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Semi-Empirical Oscillator Strengths for the Cu I Isoelectronic Sequence

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Abstract

Semi-empirical oscillator strengths for the Cu I isoelectronic sequence. A. Lindgård,[1] L. J. Curtis,[2] I. Martinson[2] and S. E. Nielsen[1] ([1]H. C. Ørsted Institute, University of Copenhagen, Universitetsparkem 5, DK-2100 Copenhagen, Denmark; and [2]Department of Physics, University of Lund, Sölvegatan 14, S-223 62 Lund, Sweden).
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Semi-empirical values for the lifetimes, transition probabilities and oscillator strengths have been computed for all $n = 4$, $n = 5$ and some $n \leqslant 9$ Rydberg transitions for ions in the Cu I isoelectronic sequence through In XXI. Extrapolation and interpolation techniques were utilised to obtain a set of estimated term values and ionisation potentials which, although crude by spectroscopic standards, are of sufficient accuracy to serve as inputs for transition probability calculations by the numerical Coulomb approximation.

1. Introduction

The need for reliable estimates of transition probabilities for ions in the Cu I isoelectronic sequence has been accentuated by their application to the determination of impurity concentrations in high temperature plasmas [1]. Hartree–Fock calculations have been made for the lowest resonance transitions in selected ions by several authors [2–4] and Cheng and Kim [5] have made similar calculations for the $n = 4$ and $n = 5$ levels, again in selected ions. A comprehensive source of values for oscillator strengths for transitions including higher lying states is useful for several reasons. Recombination phenomena often proceed through high lying states, making their transition probabilities important for plasma physical problems. A knowledge of higher lying transition probabilities is also very valuable in the experimental measurement of lower level life-times, since unusually severe cascade effects seem to occur in the Cu I sequence, at least in the case which have thus far been examined [6]. A common method for studying these cascade contributions is through an analytic or Monte Carlo simulation of the decay curves using a model population and theoretical estimates of the lifetimes and branching ratios [6, 7], thus requiring a comprehensive set of these estimates.

It is sometimes possible to trace isoelectronic and homologous trends in oscillator strengths using theoretical estimates from only a few selected ions [8]. However it has been shown [9] that there can be very sharp cancellation effects in the transition integrals for alkali-like ions which cause the oscilator strength for a transition in one particular ion to be anomalously small, so it is useful to make calculations for all lower lying Rydberg transitions for every ion in the sequence. This is a very time consuming task if ab initio calculations are made, so we have chosen instead to make a semi-empirical calculation, utilising the numerical Coulomb approximation and complementing the available measured term value and ionisation potential data with estimates obtained using established extrapolation and interpolation techniques [10]. Although these extrapolations and interpolations cannot yield transition wavelengths of the accuracy of high precision spectroscopic studies, the transition probabilities semi-empirically deduced from them should generally satisfy the 10% measurement accuracies which presently typify these quantities. Transitions involving the higher p-states in Cu I and Zn II, which are seriously perturbed by displaced terms, have, however, a much lower accuracy. Lower absolute accuracies should also be expected where cancellation effects are strong, since otherwise negligible phenomena [11] can become dominant in these cases.

2. Calculation method

The numerical Coulomb approximation has been very successfully applied earlier in the computation of atomic oscillator strengths and lifetimes for single valence electron atoms [11–13]. This method of calculation is semi-impirical and is especially useful when large numbers of transition probabilities are required, since wave functions and matrix elements are computed quickly and automatically using only energy level and ionisation potential data as inputs. The method can thus provide a set of transition probabilities as comprehensive as the known level scheme. The method uses a unique cut-off criterion derived from consideration of hydrogenic mean values [14]. Extensive calculations utilising the numerical Coulomb approximation have been made for the isoelectronic sequences of the chemical alkalis [12], for which thorough spectroscopic analyses exist, but the lack of spectroscopic data has prevented its application to more than a few charge states of the Cu I isoelectronic sequence. The results obtained from the numerical Coulomb approximation compare very favourably with those ab initio calculations which are available for the Li and Na I sequences and calculations for the Cu I sequence could be expected to be of similar accuracy.

For ions of reasonably high charge stage the Cu I sequence is a pure alkali-like system with a single electron outside a closed $3d$ shell. This gives rise to a simple Rydberg type spectrum for which the methods employed here should be quite reliable. For low charge states there are two problems which require some caution: firstly, there are terms from the displaced system $3d^9\,4s\,nl$ that are below the ionisation continuum which can mix with the Rydberg series, and secondly, core polarisation effects may occur to a significant degree.

In the neutral and first few ions of the Cu I sequence there are rather large perturbations of the ^2P Rydberg series arising from mixing with the $3d^9\,4s4p\ ^2P$ configuration. This is particularly so for neutral copper, which Shenstone and Russell described in 1932 [15] as "probably the most distorted series known". Although this configuration mixing does not perturb the $4p$ state, the higher members of the ^2P series are not well described within *LS* coupling and the single electron picture, and the methods used here yield only crude estimates for Cu I, which are included only for completeness. In the first few members of the Cu I sequence there is also a $3d^9 4s^2\ ^2D$ state rather low in the spectrum. Inspection of the measured ^2D Rydberg series does not give any indication of perturbations from such mixing. This level also provides another channel for the ^2F Rydberg series, but spectroscopic data indicate that transitions from nf levels to this displaced level are much weaker than the $4d$–nf transitions, so the nf lifetimes are only very slightly overestimated by neglecting this channel [16].

3. Energy level interpolations and extrapolations

The sources for measured term value and ionisaton potential data are shown in Table I. All are from published references [1, 17–28] with the exception of Pd XVIII, Ag XIX, Cd XX and In XXI results, which were obtained through our own reanalysis of spectrograms published earlier by Edlén [29]. These spectrograms contained the $4s$–$5p$, $4p$–$5s$, $4p$–$5d$ and $4d$–$5f$ transition wavelengths, so they establish only the $5p$ levels relative to the ground state. The missing entries in Table I were estimated through a set of combined isoelectronic and Rydberg series interpolations and extrapolations. The procedures used are well known and have been described elsewhere [10, 13, 28], and were carried out in the following manner. The energy levels and ionisation potentials were first interpolated between and extrapolated beyond the measured values using various polynomial fittings as a function of the stage of ionisation. Then the resulting ionisation potentials and energy levels were combined through the computation of quantum defects, which were fitted to a Ritz formula for each Rydberg series [13]. Studies were made both of the conformity to the Ritz formulation and of the isoelectronic regularity of the quantum defects. Where irregularities were detected for a given ion, they were examined to ascertain whether they were present for several Rydberg series, indicating a faulty ionisation potential, or were confined to a single Rydberg series, indicating a faulty energy level, and appropriate adjustments were made. The fine structure separations of the ^2P and ^2D levels were accurately deduced using a screening parametrisation method which has already been described elsewhere [28], and the estimated levels were adjusted so as to confirm. Fine structure was neglected for states with $l \geqslant 3$. The non penetrating ^2F and ^2G levels estimated by this method were also tested by use of the core polarisation formula [9]. This chain of procedures was then iterated several times to obtain internal consistency. As can be seen from Table I, it was possible to make isoelectronic interpolations from all energy levels and the ionisation potential for ions up to Mo XIV. Beyond this, extrapolations were necessary for all except the $4p$ and $5p$ energy levels. However, the extrapolation of the ionisation potential is correlated to the $4p$ and $5p$ interpolations and to the other energy level extrapolations through the Ritz formulation of Rydberg series, and is thus not an unconstrained extrapolation.

4. Results

The calculated transition quantities are given in Table II, along with the spectroscopic data upon which they are based. The empirically estimated quantities are so indicated and should not be used for precision spectroscopic work. However, the reliability of the oscillator strength calculations can be seen through comparison of the results for Mo XIV in [13]. The Mo XIV results in Table II are based on the recent spectroscopic study of Reader et al. [27], while [13] was made with earlier less precise estimates and extrapolations, yet the oscillator strengths are in nearly exact agreement. For highly ionised systems it is clear from Table II that the lifetimes arising from the $\Delta n = 0$ $4s$–$4p$ transitions are very long lived compared to all other states listed. Thus the cascade effects upon the $4p$ decay curves could be well simulated if more sophisticated calculations, such as [2–5], were used for the $4p$ levels, and the results in Table II were used for the various cascades.

5. Conclusion

The main intention of this work is to produce a crude but rather complete set of transition probabilities and lifetimes for the Cu I isoelectronic sequence. This provides a convenient means for identifying systematic trends as well as to pinpoint where cancellation effects and irregularities occur. It also provides a source of theoretical estimates for investigating cascade contributions to measured decay curves through simulations.

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Table I

	IP	5s	6s	4p	5p	6p	4d	5d	4f	5f	5g
Cu I[c]	T	AEL	AEL	AEL	AEL	AEL	AEL	AEL	AEL	AEL	
Zn II[c]	MK	MK	MK	MK	MK	MK	MK	MK	MK	MK	MK
Ga III	AEL	J	J	J	J		J	J	J		J
Ge IV	AEL	AEL	AEL	AEL	AEL	AEL	AEL	AEL	AEL		AEL
As V	AEL	AEL		AEL			AEL		AEL		
Se VI	JV	JV	JV	JV	JV	JV	JV	JV	JV		JV
Br VII				RR			RR				
Kr VIII	L	L		F	L		L	L	L	L	L
Rb IX		RA		RA							
Sr X		RA		RA							
Y XI		RA		RA	A			A			
Zr XII		RA		RA	A		A[a]	A		A[a]	
Nb XIII	A	RA		RA	A	A	A[a]	A		A[a]	
Mo XIV[c]	R	R	R	R	R	R	R	R	R	R	R
Tc XV											
Ru XVI											
Rh XVII											
Pd XVIII		E[b]			E		E[a]	E[b]		E[a]	
Ag XIX		E[b]			E		E[a]	E[b]		E[a]	
Cd XX		E[b]			E		E[a]	E[b]		E[a]	
In XXI		E[b]			E		E[a]	E[b]		E[a]	
Xe XXVI				H							

[a] 4d and 5f determined relative to each other, but not relative to 4s.

[b] 5s and 5d determined relative to the 4p, but not relative to 4s.

[c] For Cu I, Zn II and Mo XIV various additional energy levels are known, some of which have been included in Table II.

AEL	Moore [17]	L	Livingston et al. [24]
A	Alexander et al. [26]	MK	Martin and Kaufman [19]
E	Edlén (reanalysed herein) [29]	R	Reader et al. [27]
F	Fawcett et al. [23]	RA	Reader and Acquista [25]
H	Hinnov [1]	RR	Rao and Rao [22]
J	Joshi et al. [20]	T	Tondello [18]
JV	Joshi and van Kleef [21]		

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Explanation of Table II

The table for each member is headed by the member name, sequence name, and ionisation potential. The states j characterized by n, l, J are listed in order of increasing l, for each l in order of increasing n and for each n, l in order of increasing J. For each state n, l, J are listed transition specifications to the states $n', l+1, J'$ where n' runs over all principal quantum numbers considered and J' runs over the values permitted by dipole selection rules.

Table Heading

Zn II (Cu I sequence)	Singly-ionised zinc (neutral copper sequence).
144 892.60	Ionisation potential in cm^{-1}.

Data for state j

n, l, J	State configuration.
t	Lifetime (mean life) in ns (10^{-9} s).
E	Level energy E_j in cm^{-1} from lowest level.
x	(at E) extrapolation/interpolation method used.
n^*	Effective principal quantum number.
0.025, etc.	Cutoff radius ρ_{bc} reduced units.

