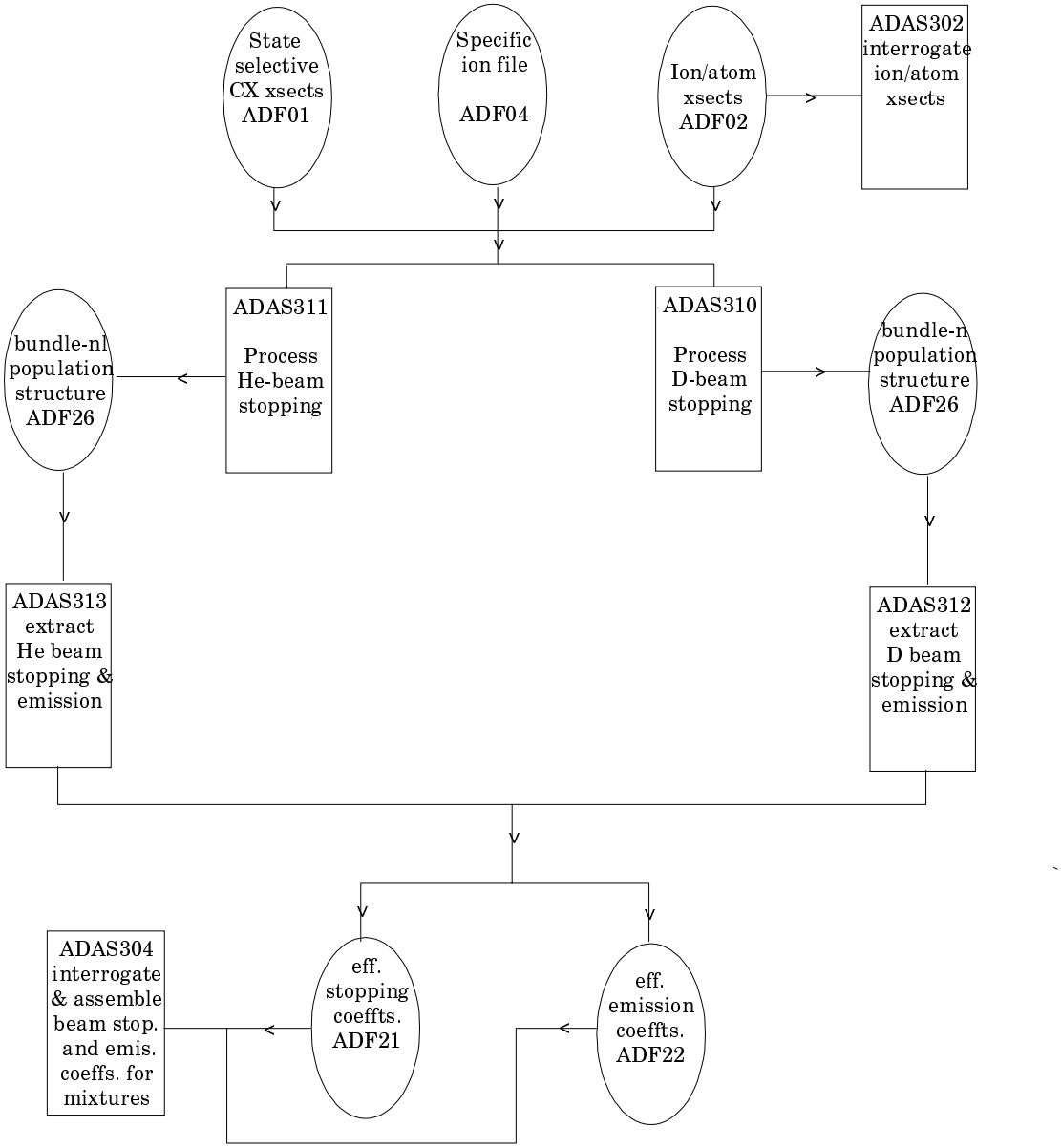

Figure 4.0b. Charge exchange spectroscopy codes and data schematics.