ADAS Subroutine c7cxee

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      SUBROUTINE C7CXEE( MXNENG , MXNSHL , NGRND  , NTOT   ,
     &                   NBOT   , NTOP   , IRZ0   , IRZ1   ,
     &                   RAMSNO , TEV    , TIEV   , DENS   ,
     &                   DENSZ  , ZEFF   , BMAG   , BMENG  ,
     &                   ITHEOR , IBSTAT , IEMMS  , NTU    ,
     &                   NTL    , NMINF  , NMAXF  , NENRGY ,
     &                   ENRGYA , ALPHAA , XSECNA , FRACLA ,
     &                   ERATE
     &                 )
C
C
C-----------------------------------------------------------------------
C
C  ****************** FORTRAN77 SUBROUTINE: C7CXEE *********************
C
C  PURPOSE:   CALCULATES THE J-RESOLVED EFFECTIVE EMISSIVITY RATE
C             COEFFICIENT FOR THE GIVEN TRANSITION.
C
C             IT IS APPLICABLE TO IMPURITIES IN PLASMA TRAVERSED BY
C             NEUTRAL BEAMS OF H OR HE. THE RECOMBINED TARGET ION MAY BE
C             H, LI OR NA-LIKE.
C
C             THE MODEL INCLUDES CAPTURE, N-N' LEVEL CASCADE, AND MIXING
C             AMONG L,J LEVELS OF SAME N BY COLLISIONS OR MAGNETIC
C             FIELDS.
C
C             ELECTRON IMPACT IONISATION IS INCLUDED TO GIVE COLLISION
C             LIMIT EFFECT.
C
C             AN INTERNAL EIKONAL APPROXIMATION IS USED FOR CAPTURE FROM
C             EXCITED H OR HE STATES, ALTHOUGH NORMALLY THE EXTERNAL DATA
C             SET SHOULD BE USED.
C
C  CALLING PROGRAM: ADAS307
C
C  INPUT : (I*4)  MXNENG   = MAXIMUM NO. OF ENERGIES IN DATA SET.
C  INPUT : (I*4)  MXNSHL   = MAXIMUM NUMBER OF N SHELLS.
C  INPUT : (I*4)  NGRND    = PRINCIPAL QUANTUM NUMBER OF GROUND STATE.
C  INPUT : (I*4)  NTOT     = PRINCIPAL QUANTUM NUMBER OF HIGHEST BOUND
C                            STATE.
C  INPUT : (I*4)  NBOT     = MINIMUM PRINCIPAL QUANTUM NUMBER FOR
C                            RATE TABLES.
C  INPUT : (I*4)  NTOP     = MAXIMUM PRINCIPAL QUANTUM NUMBER FOR
C                            RATE TABLES.
C  INPUT : (I*4)  IRZ0     = RECEIVER NUCLEAR CHARGE.
C  INPUT : (I*4)  IRZ1     = RECEIVER ION INITIAL CHARGE.
C  INPUT : (R*8)  RAMSNO   = RECEIVER ATOMIC MASS.
C  INPUT : (R*8)  TEV      = ELECTRON TEMPERATURE.
C                            UNITS: EV
C  INPUT : (R*8)  TIEV     = ION TEMPERATURE.
C                            UNITS: EV
C  INPUT : (R*8)  DENS     = ELECTRON DENSITY.
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C                                       UNITS: CM-3
C   INPUT : (R*8)  DENSZ     = PLASMA ION DENSITY.
C                                       UNITS: CM-3
C   INPUT : (R*8)  ZEFF      = EFFECTIVE ION CHARGE.
C   INPUT : (R*8)  BMAG      = PLASMA MAGNETIC INDUCTION.
C                                       UNITS: TESLA
C   INPUT : (R*8)  BMENG     = BEAM ENERGY.
C                                       UNITS: EV/AMU
C   INPUT : (I*4)  ITHEOR    = CHARGE EXCHANGE MODEL OPTION.
C                                 1 => USE INPUT DATA SET.
C                                 2 => USE EIKONAL MODEL.
C   INPUT : (I*4)  IBSTAT    = DONOR STATE FOR EIKONAL MODEL.
C                                 1 => H(1S)
C                                 2 => H(2S)
C                                 3 => H(2P)
C                                 4 => HE(1S2)
C                                 5 => HE(1S2S)
C   INPUT : (I*4)  IEMMS     = EMISSION MEASURE MODEL OPTION.
C                                 1 => CHARGE EXCHANGE.
C                                 2 => ELECTRON IMPACT EXCITATION.
C                                 3 => RADIATIVE RECOMBINATION.
C   INPUT : (I*4)  NTL       = LOWER PRINCIPAL QUANTUM NUMBER OF
C                                 TRANSITION.