Data for state j' and transition data

$n', l+1, J'$	State configuration.
A	Transition probability (decay) in $10^8\,\mathrm{s}^{-1}$, $A_{jj'}$ for $E_j > E_{j'}$ or $A_{j'j}$ for $E_{j'} > E_j$.
f	Oscillator strength (absorption), $f_{j'j}$ for $E_j > E_{j'}$ or $f_{jj'}$ for $E_{j'} > E_j$.
lambda	Wave length ($j \rightarrow j'$) in Å (10^{-10} m).
+	Absorption.
−	Emission.
x	(at lambda) Extrapolation/Interpolation method used for E_j or $E_{j'}$ or both.
b	Branching coefficient in %, $b_{jj'}$ for $E_j > E_{j'}$ or $b_{j'j}$ for $E_{j'} > E_j$.
c	Cancellation percentage
1.234′ − 5	1.234×10^{-5}.

```
2 Cu I (2 Cu I  sequence)
Ionisation Potential       62 316.60

                         E        n*          cut
  4s 1/2                 0        1.327     0.025
to              A        f        lambda     b   c
  4p 1/2 1.636'+0 2.631'-1         3275   100   0
  4p 3/2 1.674'+0 5.296'-1         3248   100   0
  5p 1/2 1.425'-1 8.762'-3         2025    55  65
  5p 3/2 1.425'-1 1.752'-2         2025    55  65
  6p 1/2 1.838'-2 9.099'-4         1817    34  83
  6p 3/2 4.642'-4 4.638'-5         1825     2  97
  7p 1/2 1.220'-2 5.548'-4         1742    41  81
  7p 3/2 5.504'-2 4.915'-3         1726    65  60
  8p 1/2 4.084'-2 1.740'-3         1686    67  55
  8p 3/2 2.891'-2 2.467'-3         1687    64  63
  9p 1/2 1.854'-2 7.700'-4         1664    64  63
  9p 3/2 1.492'-2 1.239'-3         1665    61  67

                t        E        n*          cut
  5s 1/2        23.47 43137.21    2.392     0.025
to              A        f        lambda     b   c
  4p 1/2 1.448'-1 1.367'-1        -7935    34  16
  4p 3/2 2.812'-1 1.381'-1        -8095    66  16
  5p 1/2 1.155'-1 4.439'-1        16010    45   2
  5p 3/2 1.155'-1 8.879'-1        16011    45   2
  6p 1/2 9.031'-3 9.576'-3         8410    17  81
  6p 3/2 2.145'-3 4.742'-3         8586     8  91
  7p 1/2 1.413'-3 1.039'-3         7002     5  92
  7p 3/2 1.264'-2 1.727'-2         6752    15  74
  8p 1/2 8.702'-3 4.980'-3         6178    14  74
  8p 3/2 6.207'-3 7.146'-3         6197    14  78
  9p 1/2 3.826'-3 1.997'-3         5900    13  80
  9p 3/2 3.100'-3 3.241'-3         5905    13  82

                t        E        n*          cut
  6s 1/2        52.78 52848.75    3.404     0.025
to              A        f        lambda     b   c
  4p 1/2 4.122'-2 1.241'-2        -4482    22  61
  4p 3/2 7.925'-2 1.220'-2        -4532    42  62
  5p 1/2 2.299'-2 2.871'-1       -28856    12  15
  5p 3/2 4.599'-2 2.870'-1       -28853    24  15
  6p 1/2 1.862'-2 5.879'-1        45893    34   3
  6p 3/2 1.406'-2 1.126'+0        51671    50   2
  7p 1/2 2.357'-5 1.692'-4        21879     0  98
  7p 3/2 7.371'-3 8.498'-2        19608     9  70
  8p 1/2 4.344'-3 1.554'-2        15445     7  77
  8p 3/2 3.297'-3 2.394'-2        15560     7  80
  9p 1/2 1.926'-3 5.515'-3        13819     7  83
  9p 3/2 1.612'-3 9.269'-3        13847     7  85

                t        E        n*          cut
  7s 1/2        100.5 56671.39    4.409     0.025
to              A        f        lambda     b   c
  4p 1/2 1.852'-2 4.064'-3        -3826    19  68
  4p 3/2 3.554'-2 3.975'-3        -3863    36  69
  5p 1/2 6.978'-3 1.969'-2       -13721     7  74
  5p 3/2 1.396'-2 1.970'-2       -13720    14  73
  6p 1/2 7.340'-3 4.074'-1       -60840     7  18
  6p 3/2 1.714'-2 3.606'-1       -52985    17  24
  7p 1/2 2.331'-3 6.249'-1       133704     8   1
  7p 3/2 7.570'-3 1.391'+0        78289     9  11
  8p 1/2 2.959'-3 6.309'-2        37710     5  71
  8p 3/2 2.404'-3 1.063'-1        38403     5  74
  9p 1/2 1.256'-3 1.616'-2        29293     4  83
  9p 3/2 1.080'-3 2.803'-2        29419     4  84

                t        E        n*          cut
  8s 1/2        180.9 58568.92    5.411     0.025
to              A        f        lambda     b   c
  4p 1/2 9.955'-3 1.899'-3        -3567    18  71
  4p 3/2 1.910'-2 1.854'-3        -3599    35  72
  5p 1/2 3.460'-3 6.149'-3       -10887     6  81
  5p 3/2 6.922'-3 6.150'-3       -10886    13  81
  6p 1/2 2.611'-3 3.122'-2       -28239     5  75
  6p 3/2 6.723'-3 3.518'-2       -26421    12  73
  7p 1/2 3.440'-3 3.903'-1       -86986     6  32
  7p 3/2 3.057'-3 5.957'-1      -161236     6   9
  8p 1/2 2.945'-3 7.762'-1       132582     5  16
  8p 3/2 2.747'-3 1.651'+0       141561     6  12
  9p 1/2 9.868'-4 6.435'-2        65951     3  76
  9p 3/2 8.778'-4 1.167'-1        66592     4  77

                t        E        n*          cut
  9s 1/2        306.1 59647.88    6.412     0.025
to              A        f        lambda     b   c
  4p 1/2 5.952'-3 1.053'-3        -3435    18  72
  4p 3/2 1.141'-2 1.027'-3        -3464    35  73
  5p 1/2 1.999'-3 2.844'-3        -9742     6  84
  5p 3/2 3.998 -3 2.844'-3        -9742    12  84
  6p 1/2 1.399'-3 9.825'-3       -21644     4  83
  6p 3/2 3.660'-3 1.160'-2       -20560    11  81
  7p 1/2 1.621'-3 4.894'-2       -44872     5  74
  7p 3/2 7.533'-4 1.956'-2       -58852     2  85
  8p 1/2 5.100'-4 7.252'-1      -307967     2   7
  8p 3/2 1.365'-3 7.370'-1      -268420     4   9
  9p 1/2 1.208'-3 9.467'-1       228666     4  14
  9p 3/2 1.156'-3 1.940'+0       236563     5  12
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                t        E        n*          cut
  4p 1/2        6.112 30535.30    1.858     2.150
to              A        f        lambda     b   c
  4d 3/2 6.868'-1 5.472'-1         5155    84   0
  5d 3/2 2.550'-1 1.238'-1         4024    68  19
  6d 3/2 1.236'-1 4.953'-2         3655    63  28
  7d 3/2 6.949'-2 2.527'-2         3483    61  32
  8d 3/2 4.312'-2 1.483'-2         3386    59  34

                t        E        n*          cut
  4p 3/2        5.975 30783.69    1.865     2.125
to              A        f        lambda     b   c
  4d 3/2 1.355'-1 5.539'-2         5222    16   0
  4d 5/2 8.133'-1 4.983'-1         5220   100   0
  5d 3/2 4.989'-2 1.236'-2         4064    13  19
  5d 5/2 3.000'-1 1.114'-1         4064    81  19
  6d 3/2 2.412'-2 4.920'-3         3689    12  28
  6d 5/2 1.452'-1 4.441'-2         3688    76  28
  7d 3/2 1.354'-2 2.505'-3         3513    12  32
  7d 5/2 8.153'-2 2.263'-2         3513    72  32
  8d 3/2 8.393'-3 1.468'-3         3415    12  35
  8d 5/2 5.057'-2 1.326'-2         3415    70  35

                t        E        n*          cut
  5p 1/2        38.75 49383.26    2.913     1.675
to              A        f        lambda     b   c
  4d 3/2 1.144'-4 1.126'-1       181179     0   4
  5d 3/2 5.669'-2 4.715'-1        16654    15  29
  6d 3/2 2.972'-2 1.230'-1        11751    15  50
  7d 3/2 1.703'-2 5.245'-2        10136    15  58
  8d 3/2 1.061'-2 2.787'-2         9361    15  62

                t        E        n*          cut
  5p 3/2        38.76 49382.95    2.913     1.675
to              A        f        lambda     b   c
  4d 3/2 2.291'-5 1.126'-2       181077     0   4
  4d 5/2 1.428'-4 1.028'-1       178857     0   4
  5d 3/2 1.134'-2 4.714'-2        16654     3  29
  5d 5/2 6.780'-2 4.224'-1        16644    18  29
  6d 3/2 5.943'-3 1.230'-2        11751     3  50
  6d 5/2 3.560'-2 1.105'-1        11748    19  50
  7d 3/2 3.406'-3 5.245'-3        10135     3  58
  7d 5/2 2.041'-2 4.715'-2        10134    18  58
  8d 3/2 2.122'-3 2.787'-3         9361     3  62
  8d 5/2 1.272'-2 2.507'-2         9360    17  62

                t        E        n*          cut
  6p 1/2        184.9 55027.74    3.880     1.625
to              A        f        lambda     b   c
  4d 3/2 8.055'-3 2.328'-2       -19637    15  70
  5d 3/2 1.351'-4 3.127'-1       277833     0   1
  6d 3/2 9.672'-3 3.532'-1        34900     5  50
  7d 3/2 6.403'-3 1.077'-1        23687     6  65
  8d 3/2 4.166'-3 4.922'-2        19850     6  71

                t        E        n*          cut
  6p 3/2        352.5 54784.06    3.817     1.575
to              A        f        lambda     b   c
  4d 3/2 1.165'-3 7.431'-3       -20623     4  63
  4d 5/2 1.053'-2 4.489'-2       -20653    37  63
  5d 3/2 1.259'-4 5.181'-2       165670     0   0
  5d 5/2 7.698'-4 4.695'-1       164682     0   0
  6d 3/2 1.448'-3 2.247'-2        32165     1  60
  6d 5/2 8.621'-3 2.003'-1        32144     5  60
  7d 3/2 1.059'-3 7.960'-3        22394     1  69
  7d 5/2 6.313'-3 7.116'-2        22388     6  70
  8d 3/2 7.163'-4 3.850'-3        18934     1  74
  8d 5/2 4.275'-3 3.445'-2        18931     6  74

                t        E        n*          cut
  7p 1/2        337.7 57419.31    4.734     1.450
to              A        f        lambda     b   c
  4d 3/2 6.192'-3 8.286'-3       -13362    21  78
  5d 3/2 7.448'-3 1.353'-1       -49221    25  51
  6d 3/2 7.818'-4 1.045'+0       211086     0   0
  7d 3/2 8.138'-4 7.285'-2        54640     1  81
  8d 3/2 8.450'-4 3.618'-2        37790     1  84

                t        E        n*          cut
  7p 3/2        117.9 57948.71    5.012     0.100
to              A        f        lambda     b   c
  4d 3/2 8.723'-5 2.037'-4       -12479     0  92
  4d 5/2 7.979'-4 1.244'-3       -12490     1  92
  5d 3/2 1.318'-4 3.013'-3       -39047     0  83
  5d 5/2 1.201'-3 1.836'-2       -39102     1  83
  6d 3/2 2.675'-7 1.294'-2      -180'+4     0   1
  6d 5/2 2.154'-6 7.491'-2      -187'+4     0   1
  7d 3/2 8.159'-4 7.230'-2        76879     1  41
  7d 5/2 4.877'-3 6.470'-1        76804     4  42
  8d 3/2 5.027'-4 1.682'-2        47241     1  67
  8d 5/2 3.010'-3 1.510'-1        47223     4  67

                t        E        n*          cut
  8p 1/2        164.6 59323.17    6.055     0.200
to              A        f        lambda     b   c
  4d 3/2 1.988'-4 1.691'-4       -10652     0  96
  5d 3/2 3.589'-4 1.737'-3       -25410     1  93
  6d 3/2 3.915'-4 1.435'-2       -69924     1  87
  7d 3/2 1.345'-5 1.855'-1      -136'+4     0   1
  8d 3/2 1.721'-3 9.363'-1       134709     2  41
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                t        E        n*          cut
  8p 3/2        219.7 59275.33    6.007     0.075
to              A        f        lambda     b   c
  4d 3/2 4.801'-5 8.251'-5       -10706     0  93
  4d 5/2 4.395'-4 5.043'-4       -10714     1  93
  5d 3/2 7.031'-5 6.975'-4       -25722     0  90
  5d 5/2 6.406'-4 4.244'-3       -25746     1  90
  6d 3/2 7.339'-5 5.758'-3       -72344     0  82
  6d 5/2 6.685'-4 3.507'-2       -72452     1  82
  7d 3/2 5.940'-8 1.331'-2      -387'+4     0   1
  7d 5/2 4.609'-7 7.605'-2      -406'+4     0   1
  8d 3/2 3.111'-4 7.470'-2       126553     0  47
  8d 5/2 1.858'-3 6.680'-1       126422     3  48

                t        E        n*          cut
  9p 1/2        343.2 60085.20    7.013     0.100
to              A        f        lambda     b   c
  4d 3/2 2.546'-4 1.853'-4        -9852     1  94
  5d 3/2 3.688'-4 1.253'-3       -21288     1  93
  6d 3/2 3.788'-4 5.909'-3       -45617     1  91
  7d 3/2 3.880'-4 4.164'-2      -119654     1  82
  8d 3/2 5.019'-7 9.705'-2      -508'+4     0   0

                t        E        n*          cut
  9p 3/2        407.2 60070.60    6.990     1.200
to              A        f        lambda     b   c
  4d 3/2 3.525'-5 5.144'-5        -9866     0  94
  4d 5/2 3.222'-4 3.139'-4        -9873     1  93
  5d 3/2 4.773'-5 3.263'-4       -21354     0  92
  5d 5/2 4.344'-4 1.983'-3       -21371     2  92
  6d 3/2 4.796'-5 1.516'-3       -45923     0  89
  6d 5/2 4.362'-4 9.211'-3       -45966     2  89
  7d 3/2 4.853'-5 1.079'-2      -121782     0  79
  7d 5/2 4.414'-4 6.562'-2      -121969     2  79
  8d 3/2 0.873'-9 5.050'-3      -196'+5     0   0
  8d 5/2 4.642'-9 2.545'-2      -234'+5     0   0

                t        E        n*          cut
  4d 3/2        12.16 49935.20    2.977     4.150
to              A        f        lambda     b   c
  4f 5/2 1.329'-1 9.900'-1        18200    93   0
  5f 5/2 4.421'-2 1.565'-1        12547    60  41

                t        E        n*          cut
  4d 5/2        12.29 49942.06    2.978     4.125
to              A        f        lambda     b   c
  4f 5/2 9.479'-3 4.719'-2        18222     7   0
  4f 7/2 1.420'-1 9.435'-1        18234   100   0
  5f 5/2 3.147'-3 7.440'-3        12558     4  41
  5f 7/2 4.762'-2 1.500'-1        12552    65  41

                t        E        n*          cut
  5d 3/2        26.80 55387.67    3.980     3.600
to              A        f        lambda     b   c
  4f 5/2 1.528'-7 1.936'-2       237'+4     0   9
  5f 5/2 2.443'-2 8.667'-1        39721    33  19

                t        E        n*          cut
  5d 5/2        27.13 55391.29    3.981     3.575
to              A        f        lambda     b   c
  4f 5/2 8.324'-9 8.416'-4       260'+4     0   9
  4f 7/2 9.365'-8 1.528'-2       286'+4     0   9
  5f 5/2 1.745'-3 4.140'-2        39779     2  19
  5f 7/2 2.611'-2 8.235'-1        39723    35  19

                t        E        n*          cut
  6d 3/2        51.06 57893.05    4.981     3.425
to              A        f        lambda     b   c
  4f 5/2 5.577'-4 9.187'-3       -40597     0  85
  5f 5/2 1.298'-8 1.978'-2       823'+4     0   3

                t        E        n*          cut
  6d 5/2        52.65 57895.10    4.982     3.400
to              A        f        lambda     b   c
  4f 5/2 2.620'-5 6.464'-4       -40563     0  86
  4f 7/2 5.153'-4 9.507'-3       -40506     0  86
  5f 5/2 0.532'-9 7.823'-4       990'+4     0   3
  5f 7/2 1.955'-8 2.113'-2       735'+4     0   3

                t        E        n*          cut
  7d 3/2        88.35 59249.46    5.982     3.375
to              A        f        lambda     b   c
  4f 5/2 2.234'-4 1.531'-3       -26180     0  93
  5f 5/2 4.126'-4 2.282'-2       -74390     0  83

                t        E        n*          cut
  7d 5/2        87.90 59250.72    5.983     3.350
to              A        f        lambda     b   c
  4f 5/2 1.049'-5 1.077'-4       -26172     0  93
  4f 7/2 2.048'-4 1.574'-3       -26148     0  93
  5f 5/2 1.939'-5 1.605'-3       -74321     0  84
  5f 7/2 3.962'-4 2.474'-2       -74515     0  83

                t        E        n*          cut
  8d 3/2        137.3 60065.51    6.982     3.300
to              A        f        lambda     b   c
  4f 5/2 1.107'-4 5.150'-4       -21572     0  95
  5f 5/2 1.984'-4 4.249'-3       -46290     0  92
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              t       E        n*          cut
  8d 5/2    137.5 60066.33   6.983       3.275
to            A       f      lambda      b   c
  4f 5/2 5.190'-6 3.620'-5  -21568       0  95
  4f 7/2 1.008'-4 5.262'-4  -21552       0  95
  5f 5/2 9.319'-6 2.991'-4  -46272       0  92
  5f 7/2 1.907'-4 4.607'-3  -46347       0  92

              t       E        n*          cut
  4f 5/2    70.23 55429.80   3.992       7.000

              t       E        n*          cut
  4f 7/2    70.44 55426.30   3.991       7.150

              t       E        n*          cut
  5f 5/2    136.0 57905.20   4.988       6.600

              t       E        n*          cut
  5f 7/2    135.6 57908.70   4.990       6.450
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2 Zn II (2 Cu I  sequence)
Ionisation Potential       144 892.60

                      E        n*          cut
  4s 1/2              0      1.741       0.025
to            A       f      lambda      b   c
  4p 1/2 4.648'+0 2.965'-1    2063     100   0
  4p 3/2 4.912'+0 6.046'-1    2026     100   0
  5p 1/2 4.858'-2 7.089'-4   986.5       8  93
  5p 3/2 7.761'-2 2.254'-3   984.1      12  91
  6p 1/2 3.452'-3 3.601'-5   834.1       2  98
  6p 3/2 7.204'-3 1.501'-4   833.6       5  97
  7p 1/2 1.614'-3 1.465'-5   778.1       4  98
  7p 3/2 1.666'-2 3.033'-4   779.2      30  93
  8p 1/2 3.817'-1 3.264'-3   755.2      59  62
  8p 3/2 1.108'-2 1.861'-4   748.4      23  93

              t       E        n*          cut
  5s 1/2    2.468 88437.15   2.788       0.025
to            A       f      lambda      b   c
  4p 1/2 1.356'+0 1.274'-1   -2503      33  28
  4p 3/2 2.696'+0 1.323'-1   -2559      67  28
  5p 1/2 5.093'-1 4.568'-1    7735      87   1
  5p 3/2 5.359'-1 9.258'-1    7591      83   1
  6p 1/2 1.179'-2 1.787'-3    3180       8  93
  6p 3/2 1.500'-2 4.528'-3    3172      10  92
  7p 1/2 7.427'-6 6.931'-7    2495       0 100
  7p 3/2 2.631'-3 4.953'-4    2506       5  97
  8p 1/2 1.122'-1 8.701'-3    2274      17  75
  8p 3/2 3.781'-3 5.553'-4    2213       8  95

              t       E        n*          cut
  6s 1/2    4.488 114498.0   3.800       0.025
to            A       f      lambda      b   c
  4p 1/2 4.474'-1 1.539'-2   -1515      20  63
  4p 3/2 8.847'-1 1.563'-2   -1535      40  64
  5p 1/2 3.012'-1 2.618'-1   -7615      14  26
  5p 3/2 5.948'-1 2.685'-1   -7760      27  26
  6p 1/2 1.173'-1 6.054'-1   18551      82   2
  6p 3/2 1.213'-1 1.219'+0   18311      79   2
  7p 1/2 2.547'-3 1.943'-3    7132       6  95
  7p 3/2 3.102'-4 4.852'-4    7223       1  98
  8p 1/2 4.520'-2 2.111'-2    5581       7  79
  8p 3/2 4.156'-3 3.407'-3    5229       9  94

              t       E        n*          cut
  7s 1/2    8.009 125880.0   4.805       0.025
to            A       f      lambda      b   c
  4p 1/2 2.107'-1 5.274'-3   -1292      17  70
  4p 3/2 4.166'-1 5.333'-3   -1307      33  71
  5p 1/2 1.159'-1 2.890'-2   -4079       9  70
  5p 3/2 2.269'-1 2.888'-2   -4121      18  70
  6p 1/2 9.341'-2 3.901'-1  -16690       7  26
  6p 3/2 1.851'-1 3.958'-1  -16890      15  25
  7p 1/2 3.398'-2 7.319'-1   37900      79   2
  7p 3/2 2.842'-2 1.404'+0   40594      50   1
  8p 1/2 1.952'-2 6.853'-2   15302       3  74
  8p 3/2 6.044'-3 3.023'-2   12916      13  88

              t       E        n*          cut
  8s 1/2    13.18 131876.9   5.807       0.025
to            A       f      lambda      b   c
  4p 1/2 1.169'-1 2.520'-3   -1199      15  73
  4p 3/2 2.312'-1 2.545'-3   -1212      30  73
  5p 1/2 6.129'-2 9.871'-3   -3278       8  78
  5p 3/2 1.199'-1 9.812'-3   -3304      16  78
  6p 1/2 3.929'-2 4.098'-2   -8341       5  73
  6p 3/2 7.731'-2 4.080'-2   -8391      10  74
  7p 1/2 3.694'-2 4.910'-1  -29776       5  27
  7p 3/2 7.605'-2 4.566'-1  -28301      10  30
  8p 1/2 6.818'-4 3.531'-1  185874       0   0
  8p 3/2 1.867'-2 1.838'+0   57300      39   4
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              t       E        n*          cut
  9s 1/2    20.68 135423.3   6.808       0.025
to            A       f      lambda      b   c
  4p 1/2 7.163'-2 1.421'-3   -1150      15  75
  4p 3/2 1.417'-1 1.434'-3   -1162      29  75
  5p 1/2 3.678'-2 4.754'-3   -2936       8  81
  5p 3/2 7.193'-2 4.716'-3   -2958      15  81
  6p 1/2 2.208'-2 1.372'-2   -6437       5  82
  6p 3/2 4.339'-2 1.360'-2   -6467       9  82
  7p 1/2 1.672'-2 5.259'-2  -14483       3  76
  7p 3/2 3.553'-2 5.313'-2  -14125       7  75
  8p 1/2 1.392'-2 2.305'-1  -33240       3  57
  8p 3/2 2.998'-2 6.927'-1  -55519       6  21

              t       E        n*          cut
  4p 1/2    2.151 48481.00   2.134       0.400
to            A       f      lambda      b   c
  4d 3/2 6.631'+0 8.477'-1    2065      84   0
  5d 3/2 1.772'+0 1.100'-1    1439      56  40
  6d 3/2 7.676'-1 3.674'-2    1263      49  51
  7d 3/2 4.096'-1 1.724'-2    1185      46  56
  8d 3/2 2.461'-1 9.623'-3    1142      45  59

              t       E        n*          cut
  4p 3/2    2.036 49355.04   2.143       0.425
to            A       f      lambda      b   c
  4d 3/2 1.296'+0 8.593'-2    2103      16   0
  4d 5/2 7.781'+0 7.721'-1    2101     100   0
  5d 3/2 3.389'-1 1.079'-2    1457      11  41
  5d 5/2 2.044'+0 9.755'-2    1457      66  41
  6d 3/2 1.456'-1 3.563'-3    1278       9  52
  6d 5/2 8.801'-1 3.229'-2    1277      58  52
  7d 3/2 7.738'-2 1.663'-3    1197       9  57
  7d 5/2 4.682'-1 1.509'-2    1197      54  57
  8d 3/2 4.637'-2 9.250'-4    1153       8  60
  8d 5/2 2.808'-1 8.400'-3    1153      51  60

              t       E        n*          cut
  5p 1/2    17.06 101365.9   3.176       0.425
to            A       f      lambda      b   c
  4d 3/2 2.835'-2 1.070'-1  -22441       5   9
  5d 3/2 8.668'-1 9.428'-1    6023      28  12
  6d 3/2 3.365'-1 1.463'-1    3807      21  54
  7d 3/2 1.723'-1 5.200'-2    3173      19  65
  8d 3/2 1.013'-1 2.524'-2    2883      19  70

              t       E        n*          cut
  5p 3/2    15.49 101611.4   3.185       0.450
to            A       f      lambda      b   c
  4d 3/2 3.294'-3 2.234'-2  -21269       1  10
  4d 5/2 2.886'-2 1.334'-1  -21501       4  10
  5d 3/2 1.719'-1 9.629'-2    6113       5  12
  5d 5/2 1.030'+0 8.633'-1    6104      34  12
  6d 3/2 6.558'-2 1.452'-2    3843       4  54
  6d 5/2 3.947'-1 1.310'-1    3841      26  54
  7d 3/2 3.333'-2 5.111'-3    3198       4  65
  7d 5/2 2.010'-1 4.621'-2    3197      23  65
  8d 3/2 1.952'-2 2.468'-3    2904       4  70
  8d 5/2 1.178'-1 2.233'-2    2903      21  70

              t       E        n*          cut
  6p 1/2    70.23 119888.5   4.190       0.450
to            A       f      lambda      b   c
  4d 3/2 8.292'-5 1.177'-5   -4352       0  99
  5d 3/2 9.747'-3 1.984'-1  -52105       7   5
  6d 3/2 2.105'-1 1.053'+0   12916      13  21
  7d 3/2 9.864'-2 1.752'-1    7697      11  62
  8d 3/2 5.586'-2 6.411'-2    6187      10  72

              t       E        n*          cut
  6p 3/2    64.93 119959.3   4.196       0.450
to            A       f      lambda      b   c
  4d 3/2 1.538'-7 4.341'-8   -4338       0 100
  4d 5/2 9.926'-6 1.876'-6   -4348       0 100
  5d 3/2 1.080'-3 4.087'-2  -50251       1   5
  5d 5/2 9.406'-3 2.433'-1  -50872       6   5
  6d 3/2 4.203'-2 1.071'-1   13036       3  21
  6d 5/2 2.518'-1 9.589'-1   13013      16  21
  7d 3/2 1.950'-2 1.751'-2    7739       2  62
  7d 5/2 1.172'-1 1.577'-1    7735      13  62
  8d 3/2 1.099'-2 6.365'-3    6214       2  72
  8d 5/2 6.620'-2 5.745'-2    6212      12  72

              t       E        n*          cut
  7p 1/2    231.3 128518.5   5.178       0.425
to            A       f      lambda      b   c
  4d 3/2 2.770'-4 2.078'-5   -3164       1  99
  5d 3/2 2.120'-3 1.428'-3   -9479       5  95
  6d 3/2 2.686'-3 2.554'-1 -112625       6   3
  7d 3/2 6.933'-2 1.093'+0   22925       8  29
  8d 3/2 3.720'-2 1.965'-1   13274       7  66
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              t       E        n*          cut
  7p 3/2    177.1 128343.4   5.150       0.375
to            A       f      lambda      b   c
  4d 3/2 1.716'-4 2.604'-5   -3181       0  97
  4d 5/2 1.650'-3 1.675'-4   -3186       3  97
  5d 3/2 5.053'-4 7.039'-4   -9639       1  92
  5d 5/2 4.760'-3 4.441'-3   -9662       8  92
  6d 3/2 1.422'-4 4.195'-2 -140284       0   2
  6d 5/2 1.214'-3 2.479'-1 -142910       2   2
  7d 3/2 1.362'-2 9.917'-2   22040       2  33
  7d 5/2 8.140'-2 8.862'-1   22002       9  33
  8d 3/2 7.604'-3 1.919'-2   12973       1  67
  8d 5/2 4.559'-2 1.723'-1   12965       8  67

              t       E        n*          cut
  8p 1/2    15.37 132414.9   5.931       1.550
to            A       f      lambda      b   c
  4d 3/2 2.742'-2 1.631'-3   -2816       4  88
  5d 3/2 3.182'-2 1.143'-2   -6923       5  83
  6d 3/2 3.209'-2 1.051'-1  -20902       5  66
  7d 3/2 4.556'-4 6.299'-1  214731       0   0
  8d 3/2 1.312'-2 2.973'-1   27495       2  67

              t       E        n*          cut
  8p 3/2    209.4 133622.1   6.241       0.525
to            A       f      lambda      b   c
  4d 3/2 8.896'-5 9.896'-6   -2724       0  98
  4d 5/2 7.498'-4 5.576'-5   -2728       2  98
  5d 3/2 3.790'-6 2.319'-6   -6389       0  99
  5d 5/2 2.244'-5 9.184'-6   -6399       0 100
  6d 3/2 4.368'-7 1.824'-6  -16690       0 100
  6d 5/2 9.523'-6 2.663'-5  -16727       0  99
  7d 3/2 3.230'-4 8.808'-2 -134862       1   3
  7d 5/2 2.827'-3 5.249'-1 -136295       6   3
  8d 3/2 5.735'-3 1.456'-1   41156       1  27
  8d 5/2 3.436'-2 1.304'+0   41073       6  27

              t       E        n*          cut
  4d 3/2    1.262 96909.74   3.025       0.900
to            A       f      lambda      b   c
  4f 5/2 1.948'+0 1.057'+0    4913      93   0
  5f 5/2 5.650'-1 1.384'-1    3300      55  46
  6f 5/2 2.417'-1 4.267'-2    2802      42  61
  7f 5/2 1.386'-1 2.051'-2    2565      38  66

              t       E        n*          cut
  4d 5/2    1.285 96960.40   3.026       0.925
to            A       f      lambda      b   c
  4f 5/2 1.387'-1 5.046'-2    4925       7   0
  4f 7/2 2.080'+0 1.009'+0    4925     100   0
  5f 5/2 4.007'-2 6.565'-3    3306       4  47
  5f 7/2 5.964'-1 1.304'-1    3307      59  47
  6f 5/2 1.710'-2 2.018'-3    2806       3  61
  6f 7/2 2.730'-1 4.287'-2    2803      47  60
  7f 5/2 9.796'-3 9.689'-4    2569       3  66
  7f 7/2 1.457'-1 1.922'-2    2569      40  66

              t       E        n*          cut
  5d 3/2    3.175 117969.3   4.038       0.925
to            A       f      lambda      b   c
  4f 5/2 2.511'-4 5.045'-2 -141780       0  11
  5f 5/2 3.914'-1 1.031'+0   10822      38  14
  6f 5/2 1.718'-1 1.804'-1    6833      30  55
  7f 5/2 9.389'-2 6.573'-2    5579      26  67

              t       E        n*          cut
  5d 5/2    3.253 117993.6   4.040       0.950
to            A       f      lambda      b   c
  4f 5/2 1.321'-5 3.721'-3 -137060       0  11
  4f 7/2 2.649'-4 5.587'-2 -136947       0  11
  5f 5/2 2.794'-2 4.932'-2   10851       3  14
  5f 7/2 4.194'-1 9.893'-1   10862      41  14
  6f 5/2 1.221'-2 8.578'-3    6844       2  55
  6f 7/2 1.863'-1 1.736'-1    6828      32  55
  7f 5/2 6.665'-3 3.119'-3    5587       2  67
  7f 7/2 9.965'-2 6.220'-2    5588      28  67

              t       E        n*          cut
  6d 3/2    6.365 127630.6   5.043       0.925
to            A       f      lambda      b   c
  4f 5/2 3.082'-3 2.867'-3   -9646       0  92
  5f 5/2 1.915'-4 1.079'-1 -237417       0   5
  6f 5/2 1.163'-1 1.058'+0   20107      20  24
  7f 5/2 6.224'-2 2.050'-1   12104      17  62

              t       E        n*          cut
  6d 5/2    6.537 127643.7   5.045       0.925
to            A       f      lambda      b   c
  4f 5/2 1.411'-4 1.964'-4   -9634       0  92
  4f 7/2 2.815'-3 2.938'-3   -9634       0  92
  5f 5/2 9.979'-6 7.932'-3 -230256       0   5
  5f 7/2 2.128'-4 1.213'-1 -225175       0   5
  6f 5/2 8.314'-3 5.066'-2   20160       1  24
  6f 7/2 1.232'-1 9.871'-1   20017      21  25
  7f 5/2 4.434'-3 9.769'-3   12123       1  62
  7f 7/2 6.646'-2 1.954'-1   12127      18  62
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              t         E         n*        cut
  7d 3/2     11.14 132880.6    6.045     0.925
to            A         f       lambda     b   c
  4f 5/2 1.081'-3 4.432'-4     -6403     0  96
  5f 5/2 2.542'-3 7.900'-3    -17633     0  90
  6f 5/2 1.317'-4 1.722'-1   -361651     0   3
  7f 5/2 4.316'-2 1.070'+0     33201    12  32

              t         E         n*        cut
  7d 5/2     11.48 132888.4    6.047     0.925
to            A         f       lambda     b   c
  4f 5/2 4.925'-5 3.025'-5     -6400     0  96
  4f 7/2 9.797'-4 4.512'-4     -6400     0  96
  5f 5/2 1.168'-4 5.429'-4    -17609     0  90
  5f 7/2 2.275'-3 7.904'-3    -17578     0  91
  6f 5/2 6.806'-6 1.262'-2   -351729     0   3
  6f 7/2 9.272'-5 1.681'-1   -401606     0   3
  7f 5/2 3.089'-3 5.131'-2     33287     1  32
  7f 7/2 4.642'-2 1.030'+0     33317    13  32

              t         E         n*        cut
  8d 3/2     18.28 136051.9    7.046     0.925
to            A         f       lambda     b   c
  4f 5/2 4.688'-4 1.327'-4     -5323     0  97
  5f 5/2 1.184'-3 1.514'-3    -11309     0  95
  6f 5/2 1.684'-3 1.416'-2    -29004     0  89
  7f 5/2 5.167'-5 2.035'-1   -627746     0   2

              t         E         n*        cut
  8d 5/2     18.24 136056.8    7.048     0.925
to            A         f       lambda     b   c
  4f 5/2 2.125'-5 9.020'-6     -5321     0  98
  4f 7/2 4.215'-4 1.342'-4     -5321     0  98
  5f 5/2 5.434'-5 1.041'-4    -11303     0  95
  5f 7/2 1.056'-3 1.513'-3    -11290     0  95
  6f 5/2 7.760'-5 9.759'-4    -28963     0  90
  6f 7/2 1.784'-3 1.718'-2    -29262     0  89
  7f 5/2 2.691'-6 1.496'-2   -609013     0   2
  7f 7/2 5.643'-5 2.278'-1   -599161     0   2

              t         E         n*        cut
  4f 5/2     4.793 117264.0    3.986     7.625
to            A         f       lambda     b   c
  5g 7/2 6.708'-1 1.328'+0      9953    96   0
  6g 7/2 2.223'-1 1.869'-1      6485    54  49
  7g 7/2 1.060'-1 6.084'-2      5359    41  64

              t         E         n*        cut
  4f 7/2     4.807 117263.4    3.986     7.650
to            A         f       lambda     b   c
  5g 7/2 2.485'-2 3.690'-2      9953     4   0
  5g 9/2 6.980'-1 1.296'+0      9953   100   0
  6g 7/2 8.238'-3 5.194'-3      6485     2  49
  6g 9/2 2.327'-1 1.834'-1      6485    57  49
  7g 7/2 3.926'-3 1.691'-3      5359     2  64
  7g 9/2 1.112'-1 5.983'-2      5359    42  63

              t         E         n*        cut
  5f 5/2     9.762 127209.4    4.982     6.900
to            A         f       lambda     b   c
  5g 7/2 1.164'-6 2.258'-2    985222     0  13
  6g 7/2 1.716'-1 1.145'+0     18267    42  16
  7g 7/2 8.764'-2 2.307'-1     11475    34  55

              t         E         n*        cut
  5f 7/2     9.844 127199.6    4.981     6.975
to            A         f       lambda     b   c
  5g 7/2 5.692'-8 6.889'-4    898473     0  13
  5g 9/2 1.581'-6 2.396'-2    899281     0  13
  6g 7/2 6.357'-3 3.169'-2     18234     2  16
  6g 9/2 1.781'-1 1.110'+0     18234    43  16
  7g 7/2 3.256'-3 6.413'-3     11462     1  55
  7g 9/2 9.144'-2 2.251'-1     11462    35  55

              t         E         n*        cut
  6f 5/2     17.55 132604.1    5.977     6.850
to            A         f       lambda     b   c
  5g 7/2 2.278'-3 9.144'-3    -18892     0  88
  6g 7/2 1.812'-6 5.688'-2    125'+4     0   5
  7g 7/2 5.742'-2 1.041'+0     30123    22  29

              t         E         n*        cut
  6f 7/2     17.11 132639.4    5.985     6.475
to            A         f       lambda     b   c
  5g 7/2 5.722'-5 3.022'-4    -18767     0  88
  5g 9/2 2.055'-3 8.682'-3    -18767     0  88
  6g 7/2 1.155'-8 8.742'-4    225'+4     0   5
  6g 9/2 3.226'-7 3.053'-2    225'+4     0   5
  7g 7/2 2.144'-3 2.979'-2     30447     1  28
  7g 9/2 6.004'-2 1.043'+0     30447    23  28

              t         F         n*        cut
  7f 5/2     27.41 135892.6    6.984     6.350
to            A         f       lambda     b   c
  5g 7/2 8.538'-4 1.304'-3    -11653     0  95
  6g 7/2 2.063'-3 2.253'-2    -31165     1  86
  7g 7/2 2.413'-7 4.955'-2    321'+4     0   3
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```
              t         E         n*        cut
  7f 7/2     27.68 135889.9    6.983     6.400
to            A         f       lambda     b   c
  5g 7/2 2.402'-5 4.892'-5    -11656     0  95
  5g 9/2 9.007'-4 1.468'-3    -11656     0  95
  6g 7/2 5.796'-5 8.454'-4    -31192     0  85
  6g 9/2 2.039'-3 2.380'-2    -31192     1  85
  7g 7/2 1.147'-8 1.497'-3    295'+4     0   3
  7g 9/2 3.209'-7 5.233'-2    295'+4     0   3

              t         E         n*        cut
  5g 7/2     14.38 127310.9    4.997    10.450

              t         E         n*        cut
  5g 9/2     14.33 127310.8    4.997     5.450

              t         E         n*        cut
  6g 7/2     24.48 132683.9    5.996     9.750

              t         E         n*        cut
  6g 9/2     24.34 132683.9    5.996     5.050

              t         E         n*        cut
  7g 7/2     38.41 135923.8    6.996     9.275

              t         E         n*        cut
  7g 9/2     38.08 135923.8    6.996     4.900
```

