University of Strathclyde

Atomic Data and Analysis Structure

ORNL/ADAS

Tutorial

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Table of Contents

1. The ADAS project

1.1. Viewgraphs

2. ADAS - a tutorial

2.1. Viewgraphs

2.2. Session 2 tutorial examples

3. Influx and divertor spectroscopy

3.1. Viewgraphs

3.2. Session 3 tutorial examples

4. Charge exchange and beam related spectroscopy

4.1. Viewgraphs

4.2. Session 4 tutorial examples

5. Populations and line ratio studies

5.1. Viewgraphs

5.2. Session 5 tutorial examples

6. Differential emission measure and emission functions

6.1. Viewgraphs

6.2. Session 6 tutorial examples

7. Ionisation balance

7.1. Viewgraphs

7.2. Session 7 tutorial examples

8. Table Editor and Graph Editor

Abstract

1. The origins of the Atomic Data and Analysis Structure at JET Joint Undertaking are reviewed. The capabilities and levels of sophistication of an integrated atomic modelling system, sufficient to cope with expected needs through to the end of the fusion program, are identified. The implementation of the system (now known as ADAS) at JET, its broad structure and the external support structure required to sustain it are discussed. The ADAS Project, designed to permit appropriate dissemination of the system to interested and collaborating external laboratories, is then introduced and a summary of the current status of the Project presented.

2. An introduction to the organisation of the external workstation implementation of ADAS, called IDL-ADAS, is given. The available documentation is discussed and in particular it is shown how to find the bulletins. The separation between database and processing aspects of ADAS is explained and a tour of the database structure is given. A demonstration of an interactive session with ADAS is then presented in the form of a brief tutorial. Aspects include initiating ADAS, checking the correct set up of a personal ADAS database and locating the main program series. Finally, a specific example is presented showing interrogation of some of the ionisation coefficient data collections to obtain a graph and table of results.

3. A demonstration and tutorial are given on using ADAS to assist in some aspects of influx and divertor spectroscopy. Attention is firstly focused on acquiring the 'ionisation per photon' quantities used in quick estimates of impurity flux from surfaces. The program ADAS501 is used to extract such data from the relevant ADAS data collection. The route to calculation of ionisations per photon (usually called SXB or S/XB here) is then discussed. It is explained how excited population structure calculation is the key and attention is drawn to the central role of the ADAS data class known as 'specific ion files', or *adf04* files in ADAS usage. The advanced population code from ADAS series 2 called ADAS208 is then used to obtain SXBs.

4. A demonstration and tutorial are given on using ADAS to assist in some aspects of charge exchange and beam related spectroscopy. Attention is firstly focused on the effective emission coefficients for visible charge exchange spectrum lines of hydrogen-like impurity ions driven by neutral deuterium beams. The program ADAS303 is used to extract such data from the relevant ADAS data collection. The route to calculation of CXS effective emission coefficients (usually called QEF data here) is then discussed. It is explained how angularly resolved redistributive calculations are necessary to evaluate the beam and plasma parameter dependence of these coefficients and attention is drawn to the importance of the ADAS database of state selective charge transfer cross-sections for capture by fully ionised ions. The l-resolved charge exchange processing code, ADAS308, from ADAS series 3 is demonstrated and its capabilities for investigative study of CXS briefly explained. If sufficient time remains, the issue of effective beam stopping coefficients will then be addressed. The code ADAS304 is used to extract effective stopping coefficients for a mixed impurity plasma from the database of effective stopping coefficients.

5. ADAS is used to examine ratios of emissivities of spectrum lines with a view to identifying useful density and/or temperature diagnostics for the solar atmosphere. Attention is restricted to ratios of spectrum lines from the same ion. The calculation of the excited state populations of the ion of interest is the necessary precursor to such examination. The basic population processing code for this is ADAS205. Its operation is demonstrated and it is shown how to prepare an output file, called the 'contour' passing file in readiness for the analysis code ADAS207. ADAS207 is then used to explore line ratios as functions of temperature and density and a diagnostic contour plot is prepared.

6. The talk and demonstration focus on the technique of differential emission measure analysis which is widely used for examination of the upper solar atmosphere. Special effort has been put into validating and benchmarking DEM programs by the CDS team in preparation for the SOHO satellite. The ADAS application code ADAS601 is the resulting choice. The task of preparing a DEM is presented in two steps, namely, preparing a compact 'collection file' of contribution functions (often called G(Te) functions) of all the spectrum lines of interest and then the DEM analysis itself. ADAS506 is the code for preparing a collection file. It is in fact a dual purpose code serving also as the interrogation code for the very large primary G(Te) data sets in ADAS, data type adf20. A brief tutorial and demonstration of ADAS506 is given. It is then shown how to initiate the DEM code ADAS601. This application code operates in a rather different manner from most ADAS codes. It has special flexibility. A test case is used to demonstrate the

principle features of its operation, namely, fetching in an ‘intensity’ file (the observational data), ‘kernel’ file (collection file) and ‘abundance’ file, executing the DEM analysis and displaying the results.

7. A demonstration and tutorial are given on using ADAS to examine the state of ionisation of an element in a plasma. Ionisation and recombination is a large part of ADAS, concentrated in the series 4 codes. The most basic requirement is to be able to look at equilibrium ionisation and ADAS405 provides this capability. It draws upon collections of effective ionisation and recombination coefficients to calculate fractional abundances in equilibrium. More unusually ADAS405 can use metastable resolved ionisation/recombination data if available. The program also evaluates equilibrium radiated power and has a special capability for investigating the make up and temperature/density dependence of contribution functions (some times called G(Te,Ne) functions). This is an important issue for critical studies. A tutorial and demonstration of ADAS405 is given. It is shown firstly how to select ionisation/recombination data and check data availability. Then it is shown how to set up the required processing and to obtain graphs of ionisation fractions and radiated power. A brief introduction is made to ‘script files’ which specify how contribution functions for spectrum lines are to be assembled from individual theoretical emissivity parts. A test script file is used to produce a graph of a CII contribution function with ADAS405.