C   INPUT : (I*4)  NTU       = UPPER PRINCIPAL QUANTUM NUMBER OF
C                                 TRANSITION.
C   INPUT : (I*4)  NMINF     = LOWEST N-SHELL FOR WHICH DATA READ.
C   INPUT : (I*4)  NMAXF     = HIGHEST N-SHELL FOR WHICH DATA READ.
C   INPUT : (I*4)  NENRGY    = NUMBER OF ENERGIES READ FROM DATA SET.
C   INPUT : (R*8)  ENRGYA()  = COLLISION ENERGIES READ FROM INPUT DATA
C                                 SET.
C                                 UNITS: EV/AMU
C                                 DIMENSION: ENERGY INDEX
C   INPUT : (R*8)  ALPHAA()  = EXTRAPOLATION PARAMETER ALPHA READ FROM
C                                 INPUT DATA SET.
C                                 DIMENSION: ENERGY INDEX
C   INPUT : (R*8)  XSECNA(,) = N-RESOLVED CHARGE EXCHANGE CROSS-SECTIONS
C                                 READ FROM INPUT DATA SET.
C                                 UNITS: CM2
C                                 1ST DIMENSION: ENERGY INDEX
C                                 2ND DIMENSION: N-SHELL
C   INPUT : (R*8)  FRACLA(,) = L-RESOLVED CHARGE EXCHANGE CROSS-SECTIONS.
C                                 AFTER CXDATA: ABSOLUTE VALUES (CM2).
C                                 AFTER CXFRAC: FRACTION OF N-RESOLVED
C                                                 DATA.
C                                 1ST DIMENSION: ENERGY INDEX
C                                 2ND DIMENSION: INDEXED BY I4IDFL(N,L)
C
C   OUTPUT: (R*8)  ERATE     = EFFECTIVE EMISSIVITY RATE COEFFICIENT FOR
C                                 REQUESTED TRANSITION
C                                 SPECTRUM LINE.
C                                 UNITS: CM3 SEC-1
C
C   PARAM : (I*4)  MXN       = MXNSHL.
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C  PARAM : (I*4)  MXJSHL     = MAXIMUM NUMBER OF J SUB-SHELLS.
C  PARAM : (I*4)  MXBEAM     = MAXIMUM NUMBER OF BEAM COMPONENTS.
C  PARAM : (I*4)  MXOBSL     = MAXIMUM NUMBER OF OBSERVED SPECTRUM
C                               LINES.
C  PARAM : (I*4)  MXPRSL     = MAXIMUM NUMBER OF SPECTRUM LINES TO
C                               PREDICT.
C
C  PARAM : (R*8)  EMP        = REDUCED MASS FOR POSITIVE ION.
C                               UNITS: ELECTRON MASSES
C
C          (I*4)  NBEAM      = NUMBER OF BEAM ENERGIES.
C          (I*4)  NOLINE     = NUMBER OF OBSERVED SPECTRUM LINES.
C          (I*4)  NPLINE     = NUMBER OF SPECTRUM LINES TO PREDICT.
C          (I*4)  NUMIN      = MINIMUM UPPER PRINCIPAL QUANTUM NUMBER
C                               FOR OBSERVED SPECTRUM LINES.
C          (I*4)  NUMAX      = MAXIMUM UPPER PRINCIPAL QUANTUM NUMBER
C                               FOR OBSERVED SPECTRUM LINES.
C
C          (R*8)  EM         = EMMISSION MEASURE.
C                               UNITS: CM-5
C
C          (I*4)  NL()       = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS
C                               OF OBSERVED SPECTRUM LINES.
C                               DIMENSION: SPECTRUM LINE INDEX.
C          (I*4)  NU()       = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS
C                               OF OBSERVED SPECTRUM LINES.
C                               DIMENSION: SPECTRUM LINE INDEX.
C          (I*4)  NPL()      = LIST OF LOWER PRINCIPAL QUANTUM NUMBERS
C                               OF SPECTRUM LINES TO PREDICT.
C                               DIMENSION: SPECTRUM LINE INDEX.
C          (I*4)  NPU()      = LIST OF UPPER PRINCIPAL QUANTUM NUMBERS
C                               OF SPECTRUM LINES TO PREDICT.
C                               DIMENSION: SPECTRUM LINE INDEX.
C
C          (R*8)  BMFRA()    = BEAM COMPONENT FRACTIONS.
C                               DIMENSION: COMPONENT INDEX.
C          (R*8)  BMENA()    = BEAM ENERGY COMPONENTS.
C                               UNITS: EV/AMU
C          (R*8)  EMISA()    = LIST OF EMISSIVITIES OF OBSERVED SPECTRUM
C                               LINES.
C                               UNITS: PH CM-2 SEC-1
C                               DIMENSION: SPECTRUM LINE INDEX.