2 Ga III (2 Cu I sequence)
Ionisation Potential   247 855.00

```
                        E         n*        cut
  4s 1/2                0      1.996     0.025
to            A         f       lambda     b   c
  4p 1/2 8.422'+0 2.973'-1      1534   100   0
  4p 3/2 9.123'+0 6.114'-1      1495   100   0
  5p 1/2 3.287'-2 1.907'-4     622.0     2  97
  5p 3/2 3.823'-3 4.406'-5     620.0     0  99
  6p 1/2 8.493'-2 3.302'-4    509.2x    12  94
  6p 3/2 4.458'-2 3.458'-4    508.6x     6  96

              t         E         n*        cut
  5s 1/2     0.700 140743.3    3.037     0.025
to            A         f       lambda     b   c
  4p 1/2 4.759'+0 1.249'-1     -1323    33  34
  4p 3/2 9.535'+0 1.310'-1     -1354    67  33
  5p 1/2 1.196'+0 4.475'-1      4995    65   0
  5p 3/2 1.288'+0 9.143'-1      4866    66   0
  6p 1/2 7.649'-4 3.705'-5     1797x     0  99
  6p 3/2 3.717'-4 3.569'-5     1790x     0  99

              t         E         n*        cut
  6s 1/2     1.158 187556.7    4.047     0.025
to            A         f       lambda     b   c
  4p 1/2 1.706'+0 1.708'-2    -817.1    20  65
  4p 3/2 3.403'+0 1.752'-2    -828.7    39  65
  5p 1/2 1.179'+0 2.463'-1     -3732    14  32
  5p 3/2 2.345'+0 2.549'-1     -3808    27  31
  6p 1/2 3.049'-1 5.871'-1    11334x    43   1
  6p 3/2 3.279'-1 1.197'+0    11034x    45   1

              t         E         n*        cut
  4p 1/2     1.187 65169.50    2.325     0.775
to            A         f       lambda     b   c
  4d 3/2 2.055'+1 9.894'-1      1267    84   0
  5d 3/2 3.886'+0 7.580'-2     806.6    46  56

              t         E         n*        cut
  4p 3/2     1.096 66887.30    2.336     0.800
to            A         f       lambda     b   c
  4d 3/2 3.962'+0 9.967'-2      1295    16   0
  4d 5/2 2.383'+1 8.964'-1      1293   100   0
  5d 3/2 7.167'-1 7.189'-3     817.9     8  58
  5d 5/2 4.358'+0 6.550'-2     817.5    53  57

              t         E         n*        cut
  5p 1/2     5.414 160762.6    3.368     0.800
to            A         f       lambda     b   c
  4d 3/2 6.180'-1 1.666'-1     -5996    33  14
  5d 3/2 3.247'+0 1.208'+0      3523    38   6

              t         E         n*        cut
  5p 3/2     5.129 161296.0    3.378     0.800
to            A         f       lambda     b   c
  4d 3/2 6.659'-2 3.370'-2     -5810     3  15
  4d 5/2 5.912'-1 2.022'-1     -5849    30  15
  5d 3/2 6.335'-1 1.224'-1      3590     7   6
  5d 5/2 3.810'+0 1.099'+0      3582    47   6

              t         E         n*        cut
  6p 1/2     14.02 196380.0x   4.380     0.800
to            A         f       lambda     b   c
  4d 3/2 1.119'-1 3.067'-3    -1912x    16  89
  5d 3/2 2.109'-1 3.023'-1   -13829x    30   9
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              t         E         n*        cut
  6p 3/2     13.82 196620.0x   4.391     0.800
to            A         f       lambda     b   c
  4d 3/2 1.289'-2 7.000'-4    -1904x     2  88
  4d 5/2 1.133'-1 4.120'-3    -1908x    16  88
  5d 3/2 2.285'-2 6.136'-2   -13385x     3  10
  5d 5/2 2.018'-1 3.675'-1   -13499x    28  10

              t         E         n*        cut
  4d 3/2     0.408 144085.5    3.085     1.425
to            A         f       lambda     b   c
  4f 5/2 8.614'+0 1.133'+0      2418    93   0
  5f 5/2 2.030'+0 1.118'-1     1565x    48  54

              t         E         n*        cut
  4d 5/2     0.420 144200.2    3.087     1.425
to            A         f       lambda     b   c
  4f 5/2 6.127'-1 5.402'-2      2425     7   0
  4f 7/2 9.195'+0 1.081'+0      2425   100   0
  5f 5/2 1.435'-1 5.285'-3     1567x     3  54
  5f 7/2 2.152'+0 1.057'-1     1567x    52  54

              t         E         n*        cut
  5d 3/2     1.177 189148.8    4.102     1.350
to            A         f       lambda     b   c
  4f 5/2 1.474'-2 1.068'-1    -26924     0  14
  5f 5/2 1.889'+0 1.195'+0     5305x    45  10

              t         E         n*        cut
  5d 5/2     1.222 189212.2    4.104     1.375
to            A         f       lambda     b   c
  4f 5/2 7.362'-4 7.734'-3    -26472     0  14
  4f 7/2 1.466'-2 1.159'-1    -26514     0  14
  5f 5/2 1.346'-1 5.716'-2     5323x     3   9
  5f 7/2 2.019'+0 1.143'+0     5323x    48   9

              t         E         n*        cut
  4f 5/2     1.084 185434.6    3.978     8.150
to            A         f       lambda     b   c
  5g 7/2 3.438'+0 1.320'+0      4382    96   0

              t         E         n*        cut
  4f 7/2     1.088 185440.6    3.978     8.125
to            A         f       lambda     b   c
  5g 7/2 1.273'-1 3.665'-2      4383     4   0
  5g 9/2 3.584'+0 1.290'+0      4383   100   0

              t         E         n*        cut
  5f 5/2     2.383 208000.0x   4.978     7.100
to            A         f       lambda     b   c
  5g 7/2 8.283'-6 2.528'-2   390778x     0  13

              t         E         n*        cut
  5f 7/2     2.397 208000.0x   4.978     7.100
to            A         f       lambda     b   c
  5g 7/2 3.068'-7 7.023'-4   390778x     0  13
  5g 9/2 8.502'-6 2.433'-2   390778x     0  14

              t         E         n*        cut
  5g 7/2     2.805 208255.9    4.994    11.225

              t         E         n*        cut
  5g 9/2     2.790 208255.9    4.994     5.925
```

