

ADAS Subroutine cxcrdg

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      SUBROUTINE CXCRDG ( MXNSHL , MXJSHL , IZ0      , IZ1      ,  
&                      NI      , LI      , NJ      , LJ      ,  
&                      TEV     , DENS    , ZP      , TPV     ,  
&                      EMP     , TBLF   , GAE     , GAP     ,  
&                      QEP     , QEM    , QIP     , QIM     ,  
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C ***** FORTRAN77 SUBROUTINE: CXCRDG *****

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C PURPOSE: CALCULATES ELECTRON AND +VE ION COLLISIONAL RATE
C COEFFICIENTS BETWEEN NEARLY DEGENERATE LEVELS FOR
C HYDROGEN-LIKE, LITHIUM-LIKE AND SODIUM-LIKE IONS.

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C RATES ARE CALCULATED FOR BOTH TERM AVERAGED AND
C SEPARATE NLJ->NL+1J' AND NLJ->NL-1J' STATES.

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C CALLING PROGRAM: C6TBQM , C8TBQM

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C INPUT : (I*4) MXNSHL = MAXIMUM NUMBER OF N SHELLS.

C INPUT : (I*4) MXJSHL = MAXIMUM NUMBER OF J SUB-SHELLS.

C INPUT : (I*4) IZ0 = TARGET NUCLEAR CHARGE.

C INPUT : (I*4) IZ1 = ION CHARGE.

C INPUT : (I*4) NI = VALENCE ELECTRON PRINCIPAL QUANTUM NUMBER
C IN STATE I.

C INPUT : (I*4) LI = VALENCE ELECTRON ORBITAL QUANTUM NUMBER IN
C STATE I.

C INPUT : (I*4) NJ = VALENCE ELECTRON PRINCIPAL QUANTUM NUMBER
C IN STATE J.

C INPUT : (I*4) LJ = VALENCE ELECTRON ORBITAL QUANTUM NUMBER IN
C STATE J.

C INPUT : (R*8) TEV = TEMPERATURE (ELECTRON DISTRIBUTION).
C UNITS: EV

C INPUT : (R*8) DENS = ELECTRON DENSITY.
C UNITS: CM-3

C INPUT : (R*8) ZP = CHARGE OF COLLIDING POSITIVE ION.

C INPUT : (R*8) TPV = TEMPERATURE (COLLIDING POSITIVE ION
C DISTRIBUTION).

C UNITS: EV

C INPUT : (R*8) EMP = REDUCED MASS FOR COLLIDING POSITIVE ION.
C UNITS: ELECTRON MASSES

C INPUT : (R*8) TBLF () = TABLE OF RADIATIVE LIFETIMES.
C UNITS: SECS

C DIMENSION: REFERENCED BY FUNC I4IDFL(N,L).

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C OUTPUT: (R*8) GAE = TERM AVERAGED GAMA RATE PARAMETER FOR
C ELECTRON COLLISIONS.

C OUTPUT: (R*8) GAP = TERM AVERAGED GAMA RATE PARAMETER FOR
C POSITIVE ION COLLISIONS.

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C OUTPUT: (R*8) QEP() = ELECTRON RATE COEFFT. FOR NLJ->NL+1J'
C DIMENSION: J->J' TRANSITION INDEX.
C OUTPUT: (R*8) QEM() = ELECTRON RATE COEFFT. FOR NLJ->NL-1J'
C DIMENSION: J->J' TRANSITION INDEX.
C OUTPUT: (R*8) QIP() = POSITIVE ION RATE COEFFT. FOR NLJ->NL+1J'
C DIMENSION: J->J' TRANSITION INDEX.
C OUTPUT: (R*8) QIM() = POSITIVE ION RATE COEFFT. FOR NLJ->NL-1J'
C DIMENSION: J->J' TRANSITION INDEX.
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C PARAM : (I*4) MXTEMP = MAXIMUM NUMBER OF TEMPERATURES.
C PARAM : (I*4) MXCOLL = MAXIMUM NUMBER OF COLLISION STRENGTHS.
C PARAM : (I*4) MXTERM = 2.
C PARAM : (R*8) P1 =
C
C (I*4) IZ = IZ1-1.
C (I*4) NTEMP = NUMBER OF TABULATED TEMPERATURES.
C (I*4) NCOLL = NUMBER OF TABULATED COLLISION STRENGTHS.
C (I*4) ICI =
C (I*4) ICJ =
C (I*4) IZC = INTEGER BELOW CHARGE OF POSITIVE ION.
C (I*4) I = LOOP INDEX.
C (I*4) J = LOOP INDEX.
C
C (R*8) WI = STATISTICAL WEIGHT OF STATE I.
C (R*8) WJ = STATISTICAL WEIGHT OF STATE J.
C (R*8) EI = BINDING ENERGY OF STATE I.
C UNITS: RYD
C (R*8) EJ = BINDING ENERGY OF STATE I.
C UNITS: RYD
C (R*8) TE = TEMPERATURE (ELECTRON DISTRIBUTION).
C UNITS:
C (R*8) TP = TEMPERATURE (COLLIDING POSITIVE ION
C DISTRIBUTION).
C UNITS:
C (R*8) Z1 = REAL VALUE = IZ1.
C (R*8) XNI = REAL VALUE = NI.
C (R*8) XLI = REAL VALUE = LI.
C (R*8) XLJ = REAL VALUE = LJ.
C (R*8) XLG =
C (R*8) EIO = BINDING ENERGY FOR STATE I.
C (R*8) EJO = BINDING ENERGY FOR STATE J.
C (R*8) ZEFFI = EFFECTIVE ION CHARGE FOR STATE I.
C (R*8) ZEFFJ = EFFECTIVE ION CHARGE FOR STATE J.
C (R*8) TAU =
C (R*8) W =
C (R*8) T1 =
C (R*8) T2 =
C (R*8) XXLI =
C (R*8) XXLJ =
C (R*8) XS =
C (R*8) XXJI =
C (R*8) XXJJ =
C (R*8) DE =