C          (R*8)  TBLF()     = TABLE OF RADIATIVE LIFETIMES.
C                               UNITS: SECS
C                               DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  QTHIN()    = IONISATION RATE COEFFICIENT.
C                               UNITS: CM3 SEC-1
C                               DIMENSION: N SHELL INDEX.
C          (R*8)  QTHEX()    = MEAN EXCITATION RATE COEFFICIENTS FOR
C                               N-LEVELS AVERAGED OVER BEAM FRACTIONS.
C                               UNITS: CM3 SEC-1
C                               DIMENSION: N SHELL INDEX.
C          (R*8)  QTHCH()    = MEAN CHARGE EXCHANGE COEFFICIENTS FOR
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C                                      N-LEVELS AVERAGED OVER BEAM FRACTIONS.
C                                      UNITS: CM3 SEC-1
C                                      DIMENSION: N SHELL INDEX.
C          (R*8)  QTHRC()   = MEAN RECOMBINATION RATE COEFFICIENTS FOR
C                             N-LEVELS AVERAGED OVER BEAM FRACTIONS.
C                             UNITS: CM3 SEC-1
C                             DIMENSION: N SHELL INDEX.
C          (R*8)  QEX()     =
C                             DIMENSION: N SHELL INDEX.
C          (R*8)  TOTPOP()  = TOTAL COLLISION POP. FOR PREDICTED
C                             SPECTRUM LINE.
C                             UNITS: CM-2
C                             DIMENSION: PREDICTED LINE INDEX.
C          (R*8)  TOTEMI()  = TOTAL COLLISION EMISSIVITIES FOR PREDICTED
C                             SPECTRUM LINE.
C                             UNITS: PH CM-2 SEC-1
C                             DIMENSION: PREDICTED LINE INDEX.
C          (R*8)  AVRGWL()  = AVERAGE AIR WAVELENGTH FOR PREDICTED
C                             SPECTRUM LINE.
C                             UNITS: A
C                             DIMENSION: PREDICTED LINE INDEX.
C          (R*8)  QEFF()    = EFF. RATE COEFFICIENT FOR PREDICTED
C                             SPECTRUM LINE.
C                             UNITS: CM3 SEC-1
C                             DIMENSION: PREDICTED LINE INDEX.
C
C          (R*8)  FTHEXJ(,) = FRACTION OF N-LEVEL MEAN EXCITATION RATE
C                             COEFFICIENTS IN NLJ-LEVEL.
C                             1ST DIMENSION: J SHELL INDEX WHERE:
C                                            1 GIVES J=L+0.5
C                                            2 GIVES J=L-0.5
C                             2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  FTHCHJ(,) = FRACTION OF N-LEVEL MEAN CHARGE EXCHANGE
C                             COEFFICIENTS IN NLJ-LEVEL.
C                             1ST DIMENSION: J SHELL INDEX WHERE:
C                                            1 GIVES J=L+0.5
C                                            2 GIVES J=L-0.5
C                             2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  FTHRCJ(,) = FRACTION OF N-LEVEL MEAN RECOMBINATION
C                             RATE COEFFICIENTS IN NLJ-LEVEL.
C                             1ST DIMENSION: J SHELL INDEX WHERE:
C                                            1 GIVES J=L+0.5
C                                            2 GIVES J=L-0.5
C                             2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  TBQMEP(,) = ELECTRON COLLISIONAL RATE COEFFT. FOR
C                             NLJ->NL+1J'.
C                             1ST DIMENSION: J->J' TRANSITION INDEX.
C                             2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  TBQMEM(,) = ELECTRON COLLISIONAL RATE COEFFT. FOR
C                             NLJ->NL-1J'.
C                             1ST DIMENSION: J->J' TRANSITION INDEX.
C                             2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C          (R*8)  TBQMIP(,) = POSITIVE ION COLLISIONAL RATE COEFFT. FOR
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C                              NLJ->NL+1J'.
C                              1ST DIMENSION: J->J' TRANSITION INDEX.
C                              2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C         (R*8)  TBQMIM(,) = POSITIVE ION COLLISIONAL RATE COEFFT. FOR
C                              NLJ->NL-1J'.
C                              1ST DIMENSION: J->J' TRANSITION INDEX.
C                              2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C         (R*8)  TBFMP(,)  = B-FIELD DEPENDENT MIXING RATE COEFFT. FOR
C                              NLJ->NL+1J'.
C                              1ST DIMENSION: J->J' TRANSITION INDEX.
C                              2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C         (R*8)  TBFM(,)   = B-FIELD DEPENDENT MIXING RATE COEFFT. FOR
C                              NLJ->NLJ'.
C                              1ST DIMENSION: J->J' TRANSITION INDEX.
C                              2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C         (R*8)  TBFMM(,)  = B-FIELD DEPENDENT MIXING RATE COEFFT. FOR
C                              NLJ->NL-1J'.