2 Ge IV (2 Cu I sequence)
Ionisation Potential   368 701.00

```
                        E         n*        cut
  4s 1/2                0      2.182     0.025
to            A         f       lambda     b   c
  4p 1/2 1.287'+1 2.918'-1      1230   100   0
  4p 3/2 1.427'+1 6.050'-1      1189   100   0
  5p 1/2 6.402'-1 1.872'-3     441.6    11  91
  5p 3/2 3.598'-1 2.086'-3     439.8     6  93
  6p 1/2 3.653'-1 6.808'-4     352.6    11  92
  6p 3/2 3.133'-1 1.167'-3     352.4     9  93

              t         E         n*        cut
  5s 1/2     0.295 199269.0    3.219     0.025
to            A         f       lambda     b   c
  4p 1/2 1.123'+1 1.211'-1    -847.8    33  39
  4p 3/2 2.266'+1 1.281'-1    -868.3    67  37
  5p 1/2 2.135'+0 4.330'-1      3678    36   0
  5p 3/2 2.355'+0 8.925'-1      3555    39   0
  6p 1/2 2.432'-2 5.125'-4      1186     1  97
  6p 3/2 1.651'-2 6.939'-4      1184     0  97

              t         E         n*        cut
  6s 1/2     0.453 270058.0    4.219     0.025
to            A         f       lambda     b   c
  4p 1/2 4.310'+0 1.814'-2    -529.8    20  67
  4p 3/2 8.634'+0 1.872'-2    -537.8    39  67
  5p 1/2 3.053'+0 2.408'-1     -2294    14  35
  5p 3/2 6.098'+0 2.512'-1     -2344    28  34
  6p 1/2 7.351'-1 5.991'-1      7373    22   1
  6p 3/2 7.563'-1 1.207'+0      7297    23   1
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```
              t        E          n*          cut
  4p 1/2    0.777 81315.00    2.472       1.075
to            A        f          lambda      b   c
  4d 3/2 4.178'+1 1.049'+0    915.0      84   0
  5d 3/2 4.688'+0 4.093'-2    539.6      33  71

              t        E          n*          cut
  4p 3/2    0.701 84103.00    2.484       1.100
to            A        f          lambda      b   c
  4d 3/2 7.947'+0 1.050'-1    938.9      16   0
  4d 5/2 4.792'+1 9.456'-1    936.7     100   0
  5d 3/2 8.125'-1 3.656'-3    547.8       6  73
  5d 5/2 4.964'+0 3.348'-2    547.6      37  72

              t        E          n*          cut
  5p 1/2    1.678 226459.0    3.513       1.075
to            A        f          lambda      b   c
  4d 3/2 3.182'+0 1.856'-1    -2789      53  19
  5d 3/2 7.226'+0 1.342'+0     2489      51   3

              t        E          n*          cut
  5p 3/2    1.660 227397.0    3.525       1.100
to            A        f          lambda      b   c
  4d 3/2 3.344'-1 3.704'-2    -2718       6  20
  4d 5/2 2.975'+0 2.228'-1    -2737      49  19
  5d 3/2 1.387'+0 1.350'-1     2548      10   3
  5d 5/2 8.354'+0 1.215'+0     2543      62   3

              t        E          n*          cut
  6p 1/2    2.960 283621.0    4.543       1.100
to            A        f          lambda      b   c
  4d 3/2 9.709'-1 8.412'-3    -1075      29  82
  5d 3/2 1.283'+0 3.335'-1    -5888      38  16

              t        E          n*          cut
  6p 3/2    2.976 283763.0    4.547       1.100
to            A        f          lambda      b   c
  4d 3/2 9.937'-2 1.717'-3    -1073       3  81
  4d 5/2 8.806'-1 1.020'-2    -1076      26  82
  5d 3/2 1.304'-1 6.665'-2    -5839       4  16
  5d 5/2 1.164'+0 4.004'-1    -5866      35  16

              t        E          n*          cut
  4d 3/2    0.201 190607.0    3.140       1.775
to            A        f          lambda      b   c
  4f 5/2 2.347'+1 1.180'+0     1495      93   0
  5f 5/2 4.267'+0 8.361'-2    933.5x     40  62

              t        E          n*          cut
  4d 5/2    0.209 190861.0    3.142       1.775
to            A        f          lambda      b   c
  4f 5/2 1.665'+0 5.623'-2     1501       7   0
  4f 7/2 2.498'+1 1.125'+0     1501     100   0
  5f 5/2 2.993'-1 3.928'-3    935.7x      3  62
  5f 7/2 4.489'+0 7.857'-2    935.7x     43  62

              t        E          n*          cut
  5d 3/2    0.703 266637.0    4.148       1.600
to            A        f          lambda      b   c
  4f 5/2 1.136'-1 1.359'-1   -10940       1  17
  5f 5/2 5.591'+0 1.300'+0     3216x     53   7

              t        E          n*          cut
  5d 5/2    0.744 266717.0    4.149       1.625
to            A        f          lambda      b   c
  4f 5/2 5.538'-3 9.765'-3   -10845       0  17
  4f 7/2 1.106'-1 1.464'-1   -10851       1  17
  5f 5/2 3.983'-1 6.208'-2     3224x      4   7
  5f 7/2 5.975'+0 1.242'+0     3224x     57   7

              t        E          n*          cut
  4f 5/2    0.398 257496.0    3.974       8.325
to            A        f          lambda      b   c
  5g 7/2 1.100'+1 1.315'+0     2446      96   0

              t        E          n*          cut
  4f 7/2    0.400 257501.0    3.974       8.325
to            A        f          lambda      b   c
  5g 7/2 4.072'-1 3.653'-2     2446       4   0
  5g 9/2 1.143'+1 1.282'+0     2446     100   0

              t        E          n*          cut
  5f 5/2    0.947 297734.0x   4.974       7.250
to            A        f          lambda      b   c
  5g 7/2 7.543'-5 3.624'-2   155039x      0  13

              t        E          n*          cut
  5f 7/2    0.956 297734.0x   4.974       7.250
to            A        f          lambda      b   c
  5g 7/2 2.794'-6 1.007'-3   155039x      0  13
  5g 9/2 7.782'-5 3.506'-2   155039x      0  13

              t        E          n*          cut
  5g 7/2    0.877 298379.0    4.997      10.375

              t        E          n*          cut
  5g 9/2    0.875 298379.0    4.997       5.400
```

```
2 As V (2 Cu I  sequence)
Ionisation Potential      505 136.00

                       E          n*          cut
  4s 1/2               0          2.330       0.025
to            A        f          lambda      b   c
  4p 1/2 1.797'+1 2.855'-1     1029     100   0
  4p 3/2 2.040'+1 5.969'-1    987.7     100   0
  5p 1/2 2.632'+0 4.467'-3    336.5x     18  88
  5p 3/2 1.749'+0 5.881'-3    334.8x     12  90
  6p 1/2 1.991'+0 2.087'-3    264.4x     21  88
  6p 3/2 1.465'+0 3.061'-3    264.0x     16  90

              t        E          n*          cut
  5s 1/2    0.155 263596.0    3.370       0.025
to            A        f          lambda      b   c
  4p 1/2 2.132'+1 1.154'-1   -600.7      33  42
  4p 3/2 4.332'+1 1.232'-1   -615.9      67  41
  5p 1/2 3.103'+0 4.117'-1     2975x     21   0
  5p 3/2 3.512'+0 8.565'-1     2852x     24   0
  6p 1/2 4.270'-1 4.877'-3    872.8x      5  91
  6p 3/2 2.751'-1 6.210'-3    867.6x      3  93

              t        E          n*          cut
  6s 1/2    0.231 362460.0x   4.385       0.025
to            A        f          lambda      b   c
  4p 1/2 8.261'+0 1.759'-2   -376.9x     19  69
  4p 3/2 1.674'+1 1.839'-2   -382.8x     39  69
  5p 1/2 6.046'+0 2.129'-1    -1533x     14  41
  5p 3/2 1.219'+1 2.246'-1    -1567x     28  39
  6p 1/2 8.779'-1 5.333'-1     6365x      9   0
  6p 3/2 9.911'-1 1.106'+0     6101x     11   0

              t        E          n*          cut
  4p 1/2    0.557 97135.00    2.593       1.325
to            A        f          lambda      b   c
  4d 3/2 6.965'+1 1.069'+0    715.5      84   0
  5d 3/2 7.254'+0 3.339'-2    391.8x     28  75

              t        E          n*          cut
  4p 3/2    0.490 101245.0    2.606       1.350
to            A        f          lambda      b   c
  4d 3/2 1.308'+1 1.066'-1    737.2      16   0
  4d 5/2 7.915'+1 9.610'-1    734.8     100   0
  5d 3/2 1.212'+0 2.881'-3    398.2x      5  77
  5d 5/2 7.455'+0 2.656'-2    398.0x     31  77

              t        E          n*          cut
  5p 1/2    0.667 297210.0x   3.632       1.300
to            A        f          lambda      b   c
  4d 3/2 9.248'+0 1.906'-1    -1658x     62  22
  5d 3/2 1.407'+1 1.388'+0     1814x     54   3

              t        E          n*          cut
  5p 3/2    0.677 298660.0x   3.645       1.325
to            A        f          lambda      b   c
  4d 3/2 9.585'-1 3.767'-2    -1619x      6  23
  4d 5/2 8.551'+0 2.273'-1    -1631x     58  23
  5d 3/2 2.679'+0 1.393'-1     1863x     10   3
  5d 5/2 1.615'+1 1.254'+0     1858x     66   3

              t        E          n*          cut
  6p 1/2    1.072 378170.0x   4.648       1.300
to            A        f          lambda      b   c
  4d 3/2 2.949'+0 1.108'-2   -707.8x     32  79
  5d 3/2 3.084'+0 3.468'-1    -3873x     33  17

              t        E          n*          cut
  6p 3/2    1.109 378850.0x   4.661       1.325
to            A        f          lambda      b   c
  4d 3/2 3.109'-1 2.313'-3   -704.5x      3  79
  4d 5/2 2.766'+0 1.381'-2   -706.7x     31  79
  5d 3/2 3.232'-1 6.900'-2    -3774x      4  18
  5d 5/2 2.885'+0 4.147'-1    -3792x     32  18

              t        E          n*          cut
  4d 3/2    0.121 236897.0    3.198       2.075
to            A        f          lambda      b   c
  4f 5/2 4.868'+1 1.211'+0     1052      93   0
  5f 5/2 6.540'+0 5.920'-2    634.4x     34  69

              t        E          n*          cut
  4d 5/2    0.126 237342.0    3.201       2.100
to            A        f          lambda      b   c
  4f 5/2 3.448'+0 5.771'-2     1057       7   0
  4f 7/2 5.172'+1 1.154'+0     1057     100   0
  5f 5/2 4.547'-1 2.759'-3    636.2x      2  69
  5f 7/2 6.820'+0 5.519'-2    636.2x     36  69

              t        E          n*          cut
  5d 3/2    0.386 352350.0x   4.237       2.050
to            A        f          lambda      b   c
  4f 5/2 6.917'-1 1.667'-1    -4911x      3  21
  5f 5/2 1.137'+1 1.438'+0     2372x     59   4
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              t        E          n*          cut
  5d 5/2    0.411 352480.0x   4.239       2.050
to            A        f          lambda      b   c
  4f 5/2 3.344'-2 1.194'-2    -4880x      0  21
  4f 7/2 6.688'-1 1.791'-1    -4880x      3  21
  5f 5/2 8.084'-1 6.859'-2     2379x      4   4
  5f 7/2 1.213'+1 1.372'+0     2379x     64   4

              t        E          n*          cut
  4f 5/2    0.192 331987.0    3.980       8.000
to            A        f          lambda      b   c
  5g 7/2 2.644'+1 1.323'+0     1582x     96   0

              t        E          n*          cut
  4f 7/2    0.193 331987.0    3.980       8.000
to            A        f          lambda      b   c
  5g 7/2 9.792'-1 3.674'-2     1582x      4   0
  5g 9/2 2.754'+1 1.291'+0     1582x    100   0

              t        E          n*          cut
  5f 5/2    0.522 394516.0x   4.980       7.000
to            A        f          lambda      b   c
  5g 7/2 5.698'-5 2.435'-2   146199x      0  13

              t        E          n*          cut
  5f 7/2    0.528 394516.0x   4.980       7.000
to            A        f          lambda      b   c
  5g 7/2 2.110'-6 6.763'-4   146199x      0  13
  5g 9/2 5.864'-5 2.349'-2   146199x      0  14

              t        E          n*          cut
  5g 7/2    0.365 395200.0x   4.995      10.850

              t        E          n*          cut
  5g 9/2    0.363 395200.0x   4.995       5.675
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2 Se VI (2 Cu I  sequence)
Ionisation Potential      659 980.00

                       E          n*          cut
  4s 1/2               0          2.447       0.025
to            A        f          lambda      b   c
  4p 1/2 2.340'+1 2.758'-1    886.8     100   0
  4p 3/2 2.722'+1 5.816'-1    844.1     100   0
  5p 1/2 7.091'+0 7.545'-3    266.4      22  85
  5p 3/2 5.032'+0 1.059'-2    264.9      16  87
  6p 1/2 5.014'+0 3.206'-3    206.5      22  86
  6p 3/2 3.823'+0 4.869'-3    206.1      18  88
  7p 1/2 3.027'+0 1.553'-3    185.0      26  87
  7p 3/2 2.370'+0 2.428'-3    184.8      22  89

              t        E          n*          cut
  5s 1/2   0.0888 333602.5    3.479       0.025
to            A        f          lambda      b   c
  4p 1/2 3.702'+1 1.138'-1   -452.8      33  44
  4p 3/2 7.558'+1 1.224'-1   -464.8      67  43
  5p 1/2 4.685'+0 4.026'-1     2394      14   0
  5p 3/2 5.404'+0 8.429'-1     2281      17   0
  6p 1/2 1.150'+0 7.601'-3    663.9       5  89
  6p 3/2 7.820'-1 1.020'-2    659.5       4  91
  7p 1/2 1.049'+0 3.672'-3    483.3       9  90
  7p 3/2 7.973'-1 5.555'-3    482.0       7  91

              t        E          n*          cut
  6s 1/2    0.128 464144.0    4.491       0.025
to            A        f          lambda      b   c
  4p 1/2 1.477'+1 1.794'-2   -284.6      19  70
  4p 3/2 3.004'+1 1.885'-2   -289.3      38  69
  5p 1/2 1.100'+1 2.093'-1    -1126      14  42
  5p 3/2 2.226'+1 2.220'-1    -1153      29  41
  6p 1/2 1.404'+0 5.220'-1     4980       6   0
  6p 3/2 1.616'+0 1.090'+0     4743       7   0
  7p 1/2 2.532'-1 6.505'-3     1309       2  92
  7p 3/2 1.625'-1 8.235'-3     1300       2  93

              t        E          n*          cut
  7s 1/2    0.198 529240.0    5.497       0.025
to            A        f          lambda      b   c
  4p 1/2 7.591'+0 6.561'-3   -240.1      15  76
  4p 3/2 1.544'+1 6.861'-3   -243.4      31  76
  5p 1/2 5.037'+0 3.190'-2   -649.9      10  73
  5p 3/2 1.012'+1 3.291'-2   -658.8      20  73
  6p 1/2 4.079'+0 3.018'-1    -2221       8  42
  6p 3/2 8.231'+0 3.185'-1    -2272      16  40
  7p 1/2 5.460'-1 6.427'-1     8861       5   0
  7p 3/2 6.231'-1 1.336'+0     8457       6   1

              t        E          n*          cut
  4p 1/2    0.427 112771.1    2.687       1.500
to            A        f          lambda      b   c
  4d 3/2 1.024'+2 1.061'+0    588.0      84   0
  5d 3/2 4.771'+0 1.314'-2    303.1      15  85

              t        E          n*          cut
  4p 3/2    0.367 118469.1    2.701       1.525
to            A        f          lambda      b   c
  4d 3/2 1.896'+1 1.052'-1    608.4      16   0
  4d 5/2 1.151'+2 9.499'-1    605.9     100   0
  5d 3/2 6.773'-1 9.660'-4    308.4       2  87
  5d 5/2 4.384'+0 9.362'-3    308.2      14  87
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             t       F         n*          cut
 5p 1/2     0.304 375372.6    3.726       1.475
to            A       f        lambda      b   c
 4d 3/2 2.116'+1 1.852'-1    -1081       64  26
 5d 3/2 2.124'+1 1.406'+0     1486       65   2

             t       F         n*          cut
 5p 3/2     0.313 377448.3    3.739       1.475
to            A       f        lambda      b   c
 4d 3/2 2.165'+0 3.626'-2    -1057        7  28
 4d 5/2 1.935'+1 2.193'-1    -1065       61  27
 5d 3/2 3.977'+0 1.401'-1     1533       12   1
 5d 5/2 2.412'+1 1.263'+0     1526       79   1

             t       F         n*          cut
 6p 1/2     0.444 484223.0    4.741       1.450
to            A       f        lambda      b   c
 4d 3/2 7.261'+0 1.342'-2    -496.6      32  77
 5d 3/2 7.701'+0 3.346'-1    -2407       34  22

             t       E         n*          cut
 6p 3/2     0.463 485227.0    4.755       1.475
to            A       f        lambda      b   c
 4d 3/2 7.528'-1 2.755'-3    -494.1       3  77
 4d 5/2 6.719'+0 1.651'-2    -495.8      31  77
 5d 3/2 7.951'-1 6.586'-2    -2351        4  23
 5d 5/2 7.093'+0 3.972'-1    -2367       33  23

             t       E         n*          cut
 7p 1/2     0.870 540526.0    5.751       1.450
to            A       f        lambda      b   c
 4d 3/2 3.815'+0 4.306'-3    -388.1      33  84
 5d 3/2 2.808'+0 2.199'-2    -1022       24  80

             t       E         n*          cut
 7p 3/2     0.927 541064.0    5.764       1.475
to            A       f        lambda      b   c
 4d 3/2 3.941'-1 8.860'-4    -387.3       4  84
 4d 5/2 3.521'+0 5.306'-3    -388.3      33  84
 5d 3/2 2.954'-1 4.576'-3    -1016        3  79
 5d 5/2 2.625'+0 2.727'-2    -1020       24  79

             t       E         n*          cut
 4d 3/2    0.0824 282839.0    3.237       2.275
to            A       f        lambda      b   c
 4f 5/2 8.198'+1 1.192'+0    804.2       93   0
 5f 5/2 5.771'+0 2.779'-2    462.7x      20  79

             t       E         n*          cut
 4d 5/2    0.0869 283518.9    3.239       2.300
to            A       f        lambda      b   c
 4f 5/2 5.792'+0 5.679'-2    808.7        7   0
 4f 7/2 8.689'+1 1.136'+0    808.7      100   0
 5f 5/2 3.935'-1 1.271'-3    464.2x       1  80
 5f 7/2 5.903'+0 2.543'-2    464.2x      21  80

             t       E         n*          cut
 5d 3/2     0.305 442685.6    4.264       2.150
to            A       f        lambda      b   c
 4f 5/2 2.174'+0 1.724'-1    -2816        7  24
 5f 5/2 2.088'+1 1.483'+0     1777x      73   3

             t       E         n*          cut
 5d 5/2     0.326 442981.7    4.267       2.175
to            A       f        lambda      b   c
 4f 5/2 1.054'-1 1.233'-2    -2793        0  25
 4f 7/2 2.108'+0 1.849'-1    -2793        7  25
 5f 5/2 1.478'+0 7.075'-2     1787x       5   3
 5f 7/2 2.217'+1 1.415'+0     1787x      79   3

             t       E         n*          cut
 4f 5/2     0.114 407179.2    3.953       8.900
to            A       f        lambda      b   c
 5g 7/2 5.764'+1 1.292'+0     1059       96   0
 6g 7/2 2.039'+1 2.001'-1    700.7       57  46

             t       E         n*          cut
 4f 7/2     0.115 407179.2    3.953       8.900
to            A       f        lambda      b   c
 5g 7/2 2.135'+0 3.589'-2     1059        4   0
 5g 9/2 5.978'+1 1.256'+0     1059      100   0
 6g 7/2 7.551'-1 5.558'-3    700.7        2  46
 6g 9/2 2.160'+1 1.987'-1    700.7       60  46

             t       E         n*          cut
 5f 5/2     0.351 498946.0x   4.953       7.750
to            A       f        lambda      b   c
 5g 7/2 2.438'-3 6.814'-2    37393x       0  12
 6g 7/2 1.397'+1 1.075'+0     1962x      39  18

             t       E         n*          cut
 5f 7/2     0.356 498946.0x   4.953       7.750
to            A       f        lambda      b   c
 5g 7/2 9.029'-5 1.893'-3    37393x       0  12
 5g 9/2 2.528'-3 6.625'-2    37393x       0  12
 6g 7/2 5.173'-1 2.987'-2     1962x       1  18
 6g 9/2 1.452'+1 1.048'+0     1962x      40  17

             t       E         n*          cut
 5g 7/2     0.167 501620.3    4.995      11.075
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             t       F         n*          cut
 5g 9/2     0.167 501620.3    4.995      11.075

             t       F         n*          cut
 6g 7/2     0.281 549902.4    5.991      10.775

             t       F         n*          cut
 6g 9/2     0.277 549902.4    5.991       5.750


2 Br VII (2 Cu I  sequence)
Ionisation Potential      831 000.00

                     E         n*          cut
 4s 1/2              0        2.544       0.025
to            A       f        lambda      b   c
 4p 1/2 2.922'+1 2.662'-1    779.6      100   0
 4p 3/2 3.484'+1 5.660'-1    736.1      100   0
 5p 1/2 2.031'+1 1.462'-2    219.1x      31  80
 5p 3/2 1.563'+1 2.222'-2    217.8x      25  82
 6p 1/2 1.422'+1 5.974'-3    167.4x      30  82
 6p 3/2 1.155'+1 9.658'-3    167.0x      25  84

             t       E         n*          cut
 5s 1/2    0.0548 408170.0x   3.566       0.025
to            A       f        lambda      b   c
 4p 1/2 5.996'+1 1.147'-1    -357.3x     33  45
 4p 3/2 1.227'+2 1.240'-1    -367.2x     67  44
 5p 1/2 5.823'+0 3.761'-1     2076x       9   0
 5p 3/2 6.910'+0 7.957'-1     1960x      11   0
 6p 1/2 3.562'+0 1.491'-2    528.4x       7  85
 6p 3/2 2.660'+0 2.194'-2    524.5x       6  87

             t       E         n*          cut
 6s 1/2    0.0772 574120.0x   4.575       0.025
to            A       f        lambda      b   c
 4p 1/2 2.454'+1 1.851'-2    -224.3x     19  70
 4p 3/2 4.996'+1 1.950'-2    -228.2x     39  70
 5p 1/2 1.813'+1 1.960'-1    -849.1x     14  45
 5p 3/2 3.692'+1 2.095'-1    -870.2x     28  43
 6p 1/2 1.746'+0 4.822'-1     4292x       4   0
 6p 3/2 2.071'+0 1.018'+0     4049x       5   0

             t       E         n*          cut
 4p 1/2     0.342 128274.0    2.766       1.625
to            A       f        lambda      b   c
 4d 3/2 1.366'+2 1.035'+0    502.7       85   0
 5d 3/2 3.124'+0 5.504'-3    242.4x       6  91

             t       E         n*          cut
 4p 3/2     0.287 135854.0    2.781       1.625