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C (R*8) PHI =
 C (R*8) ZC =
 C (R*8) EMM =
 C (R*8) QI1 = COLLISIONAL EXCITATION RATE COEFFICIENT FROM
 C PENGELLY AND SEATON.
 C UNITS: CM3 SEC-1
 C (R*8) QIJ = COLLISIONAL DEEXCITATION RATE COEFFICIENT
 C FROM PENGELLY AND SEATON.
 C UNITS: CM3 SEC-1
 C (R*8) G1 = GAMMA RATE PARAMETER FROM PENGELLY AND
 C SEATON.
 C UNITS:
 C (R*8) RAT =
 C (R*8) SCF = SCALING FACTOR.
 C
 C (R*8) EPS () = INCIDENT ELECTRON ENERGIES.
 C UNITS: RYD
 C DIMENSION: COLLISION INDEX.
 C (R*8) OMEG () = COLLISION STRENGTHS.
 C DIMENSION: COLLISION INDEX.
 C (R*8) TA () = TEMPERATURES (INCIDENT POSITIVE ION
 C DISTRIBUTION).
 C UNITS: EV
 C DIMENSION: TEMPERATURE INDEX.
 C (R*8) QI () = COLLISIONAL EXCITATION RATE COEFFICIENTS
 C FROM IMPACT PARAMETER APPROXIMATION.
 C UNITS: CM3 SEC-1
 C DIMENSION: TEMPERATURE INDEX.
 C (R*8) QJ () = COLLISIONAL DEEXCITATION RATE COEFFICIENTS
 C FROM IMPACT PARAMETER APPROXIMATION.
 C UNITS: CM3 SEC-1
 C DIMENSION: TEMPERATURE INDEX.
 C (R*8) GA () = GAMMA RATE PARAMETERS FROM IMPACT PARAMETER
 C APPROXIMATION.
 C UNITS:
 C DIMENSION: TEMPERATURE INDEX.
 C (R*8) XSJ () =
 C DIMENSION: 2
 C (R*8) XJJ () =
 C DIMENSION: 2
 C (R*8) XEJ () =
 C DIMENSION: 2
 C (R*8) XSI () =
 C DIMENSION: 2
 C (R*8) XJI () =
 C DIMENSION: 2
 C (R*8) XEI () =
 C DIMENSION: 2

C ROUTINES:

ROUTINE	SOURCE	BRIEF DESCRIPTION
I4UNIT	ADAS	RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.

C I4IDFL ADAS RETURNS UNIQUE INDEX GIVEN QUANTUM
 C NUMBERS N AND L.
 C R8ZETA ADAS
 C R8WIG6 ADAS
 C CXHYDE ADAS CALCULATES BINDING ENERGY FOR H-LIKE
 C ION.
 C CXLTHE ADAS CALCULATES BINDING ENERGY FOR LI-LIKE
 C ION.
 C CXSODE ADAS CALCULATES BINDING ENERGY FOR NA-LIKE
 C ION.
 C CXCRPS ADAS CALCULATES COLLISON RATE COEFFICIENTS
 C FROM PENGELLY AND SEATON.
 C CXCRIP ADAS CALCULATES COLLISON RATE COEFFICIENTS
 C FROM IMPACT PARAMETER APPROXIMATION.
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C NOTES:

- C 1) THE $J \rightarrow J'$ TRANSITION INDEX IS AS FOLLOWS:
 C 1 : $J=L+0.5 \rightarrow J'=L'+0.5$
 C 2 : $J=L+0.5 \rightarrow J'=L'-0.5$
 C 3 : $J=L-0.5 \rightarrow J'=L'+0.5$
 C 4 : $J=L-0.5 \rightarrow J'=L'-0.5$
 C
 C 2) THE SCALING FACTOR 'SCF' USED IN CALCULATING THE POSITIVE ION
 C RATES IS NEEDED BECAUSE THE CROSS-SECTION ROUTINES REQUIRE AN
 C INTEGER VALUE FOR THE ION CHARGE. THE ADJACENT LOWER INTEGER
 C VALUE IS USED AND THE RESULTS SCALED BY 'SCF'.
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 C K1/0/81
 C JET EXT. 5183
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C DATE: 08/10/93

C UPDATE: 01/11/93 - J NASH - ADAS91:
 C UPDATED TO MORE GENERAL FORM TO ALLOW USE BY EITHER ADAS306
 C OR ADAS308. NOW HANDLES H-, LI-, OR NA-LIKE IONS, AND
 C RETURNS EXPLICIT RATES FOR J-RESOLVED TRANSITIONS.
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C VERSION : 1.2

C DATE : 28-09-2005

C MODIFIED: Martin O'Mullane

C - Scale the gamma (GAP) in addition to the rates
 C since 308 and 309 use this and ignore QIP and QIM.
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C VERSION : 1.3

C DATE : 17-05-2007

C MODIFIED: Allan Whiteford

C - Updated comments as part of subroutine documentation
 C procedure.
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INTEGER	IZ0,	IZ1,	LI,	LJ
INTEGER	MXJSHL,	MXNSHL,	NI,	NJ
REAL*8	DENS,	EMP,	GAE,	GAP
REAL*8	QEM(2*MXJSHL),		QEP(2*MXJSHL)	
REAL*8	QIM(2*MXJSHL),		QIP(2*MXJSHL)	
REAL*8	TBLF((MXNSHL*(MXNSHL+1))/2),			TEV
REAL*8	TPV,	ZP		