C                              1ST DIMENSION: J->J' TRANSITION INDEX.
C                              2ND DIMENSION: REFERENCED BY I4IDFL(N,L).
C
C         (R*8)  TBLPOP(,,)= TABLE OF COLLISION POP. FOR PREDICTED
C                              SPECTRUM LINE.
C                              UNITS: CM-2
C                              1ST DIMENSION: J->J' TRANSITION INDEX.
C                              2ND DIMENSION: REFERENCED BY I4IDLI().
C                              3RD DIMENSION: PREDICTED LINE INDEX.
C         (R*8)  TBLEMI(,,)= TABLE OF COLLISION EMISSIVITIES FOR
C                              PREDICTED SPECTRUM LINE.
C                              UNITS: PH CM-2 SEC-1
C                              1ST DIMENSION: J->J' TRANSITION INDEX.
C                              2ND DIMENSION: REFERENCED BY I4IDLI().
C                              3RD DIMENSION: PREDICTED LINE INDEX.
C         (R*8)  TBLWLN(,,)= TABLE OF WAVELENGTHS FOR PREDICTED
C                              SPECTRUM LINE.
C                              UNITS: A
C                              1ST DIMENSION: J->J' TRANSITION INDEX.
C                              2ND DIMENSION: REFERENCED BY I4IDLI().
C                              3RD DIMENSION: PREDICTED LINE INDEX.
C
C ROUTINES:
C         ROUTINE    SOURCE    BRIEF DESCRIPTION
C         ------------------------------------------------------------
C         I4UNIT     ADAS      RETURNS UNIT NO. FOR OUTPUT OF MESSAGES.
C         CXTBLF     ADAS      FILLS L-RESOLVED RADIATIVE LIFETIME
C                              TABLE.
C         C6TBIN     ADAS      FILLS N-RESOLVED ELECTRON IMPACT
C                              IONISATION RATE TABLE.
C         C6TBEX     ADAS      FILLS N AND J-RESOLVED ELECTRON IMPACT
C                              EXCITATION RATE TABLES.
C         C6QEIK     ADAS      FILLS N AND J-RESOLVED CHARGE EXCHANGE
C                              RATE TABLES USING EIKONAL APPROXIMATION.
C         C6QXCH     ADAS      FILLS N AND J-RESOLVED CHARGE EXCHANGE
C                              RATE TABLES USING INPUT DATA SET.
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C             C6TBRC      ADAS        FILLS N AND J-RESOLVED RADIATIVE
C                                     RECOMBINATION RATE TABLES.
C             C6TBQM      ADAS        FILLS N AND J-RESOLVED COLLISIONAL RATE
C                                     TABLES.
C             C6TBFM      ADAS        FILLS N AND J-RESOLVED B-FIELD
C                                     DEPENDENT MIXING RATE TABLES.
C             C7EMIS      ADAS        PREDICTS THE J-RESOLVED EMISSIVITY FOR
C                                     REQUESTED TRANSITIONS.
C
C NOTES:
C       1) THE J->J' TRANSITION INDEX IS AS FOLLOWS:
C             1 : J=L+0.5 -> J'=L'+0.5
C             2 : J=L+0.5 -> J'=L'-0.5
C             3 : J=L-0.5 -> J'=L'+0.5
C             4 : J=L-0.5 -> J'=L'-0.5
C
C AUTHOR:  JONATHAN NASH (TESSELLA SUPPORT SERVICES PLC)
C          K1/0/87
C          JET EXT. 5183
C
C DATE:    26/11/93
C
C UNIX-IDL PORT:
C
C AUTHOR:  WILLIAM OSBORN (TESSELLA SUPPORT SERVICES PLC)
C
C DATE:    24TH MAY 1996
C
C VERSION: 1.1                         DATE: 24-05-96
C MODIFIED: WILLIAM OSBORN
C             - FIRST VERSION
C
C-------------------------------------------------------------------
C
C-------------------------------------------------------------------
      INTEGER             IBSTAT,      IEMMS,       IRZ0,        IRZ1
      INTEGER             ITHEOR,      MXNENG,      MXNSHL,      NBOT
      INTEGER             NENRGY,      NGRND,       NMAXF,       NMINF
      INTEGER             NTL,         NTOP,        NTOT,        NTU
      REAL*8              ALPHAA(MXNENG),           BMAG,        BMENG
      REAL*8              DENS,        DENSZ,       ENRGYA(MXNENG)
      REAL*8              ERATE
      REAL*8              FRACLA(MXNENG,(MXNSHL*(MXNSHL+1))/2),  RAMSNO
      REAL*8              TEV,         TIEV
      REAL*8              XSECNA(MXNENG,MXNSHL),    ZEFF
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