to            A       f        lambda      b   c
 4d 3/2 2.488'+1 1.019'-1    522.6       15   0
 4d 5/2 1.513'+2 9.208'-1    520.3      100   0
 5d 3/2 3.354'-1 3.066'-4    246.9x       1  93
 5d 5/2 2.235'+0 3.060'-3    246.7x       5  93

             t       E         n*          cut
 5p 1/2     0.151 456350.0x   3.788       1.550
to            A       f        lambda      b   c
 4d 3/2 4.011'+1 1.803'-1    -774.3x     61  29
 5d 3/2 3.361'+1 1.411'+0     1183x      69   1

             t       E         n*          cut
 5p 3/2     0.158 459200.0x   3.803       1.575
to            A       f        lambda      b   c
 4d 3/2 4.076'+0 3.507'-2    -757.6x      6  30
 4d 5/2 3.651'+1 2.122'-1    -762.6x     58  30
 5d 3/2 6.241'+0 1.403'-1     1225x      13   1
 5d 5/2 3.775'+1 1.264'+0     1220x      83   1

             t       E         n*          cut
 6p 1/2     0.209 597420.0x   4.798       1.525
to            A       f        lambda      b   c
 4d 3/2 1.410'+1 1.447'-2    -370.1x     29  77
 5d 3/2 1.428'+1 3.346'-1    -1768x      30  23

             t       E         n*          cut
 6p 3/2     0.221 598820.0x   4.812       1.550
to            A       f        lambda      b   c
 4d 3/2 1.451'+0 2.948'-3    -368.2x      3  76
 4d 5/2 1.298'+1 1.770'-2    -369.3x     29  77
 5d 3/2 1.471'+0 6.565'-2    -1725x       3  24
 5d 5/2 1.316'+1 3.953'-1    -1734x      29  24

             t       F         n*          cut
 4d 3/2    0.0619 327205.0    3.267       2.425
to            A       f        lambda      b   c
 4f 5/2 1.311'+2 1.177'+0    631.7x      93   0
 5f 5/2 5.082'+0 1.418'-2    352.2x      12  85

             t       E         n*          cut
 4d 5/2    0.0661 328066.0    3.270       2.450
to            A       f        lambda      b   c
 4f 5/2 9.259'+0 5.600'-2    635.1x       7   0
 4f 7/2 1.389'+2 1.120'+0    635.1x     100   0
 5f 5/2 3.404'-1 6.370'-4    353.3x       1  86
 5f 7/2 5.105'+0 1.274'-2    353.3x      13  86
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             t       F         n*          cut
 5d 3/2     0.206 540860.0x   4.305       2.350
to            A       f        lambda      b   c
 4f 5/2 5.276'+0 1.721'-1    -1807x      11  28
 5f 5/2 3.301'+1 1.504'+0     1424x      81   2

             t       E         n*          cut
 5d 5/2     0.221 541140.0x   4.307       2.350
to            A       f        lambda      b   c
 4f 5/2 2.536'-1 1.228'-2    -1798x       1  28
 4f 7/2 5.071'+0 1.843'-1    -1798x      11  28
 5f 5/2 2.339'+0 7.164'-2     1429x       6   2
 5f 7/2 3.509'+1 1.433'+0     1429x      87   2

             t       F         n*          cut
 4f 5/2    0.0712 485510.0x   3.945       9.075
to            A       f        lambda      b   c
 5g 7/2 1.086'+2 1.283'+0    768.7x      96   0

             t       E         n*          cut
 4f 7/2    0.0720 485510.0x   3.945       9.075
to            A       f        lambda      b   c
 5g 7/2 4.024'+0 3.565'-2    768.7x       4   0
 5g 9/2 1.131'+2 1.252'+0    768.7x     100   0

             t       E         n*          cut
 5f 5/2     0.245 611106.0x   4.945       7.875
to            A       f        lambda      b   c
 5g 7/2 8.608'-3 8.520'-2    22252x       0  12

             t       E         n*          cut
 5f 7/2     0.249 611106.0x   4.945       7.875
to            A       f        lambda      b   c
 5g 7/2 3.188'-4 2.367'-3    22252x       0  12
 5g 9/2 8.874'-3 8.234'-2    22252x       0  12

             t       E         n*          cut
 5g 7/2    0.0887 615600.0x   4.996      10.550

             t       E         n*          cut
 5g 9/2    0.0884 615600.0x   4.996       5.500


2 Kr VIII (2 Cu I  sequence)
Ionisation Potential    1 016 000.00

                     E         n*          cut
 4s 1/2              0        2.629       0.025
to            A       f        lambda      b   c
 4p 1/2 3.551'+1 2.578'-1    695.9      100   0
 4p 3/2 4.349'+1 5.537'-1    651.6      100   0
 5p 1/2 3.127'+1 1.569'-2    182.9       29  80
 5p 3/2 2.374'+1 2.350'-2    181.7       23  82
 6p 1/2 2.364'+1 6.834'-3    138.9x      28  81
 6p 3/2 1.919'+1 1.104'-2    138.5x      24  83

             t       E         n*          cut
 5s 1/2    0.0377 491170.0    3.658       0.025
to            A       f        lambda      b   c
 4p 1/2 8.655'+1 1.075'-1    -287.8      33  48
 4p 3/2 1.787'+2 1.175'-1    -296.1      67  46
 5p 1/2 7.527'+0 3.662'-1     1801        7   0
 5p 3/2 9.145'+0 7.811'-1     1688        9   0
 6p 1/2 7.175'+0 2.052'-2    436.7x       9  83
 6p 3/2 5.492'+0 3.090'-2    433.2x       7  85

             t       E         n*          cut
 6s 1/2    0.0508 692920.0x   4.662       0.025
to            A       f        lambda      b   c
 4p 1/2 3.672'+1 1.825'-2    -182.1x     19  71
 4p 3/2 7.533'+1 1.941'-2    -185.4x     38  71
 5p 1/2 2.787'+1 1.954'-1    -683.8x     14  46
 5p 3/2 5.692'+1 2.101'-1    -701.8x     29  44
 6p 1/2 2.305'+0 4.658'-1     3671x       3   0
 6p 3/2 2.800'+0 9.914'-1     3436x       4   0

             t       E         n*          cut
 4p 1/2     0.282 143697.0    2.837       1.675
to            A       f        lambda      b   c
 4d 3/2 1.800'+2 1.017'+0    434.1       85   0
 5d 3/2 1.920'-1 2.327'-4    201.0        0  98

             t       E         n*          cut
 4p 3/2     0.230 153475.0    2.854       1.700
to            A       f        lambda      b   c
 4d 3/2 3.238'+1 9.977'-2    453.3       15   0
 4d 5/2 1.976'+2 9.025'-1    450.7      100   0
 5d 3/2 6.809'-3 4.293'-6    205.1        0  99
 5d 5/2 4.754'-3 4.487'-6    204.9        0 100

             t       E         n*          cut
 5p 1/2    0.0933 546680.0    3.868       1.625
to            A       f        lambda      b   c
 4d 3/2 6.840'+1 1.721'-1    -579.3      64  32
 5d 3/2 4.082'+1 1.373'+0     1059       69   1
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```
                t         E        n*          cut
  5p 3/2    0.0986 550420.0     3.884      1.625
to              A         f     lambda     b    c
  4d 3/2 6.884'+0 3.318'-2    -567.0      7   34
  4d 5/2 6.165'+1 2.011'-1    -571.2     61   33
  5d 3/2 7.425'+0 1.353'-1      1103     13    1
  5d 5/2 4.518'+1 1.222'+0      1097     81    1

                t         E        n*          cut
  6p 1/2     0.119 720160.0x   4.872      1.575
to              A         f     lambda     b    c
  4d 3/2 2.486'+1 1.556'-2   -288.9x    30   76
  5d 3/2 2.605'+1 3.125'-1    -1265x    31   28

                t         E        n*          cut
  6p 3/2     0.127 722020.0x   4.888      1.600
to              A         f     lambda     b    c
  4d 3/2 2.534'+0 3.138'-3   -287.4x     3   76
  4d 5/2 2.264'+1 1.883'-2   -288.5x    29   76
  5d 3/2 2.651'+0 6.071'-2    -1236x     3   29
  5d 5/2 2.372'+1 3.666'-1    -1243x    30   29

                t         E        n*          cut
  4d 3/2    0.0471 374060.0     3.308      2.625
to              A         f     lambda     b    c
  4f 5/2 1.813'+2 1.144'+0     529.8     93    0
  5f 5/2 1.414'-1 2.583'-4     284.9      0   98

                t         E        n*          cut
  4d 5/2    0.0506 375350.0     3.311      2.625
to              A         f     lambda     b    c
  4f 5/2 1.274'+1 5.434'-2     533.4      7    0
  4f 7/2 1.907'+2 1.086'+0     533.8    100    0
  5f 5/2 5.127'-3 6.287'-6     286.0      0   99
  5f 7/2 7.691'-2 1.257'-4     286.0      0   99

                t         E        n*          cut
  5d 3/2     0.170 641110.0     4.328      2.450
to              A         f     lambda     b    c
  4f 5/2 1.035'+1 1.687'-1     -1277     18   30
  5f 5/2 4.659'+1 1.489'+0      1192     93    1

                t         E        n*          cut
  5d 5/2     0.180 641600.0     4.331      2.450
to              A         f     lambda     b    c
  4f 5/2 4.978'-1 1.202'-2     -1269      1   30
  4f 7/2 9.977'+0 1.802'-1     -1267     18   30
  5f 5/2 3.285'+0 7.081'-2      1199      7    1
  5f 7/2 4.928'+1 1.416'+0      1199    100    1

                t         E        n*          cut
  4f 5/2    0.0515 562810.0     3.937      9.250
to              A         f     lambda     b    c
  5g 7/2 1.874'+2 1.275'+0     583.4     96    0

                t         E        n*          cut
  4f 7/2    0.0524 562690.0     3.936      9.250
to              A         f     lambda     b    c
  5g 7/2 6.944'+0 3.538'-2     583.0      4    0
  5g 9/2 1.961'+2 1.249'+0     583.0    100    0

                t         E        n*          cut
  5f 5/2     0.200 725000.0     4.913      8.200
to              A         f     lambda     b    c
  5g 7/2 5.860'-2 1.376'-1     10840      0   10

                t         E        n*          cut
  5f 7/2     0.203 725000.0     4.913      8.200
to              A         f     lambda     b    c
  5g 7/2 2.170'-3 3.824'-3     10840      0   10
  5g 9/2 5.995'-2 1.320'-1     10840      0   11

                t         E        n*          cut
  5g 7/2    0.0514 734225.0     4.992     11.575

                t         E        n*          cut
  5g 9/2    0.0510 734225.0     4.992      6.125



2 Rb IX (2 Cu I  sequence)
Ionisation Potential   1 217 000.00

                          E        n*          cut
  4s 1/2                  0     2.703      0.025
to              A         f     lambda     b    c
  4p 1/2 4.214'+1 2.497'-1     628.6    100    0
  4p 3/2 5.302'+1 5.411'-1     583.4    100    0
  5p 1/2 5.990'+1 2.203'-2    156.6x    34   77
  5p 3/2 4.665'+1 3.380'-2    155.4x    28   79
  6p 1/2 4.032'+1 8.345'-3    117.5x    29   80
  6p 3/2 3.296'+1 1.356'-2    117.2x    26   82

                t         E        n*          cut
  5s 1/2    0.0260 576495.0     3.725      0.025
to              A         f     lambda     b    c
  4p 1/2 1.251'+2 1.076'-1    -239.6     33   49
  4p 3/2 2.591'+2 1.184'-1    -246.9     67   47
  5p 1/2 8.883'+0 3.466'-1     1613x      5    0
  5p 3/2 1.114'+1 7.477'-1     1496x      7    0
  6p 1/2 1.225'+1 2.435'-2    364.1x     9   81
  6p 3/2 9.405'+0 3.673'-2    360.9x     7   84
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```
                t         F        n*          cut
  6s 1/2    0.0352 820520.0x   4.735      0.025
to              A         f     lambda     b    c
  4p 1/2 5.292'+1 1.814'-2   -151.2x    19   72
  4p 3/2 1.091'+2 1.941'-2   -154.1x    38   72
  5p 1/2 3.991'+1 1.806'-1   -549.3x    14   49
  5p 3/2 8.216'+1 1.962'-1   -564.4x    29   46
  6p 1/2 2.758'+0 4.407'-1     3265x     2    0
  6p 3/2 3.457'+0 9.483'-1     3025x     3    0

                t         F        n*          cut
  4p 1/2     0.237 159075.6     2.899      1.700
to              A         f     lambda     b    c
  4d 3/2 2.206'+2 9.852'-1    386.0x    85    0
  5d 3/2 5.024'-1 4.322'-4    169.4x     1   98

                t         E        n*          cut
  4p 3/2     0.189 171409.3     2.916      1.675
to              A         f     lambda     b    c
  4d 3/2 3.899'+1 9.600'-2    405.3x    15    0
  4d 5/2 2.387'+2 8.701'-1    402.6x   100    0
  5d 3/2 4.516'-1 2.026'-4    173.0x     1   95
  5d 5/2 2.198'+0 1.476'-3    172.8x     3   95

                t         E        n*          cut
  5p 1/2    0.0567 638480.0x   3.920      1.600
to              A         f     lambda     b    c
  4d 3/2 1.077'+2 1.663'-1   -453.9x    61   34
  5d 3/2 5.579'+1 1.358'+0    901.1x    65    1

                t         E        n*          cut
  5p 3/2    0.0605 643340.0x   3.936      1.575
to              A         f     lambda     b    c
  4d 3/2 1.077'+1 3.185'-2   -444.1x     7   36
  4d 5/2 9.674'+1 1.935'-1   -447.3x    59   36
  5d 3/2 1.002'+1 1.334'-1    942.3x    12    0
  5d 5/2 6.104'+1 1.205'+0    936.9x    74    0

                t         E        n*          cut
  6p 1/2    0.0729 851150.0x   4.929      1.550
to              A         f     lambda     b    c
  4d 3/2 4.028'+1 1.611'-2   -231.0x    29   76
  5d 3/2 4.165'+1 3.019'-1   -983.4x    30   30

                t         E        n*          cut
  6p 3/2    0.0779 853580.0x   4.946      1.525
to              A         f     lambda     b    c
  4d 3/2 4.070'+0 3.219'-3   -229.7x     3   76
  4d 5/2 3.651'+1 1.939'-2   -230.5x    28   76
  5d 3/2 4.213'+0 5.826'-2   -960.4x     3   32
  5d 5/2 3.775'+1 3.521'-1   -966.1x    29   31

                t         E        n*          cut
  4d 3/2    0.0385 418160.0x   3.336      2.750
to              A         f     lambda     b    c
  4f 5/2 2.462'+2 1.111'+0    448.0x    93    0
  5f 5/2 2.199'-2 2.636'-5    230.9x     0   99

                t         E        n*          cut
  4d 5/2    0.0419 419800.0x   3.339      2.775
to              A         f     lambda     b    c
  4f 5/2 1.728'+1 5.278'-2    451.3x     7    0
  4f 7/2 2.593'+2 1.056'+0    451.3x   100    0
  5f 5/2 5.473'-6 4.407'-9    231.8x     0  100
  5f 7/2 8.209'-5 8.814'-8    231.8x     0  100

                t         E        n*          cut
  5d 3/2     0.117 749460.0x   4.360      2.575
to              A         f     lambda     b    c
  4f 5/2 1.891'+1 1.618'-1   -925.2x    22   33
  5f 5/2 6.850'+1 1.486'+0    982.1x    93    1

                t         E        n*          cut
  5d 5/2     0.122 750070.0x   4.363      2.575
to              A         f     lambda     b    c
  4f 5/2 9.072'-1 1.151'-2   -920.0x     1   33
  4f 7/2 1.814'+1 1.727'-1   -920.0x    22   33
  5f 5/2 4.828'+0 7.065'-2    988.0x     7    1
  5f 7/2 7.242'+1 1.413'+0    988.0x   100    1

                t         E        n*          cut
  4f 5/2    0.0380 641380.0x   3.930      9.375
to              A         f     lambda     b    c
  5g 7/2 3.059'+2 1.268'+0    455.3x    96    0

                t         E        n*          cut
  4f 7/2    0.0386 641380.0x   3.930      9.375
to              A         f     lambda     b    c
  5g 7/2 1.133'+1 3.521'-2    455.3x     4    0
  5g 9/2 3.181'+2 1.236'+0    455.3x   100    0

                t         E        n*          cut
  5f 5/2     0.136 851286.0x   4.930      8.050
to              A         f     lambda     b    c
  5g 7/2 5.353'-2 1.134'-1    10294x     0   11

                t         E        n*          cut
  5f 7/2     0.138 851286.0x   4.930      8.050
to              A         f     lambda     b    c
  5g 7/2 1.982'-3 3.150'-3    10294x     0   11
  5g 9/2 5.522'-2 1.097'-1    10294x     0   11
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                t         F        n*          cut
  5g 7/2    0.0315 861000.0x   4.997     10.375

                t         F        n*          cut
  5g 9/2    0.0314 861000.0x   4.997      5.400



2 Sr X (2 Cu I  sequence)
Ionisation Potential   1 433 000.00

                          E        n*          cut
  4s 1/2                  0     2.767      0.025
to              A         f     lambda     b    c
  4p 1/2 4.910'+1 2.419'-1     573.3    100    0
  4p 3/2 6.358'+1 5.297'-1     527.1    100    0
  5p 1/2 9.232'+1 2.540'-2    135.5x    35   75
  5p 3/2 7.196'+1 3.895'-2    134.4x    29   78
  6p 1/2 6.134'+1 9.361'-3    100.9x    30   79
  6p 3/2 5.013'+1 1.521'-2    100.6x    26   81

                t         E        n*          cut
  5s 1/2    0.0189 668301.0     3.788      0.025
to              A         f     lambda     b    c
  4p 1/2 1.720'+2 1.057'-1    -202.5     32   50
  4p 3/2 3.582'+2 1.172'-1    -208.9     68   48
  5p 1/2 1.099'+1 3.376'-1     1431x      4    0
  5p 3/2 1.415'+1 7.349'-1     1316x      6    0
  6p 1/2 1.931'+1 2.777'-2    309.7x     9   80
  6p 3/2 1.482'+1 4.183'-2    306.8x     8   83

                t         E        n*          cut
  6s 1/2    0.0251 956150.0x   4.797      0.025
to              A         f     lambda     b    c
  4p 1/2 7.386'+1 1.812'-2   -127.9x    19   73
  4p 3/2 1.530'+2 1.953'-2   -130.5x    38   72
  5p 1/2 5.615'+1 1.772'-1   -458.8x    14   50
  5p 3/2 1.161'+2 1.939'-1   -472.0x    29   47
  6p 1/2 3.514'+0 4.298'-1     2856x     2    0
  6p 3/2 4.513'+0 9.326'-1     2625x     2    0

                t         E        n*          cut
  4p 1/2     0.204 174437.0     2.953      1.575
to              A         f     lambda     b    c
  4d 3/2 2.755'+2 9.677'-1    342.3x    85    0
  5d 3/2 5.366'+0 3.398'-3    145.3x     5   93

                t         E        n*          cut
  4p 3/2     0.157 189702.6     2.971      1.475
to              A         f     lambda     b    c
  4d 3/2 4.801'+1 9.388'-2    361.1x    15    0
  4d 5/2 2.950'+2 8.520'-1    358.4x   100    0
  5d 3/2 2.184'+0 7.232'-4    148.6x     2   90
  5d 5/2 1.160'+1 5.745'-3    148.4x    10   91

                t         E        n*          cut
  5p 1/2    0.0381 738170.0x   3.974      1.400
to              A         f     lambda     b    c
  4d 3/2 1.591'+2 1.618'-1   -368.2x    61   36
  5d 3/2 6.823'+1 1.322'+0    803.9x    58    0

                t         E        n*          cut
  5p 3/2    0.0410 744290.0x   3.992      1.175
to              A         f     lambda     b    c
  4d 3/2 1.582'+1 3.077'-2   -360.1x     6   38
  4d 5/2 1.422'+2 1.873'-1   -362.9x    58   38
  5d 3/2 1.204'+1 1.290'-1    845.5x    10    0
  5d 5/2 7.369'+1 1.168'+0    839.6x    63    0

                t         E        n*          cut
  6p 1/2    0.0481 991160.0x   4.984      1.300
to              A         f     lambda     b    c
  4d 3/2 6.062'+1 1.651'-2   -190.6x    29   76
  5d 3/2 6.315'+1 2.862'-1   -777.6x    30   33

                t         E        n*          cut
  6p 3/2    0.0517 994240.0x   5.001      0.050
to              A         f     lambda     b    c
  4d 3/2 6.085'+0 3.277'-3   -189.5x     3   76
  4d 5/2 5.464'+1 1.978'-2   -190.3x    28   76
  5d 3/2 6.339'+0 5.481'-2   -759.4x     3   35
  5d 5/2 5.689'+1 3.321'-1   -764.3x    29   34

                t         E        n*          cut
  4d 3/2    0.0309 466610.0x   3.370      2.900
to              A         f     lambda     b    c
  4f 5/2 3.116'+2 1.074'+0    391.5x    93    0
  5f 5/2 2.445'+0 2.076'-3    194.3x     2   95

                t         F        n*          cut
  4d 5/2    0.0339 468750.0x   3.374      2.925
to              A         f     lambda     b    c
  4f 5/2 2.181'+1 5.095'-2    394.8x     7    0
  4f 7/2 3.271'+2 1.019'+0    394.8x   100    0
  5f 5/2 2.177'-1 1.242'-4    195.1x     0   94
  5f 7/2 3.266'+0 2.485'-3    195.1x     3   94

                t         E        n*          cut
  5d 3/2    0.0843 862560.0x   4.386      2.675
to              A         f     lambda     b    c
  4f 5/2 3.077'+1 1.558'-1   -711.7x    26   35
  5f 5/2 9.191'+1 1.466'+0    842.0x    91    1
```

```
             t        E         n*        cut
  5d 5/2   0.0860 863400.0x  4.389      2.700
to           A        f       lambda     b   c
  4f 5/2 1.476'+0 1.107'-2  -707.5x     1  36
  4f 7/2 2.951'+1 1.661'-1  -707.5x    25  36
  5f 5/2 6.461'+0 6.967'-2   848.0x     6   1
  5f 7/2 9.692'+1 1.393'+0   848.0x    97   1

             t        E         n*        cut
  4f 5/2   0.0300 722060.0x  3.929      9.400
to           A        f       lambda     b   c
  5g 7/2 4.667'+2 1.267'+0   368.5x    96   0

             t        E         n*        cut
  4f 7/2   0.0306 722060.0x  3.929      9.400
to           A        f       lambda     b   c
  5g 7/2 1.729'+1 3.520'-2   368.5x     4   0
  5g 9/2 4.857'+2 1.236'+0   368.5x   100   0

             t        E         n*        cut
  5f 5/2   0.0990 981318.0x  4.929      8.075
to           A        f       lambda     b   c
  5g 7/2 8.343'-2 1.142'-1     8277x    0  11

             t        E         n*        cut
  5f 7/2   0.0998 981318.0x  4.929      8.075
to           A        f       lambda     b   c
  5g 7/2 3.090'-3 3.174'-3     8277x    0  11
  5g 9/2 8.599'-2 1.104'-1     8277x    0  11

             t        E         n*        cut
  5g 7/2   0.0207 993400.0x  4.996     10.575

             t        E         n*        cut
  5g 9/2   0.0206 993400.0x  4.996      5.525
```

2 Y XI (2 Cu I sequence)
Ionisation Potential   1 661 500.00

```
                      E         n*        cut
  4s 1/2              0      2.827      0.025
to           A        f       lambda     b   c
  4p 1/2 5.664'+1 2.357'-1   526.8    100   0
  4p 3/2 7.572'+1 5.226'-1   479.8    100   0
  5p 1/2 1.230'+2 2.585'-2   118.4     34  76
  5p 3/2 9.433'+1 3.894'-2   117.3     28  79
  6p 1/2 8.294'+1 9.585'-3   87.80x    28  80
  6p 3/2 6.688'+1 1.535'-2   87.50x    25  82

             t        E         n*        cut
  5s 1/2   0.0142 765540.0   3.850      0.025
to           A        f       lambda     b   c
  4p 1/2 2.269'+2 1.026'-1  -173.7     32  52
  4p 3/2 4.764'+2 1.151'-1  -179.5     68  49
  5p 1/2 1.413'+1 3.374'-1    1262      4   0
  5p 3/2 1.858'+1 7.399'-1    1152      6   0
  6p 1/2 2.751'+1 2.957'-2   267.8x     9  80
  6p 3/2 2.089'+1 4.402'-2   265.1x     8  83

             t        E         n*        cut
  6s 1/2   0.0184  1098500x  4.856      0.025
to           A        f       lambda     b   c
  4p 1/2 9.954'+1 1.807'-2  -110.0x    18  73
  4p 3/2 2.077'+2 1.965'-2  -112.4x    38  73
  5p 1/2 7.734'+1 1.801'-1  -394.1x    14  50
  5p 3/2 1.603'+2 1.983'-1  -406.2x    29  47
  6p 1/2 4.715'+0 4.314'-1    2470x     2   0
  6p 3/2 6.166'+0 9.417'-1    2257x     2   0

             t        E         n*        cut
  4p 1/2    0.177 189809.0   3.004      0.075
to           A        f       lambda     b   c
  4d 3/2 3.234'+2 9.406'-1   311.4x    85   0
  5d 3/2 1.399'+1 6.696'-3   126.3      9  91

             t        E         n*        cut
  4p 3/2    0.132 208433.0   3.023      0.125
to           A        f       lambda     b   c
  4d 3/2 5.543'+1 9.084'-2   330.6x    15   0
  4d 5/2 3.424'+2 8.260'-1   327.5x   100   0
  5d 3/2 4.918'+0 1.234'-3   129.4      3  88
  5d 5/2 2.599'+1 9.752'-3   129.2     16  89

             t        E         n*        cut
  5p 1/2   0.0276 844780.0   4.032      0.150
to           A        f       lambda     b   c
  4d 3/2 2.247'+2 1.511'-1  -299.5x    62  39
  5d 3/2 8.012'+1 1.287'+0   732.1     50   0

             t        E         n*        cut
  5p 3/2   0.0299 852310.0   4.051      0.200
to           A        f       lambda     b   c
  4d 3/2 2.213'+1 2.846'-2  -292.9x     7  41
  4d 5/2 1.993'+2 1.738'-1  -295.4x    60  41
  5d 3/2 1.387'+1 1.249'-1   774.8      9   0
  5d 5/2 8.559'+1 1.133'+0   767.2     53   0
```

```
             t        E         n*        cut
  6p 1/2   0.0341  1138980x  5.041      0.175
to           A        f       lambda     b   c
  4d 3/2 8.732'+1 1.659'-2  -159.2x    30  76
  5d 3/2 9.038'+1 2.728'-1  -634.5x    31  35

             t        E         n*        cut
  6p 3/2   0.0370  1142810x  5.060      0.200
to           A        f       lambda     b   c
  4d 3/2 8.672'+0 3.256'-3  -158.2x     3  76
  4d 5/2 7.802'+1 1.971'-2  -159.0x    29  76
  5d 3/2 9.006'+0 5.181'-2  -619.5x     3  37
  5d 5/2 8.085'+1 3.151'-1  -624.4x    30  37

             t        E         n*        cut
  4d 3/2   0.0264 510890.0x  3.397      3.025
to           A        f       lambda     b   c
  4f 5/2 3.741'+2 1.025'+0   349.0x    93   0
  5f 5/2 3.284'+1 2.075'-2   167.6x    24  84

             t        E         n*        cut
  4d 5/2   0.0292 513750.0x  3.401      3.050
to           A        f       lambda     b   c
  4f 5/2 2.605'+1 4.854'-2   352.5x     7   0
  4f 7/2 3.908'+2 9.709'-1   352.5x   100   0
  5f 5/2 2.541'+0 1.081'-3   168.4x     2  83
  5f 7/2 3.811'+1 2.161'-2   168.4x    27  83

             t        E         n*        cut
  5d 3/2   0.0618 981380.0   4.419      2.825
to           A        f       lambda     b   c
  4f 5/2 4.881'+1 1.441'-1  -543.5x    30  39
  5f 5/2 9.714'+1 1.374'+0   793.2x    70   0

             t        E         n*        cut
  5d 5/2   0.0623 982660.0   4.423      2.825
to           A        f       lambda     b   c
  4f 5/2 2.335'+0 1.020'-2  -539.8x     1  39
  4f 7/2 4.670'+1 1.530'-1  -539.8x    29  39
  5f 5/2 6.763'+0 6.511'-2   801.3x     5   0
  5f 7/2 1.014'+2 1.302'+0   801.3x    73   0

             t        E         n*        cut
  4f 5/2   0.0250 797400.0x  3.920      9.550
to           A        f       lambda     b   c
  5g 7/2 6.864'+2 1.258'+0   302.8x    96   0

             t        E         n*        cut
  4f 7/2   0.0256 797400.0x  3.920      9.550
to           A        f       lambda     b   c
  5g 7/2 2.542'+1 3.495'-2   302.8x     4   0
  5g 9/2 7.229'+2 1.242'+0   302.8x   100   0

             t        E         n*        cut
  5f 5/2   0.0718  1107450x  4.895      8.300
to           A        f       lambda     b   c
  5g 7/2 3.283'-1 1.608'-1     4950x    0  10

             t        E         n*        cut
  5f 7/2   0.0717  1107450x  4.895      8.300
to           A        f       lambda     b   c
  5g 7/2 1.216'-2 4.467'-3     4950x    0  10
  5g 9/2 3.323'-1 1.526'-1     4950x    0  11

             t        E         n*        cut
  5g 7/2   0.0140  1127650x  4.987     12.400

             t        E         n*        cut
  5g 9/2   0.0138  1127650x  4.987      6.650
```

2 Zr XII (2 Cu I sequence)
Ionisation Potential   1 909 100.00

```
                      E         n*        cut
  4s 1/2              0      2.877      0.025
to           A        f       lambda     b   c
  4p 1/2 6.443'+1 2.294'-1   487.3    100   0
  4p 3/2 8.883'+1 5.141'-1   439.3    100   0
  5p 1/2 1.858'+2 3.054'-2   104.7     36  74
  5p 3/2 1.434'+2 4.626'-2   103.7     31  77
  6p 1/2 1.199'+2 1.069'-2   77.10x    29  79
  6p 3/2 9.717'+1 1.720'-2   76.83x    26  81

             t        E         n*        cut
  5s 1/2   0.0107 868150.0   3.896      0.025
to           A        f       lambda     b   c
  4p 1/2 3.001'+2 1.024'-1  -150.8     32  52
  4p 3/2 6.328'+2 1.156'-1  -156.1     68  50
  5p 1/2 1.640'+1 3.259'-1    1151      3   0
  5p 3/2 2.220'+1 7.219'-1    1041      5   0
  6p 1/2 3.998'+1 3.259'-2   233.2x    10  79
  6p 3/2 3.046'+1 4.861'-2   230.7x     8  82
```

```
             t        E         n*        cut
  6s 1/2   0.0138  1252200x  4.905      0.025
to           A        f       lambda     b   c
  4p 1/2 1.320'+2 1.806'-2  -95.51x    18  74
  4p 3/2 2.767'+2 1.976'-2  -97.60x    38  73
  5p 1/2 1.021'+2 1.733'-1  -336.5x    14  51
  5p 3/2 2.128'+2 1.923'-1  -347.2x    29  49
  6p 1/2 5.590'+0 4.176'-1    2232x     1   0
  6p 3/2 7.477'+0 9.187'-1    2024x     2   0

             t        E         n*        cut
  4p 1/2    0.155 205202.0   3.045      0.175
to           A        f       lambda     b   c
  4d 3/2 3.884'+2 9.246'-1   281.8x    86   0
  5d 3/2 3.711'+1 1.372'-2   111.0     16  87

             t        E         n*        cut
  4p 3/2    0.113 227627.0   3.066      0.225
to           A        f       lambda     b   c
  4d 3/2 6.545'+1 8.877'-2   300.8x    14   0
  4d 5/2 4.057'+2 8.083'-1   297.6x   100   0
  5d 3/2 1.142'+1 2.219'-3   113.9      5  84
  5d 5/2 6.217'+1 1.806'-2   113.6     27  85

             t        E         n*        cut
  5p 1/2   0.0196 955000.0   4.070      0.225
to           A        f       lambda     b   c
  4d 3/2 3.082'+2 1.481'-1  -253.2x    60  40
  5d 3/2 9.505'+1 1.251'+0   662.4     41   0

             t        E         n*        cut
  5p 3/2   0.0214 964170.0   4.089      0.275
to           A        f       lambda     b   c
  4d 3/2 3.020'+1 2.773'-2  -247.5x     6  42
  4d 5/2 2.722'+2 1.696'-1  -249.6x    58  42
  5d 3/2 1.616'+1 1.205'-1   705.2      7   0
  5d 5/2 1.001'+2 1.095'+0   697.5     43   0

             t        E         n*        cut
  6p 1/2   0.0243  1297000x  5.081      0.250
to           A        f       lambda     b   c
  4d 3/2 1.207'+2 1.666'-2  -135.7x    29  76
  5d 3/2 1.255'+2 2.578'-1  -523.5x    30  38

             t        E         n*        cut
  6p 3/2   0.0264  1301600x  5.100      0.275
to           A        f       lambda     b   c
  4d 3/2 1.192'+1 3.249'-3  -134.9x     3  76
  4d 5/2 1.073'+2 1.970'-2  -135.5x    28  76
  5d 3/2 1.241'+1 4.862'-2  -511.2x     3  40
  5d 5/2 1.117'+2 2.964'-1  -515.3x    30  39

             t        E         n*        cut
  4d 3/2   0.0220 560100.0x  3.423      3.125
to           A        f       lambda     b   c
  4f 5/2 4.357'+2 9.751'-1   315.5x    94   0
  5f 5/2 7.477'+1 3.542'-2   145.1     35  79

             t        E         n*        cut
  4d 5/2   0.0246 563600.0x  3.427      3.150
to           A        f       lambda     b   c
  4f 5/2 3.023'+1 4.612'-2   319.0x     6   0
  4f 7/2 4.535'+2 9.224'-1   319.0x   100   0
  5f 5/2 5.692'+0 1.816'-3   145.9      3  78
  5f 7/2 8.538'+1 3.632'-2   145.9     40  78

             t        E         n*        cut
  5d 3/2   0.0433  1105970   4.436      2.875
to           A        f       lambda     b   c
  4f 5/2 7.137'+1 1.362'-1  -436.9x    31  41
  5f 5/2 1.221'+2 1.340'+0   698.7x    58   0

             t        E         n*        cut
  5d 5/2   0.0428  1107540   4.440      2.900
to           A        f       lambda     b   c
  4f 5/2 3.410'+0 9.626'-3  -434.0x     1  41
  4f 7/2 6.819'+1 1.444'-1  -434.0x    29  41
  5f 5/2 8.483'+0 6.346'-2   706.4x     4   0
  5f 7/2 1.272'+2 1.269'+0   706.4x    60   0

             t        E         n*        cut
  4f 5/2   0.0215 877100.0x  3.913      9.650
to           A        f       lambda     b   c
  5g 7/2 9.971'+2 1.252'+0   250.6x    96   0

             t        E         n*        cut
  4f 7/2   0.0221 877100.0x  3.913      9.650
to           A        f       lambda     b   c
  5g 7/2 3.693'+1 3.478'-2   250.6x     4   0
  5g 9/2 1.038'+3 1.221'+0   250.6x   100   0

             t        E         n*        cut
  5f 5/2   0.0474  1249100x  4.893      8.325
to           A        f       lambda     b   c
  5g 7/2 6.710'-1 1.840'-1     3704x    0  10

             t        E         n*        cut
  5f 7/2   0.0470  1249100x  4.893      8.325
to           A        f       lambda     b   c
  5g 7/2 2.485'-2 5.111'-3     3704x    0  10
  5g 9/2 6.917'-1 1.778'-1     3704x    0  10
```

	t	E	n*	cut	
5g 7/2	0.00966	1276100x	4.996	10.550	

	t	E	n*	cut	
5g 9/2	0.00963	1276100x	4.996	5.500	

2 Nb XIII (2 Cu I sequence)
Ionisation Potential 2 167 000.00

		E	n*	cut	
4s 1/2		0	2.925	0.025	
to	A	f	lambda	b	c
4p 1/2	7.285'+1	2.244'-1	453.3	100	0
4p 3/2	1.037'+2	5.084'-1	404.3	100	0
5p 1/2	2.437'+2	3.182'-2	93.32	36	74
5p 3/2	1.854'+2	4.742'-2	92.36	30	77
6p 1/2	1.757'+2	1.239'-2	68.58	31	78
6p 3/2	1.425'+2	1.995'-2	68.31	27	80

	t	E	n*	cut	
5s 1/2	0.00843	976200.0	3.946	0.025	
to	A	f	lambda	b	c
4p 1/2	3.799'+2	9.975'-2	-132.3	32	53
4p 3/2	8.059'+2	1.137'-1	-137.2	68	51
5p 1/2	1.949'+1	3.210'-1	1048	3	0
5p 3/2	2.719'+1	7.182'-1	938.6	4	0
6p 1/2	6.315'+1	4.077'-2	207.5	11	77
6p 3/2	4.856'+1	6.124'-2	205.1	9	80

	t	E	n*	cut	
6s 1/2	0.0107	1411900x	4.956	0.025	
to	A	f	lambda	b	c
4p 1/2	1.681'+2	1.776'-2	-83.94x	18	74
4p 3/2	3.546'+2	1.960'-2	-85.87x	38	73
5p 1/2	1.318'+2	1.707'-1	-293.9x	14	52
5p 3/2	2.763'+2	1.911'-1	-303.8x	30	49
6p 1/2	5.455'+0	3.829'-1	2164x	1	0
6p 3/2	7.724'+0	8.592'-1	1926x	1	0

	t	E	n*	cut	
4p 1/2	0.137	220617.0	3.087	0.275	
to	A	f	lambda	b	c
4d 3/2	4.587'+2	9.115'-1	257.4x	86	0
5d 3/2	6.043'+1	1.754'-2	98.40	20	86

	t	E	n*	cut	
4p 3/2	0.0964	247340.0	3.108	0.300	
to	A	f	lambda	b	c
4d 3/2	7.592'+1	8.697'-2	276.4x	14	0
4d 5/2	4.726'+2	7.931'-1	273.2x	100	0
5d 3/2	1.815'+1	2.778'-3	101.1	6	82
5d 5/2	9.991'+1	2.286'-2	100.9	32	83

	t	E	n*	cut	
5p 1/2	0.0149	1071620	4.115	0.300	
to	A	f	lambda	b	c
4d 3/2	4.072'+2	1.427'-1	-216.2x	61	42
5d 3/2	1.116'+2	1.225'+0	605.0	36	0

	t	E	n*	cut	
5p 3/2	0.0164	1082740	4.136	0.350	
to	A	f	lambda	b	c
4d 3/2	3.959'+1	2.646'-2	-211.1x	6	44
4d 5/2	3.574'+2	1.622'-1	-213.1x	59	44
5d 3/2	1.859'+1	1.172'-1	648.7	6	0
5d 5/2	1.153'+2	1.067'+0	641.3	37	0

	t	E	n*	cut	
6p 1/2	0.0174	1458119	5.115	0.300	
to	A	f	lambda	b	c
4d 3/2	1.623'+2	1.688'-2	-117.8x	28	76
5d 3/2	1.683'+2	2.579'-1	-452.0	29	38

	t	E	n*	cut	
6p 3/2	0.0191	1463817	5.136	0.350	
to	A	f	lambda	b	c
4d 3/2	1.597'+1	3.278'-3	-117.0x	3	76
4d 5/2	1.439'+2	1.989'-2	-117.6x	27	76
5d 3/2	1.661'+1	4.836'-2	-440.7	3	40
5d 5/2	1.495'+2	2.948'-1	-444.2	28	40

	t	E	n*	cut	
4d 3/2	0.0187	609100.0x	3.450	3.250	
to	A	f	lambda	b	c
4f 5/2	4.944'+2	9.288'-1	289.0x	94	0
5f 5/2	1.223'+2	4.437'-2	127.0	42	77

	t	E	n*	cut	
4d 5/2	0.0212	613400.0x	3.455	3.275	
to	A	f	lambda	b	c
4f 5/2	3.415'+1	4.385'-2	292.7x	6	0
4f 7/2	5.123'+2	8.770'-1	292.7x	100	0
5f 5/2	9.282'+0	2.270'-3	127.7	3	76
5f 7/2	1.392'+2	4.541'-2	127.7	47	76

	t	E	n*	cut	
5d 3/2	0.0324	1236900	4.465	3.000	
to	A	f	lambda	b	c
4f 5/2	9.993'+1	1.258'-1	-354.9x	32	44
5f 5/2	1.481'+2	1.311'+0	627.4x	51	0

	t	F	n*	cut	
5d 5/2	0.0317	1238680	4.470	3.025	
to	A	f	lambda	b	c
4f 5/2	4.762'+0	8.878'-3	-352.6x	2	44
4f 7/2	9.524'+1	1.332'-1	-352.6x	30	44
5f 5/2	1.028'+1	6.204'-2	634.4x	4	0
5f 7/2	1.542'+2	1.241'+0	634.4x	53	0

	t	E	n*	cut	
4f 5/2	0.0189	955100.0x	3.912	9.675	
to	A	f	lambda	b	c
5g 7/2	1.377'+3	1.251'+0	213.2x	96	0

	t	E	n*	cut	
4f 7/2	0.0195	955100.0x	3.912	9.675	
to	A	f	lambda	b	c
5g 7/2	5.099'+1	3.476'-2	213.2x	4	0
5g 9/2	1.433'+3	1.221'+0	213.2x	100	0

	t	E	n*	cut	
5f 5/2	0.0345	1396300x	4.905	8.250	
to	A	f	lambda	b	c
5g 7/2	6.164'-1	1.594'-1	3597x	0	10

	t	E	n*	cut	
5f 7/2	0.0341	1396300x	4.905	8.250	
to	A	f	lambda	b	c
5g 7/2	2.283'-2	4.429'-3	3597x	0	10
5g 9/2	6.354'-1	1.541'-1	3597x	0	11

	t	E	n*	cut	
5g 7/2	0.00700	1424100x	4.996	10.550	

	t	E	n*	cut	
5g 9/2	0.00698	1424100x	4.996	5.500	

2 Mo XIV (2 Cu I sequence)
Ionisation Potential 2 440 600.00

		E	n*	cut	
4s 1/2		0	2.969	0.025	
to	A	f	lambda	b	c
4p 1/2	8.149'+1	2.192'-1	423.6	100	0
4p 3/2	1.200'+2	5.024'-1	373.6	100	0
5p 1/2	3.306'+2	3.489'-2	83.89	38	73
5p 3/2	2.508'+2	5.176'-2	82.97	32	77
6p 1/2	2.104'+2	1.182'-2	61.21	29	79
6p 3/2	1.694'+2	1.888'-2	60.97	26	81
7p 1/2	1.265'+2	5.389'-3	53.30	30	82
7p 3/2	1.021'+2	8.658'-3	53.19	28	84

	t	E	n*	cut	
5s 1/2	0.00672	1089691	3.990	0.025	
to	A	f	lambda	b	c
4p 1/2	4.749'+2	9.772'-2	-117.2	32	54
4p 3/2	1.014'+3	1.125'-1	-121.6	68	51
5p 1/2	2.165'+1	3.099'-1	977.1	2	0
5p 3/2	3.126'+1	7.018'-1	865.3	4	0
6p 1/2	7.645'+1	3.874'-2	183.8	11	78
6p 3/2	5.827'+1	5.768'-2	181.7	9	81
7p 1/2	5.509'+1	1.335'-2	127.1	13	84
7p 3/2	4.356'+1	2.091'-2	126.5	12	86

	t	E	n*	cut	
6s 1/2	0.00844	1579705	4.998	0.025	
to	A	f	lambda	b	c
4p 1/2	2.129'+2	1.768'-2	-74.43	18	75
4p 3/2	4.515'+2	1.966'-2	-76.22	38	74
5p 1/2	1.674'+2	1.670'-1	-258.0	14	53
5p 3/2	3.525'+2	1.885'-1	-267.1	30	50
6p 1/2	7.723'+0	3.984'-1	1855	1	0
6p 3/2	1.081'+1	8.902'-1	1657	2	0
7p 1/2	2.197'+1	3.747'-2	337.3	5	82
7p 3/2	1.606'+1	5.339'-2	333.0	4	85

	t	E	n*	cut	
7s 1/2	0.0120	1843580	6.002	0.025	
to	A	f	lambda	b	c
4p 1/2	1.163'+2	6.748'-3	-62.21	14	80
4p 3/2	2.465'+2	7.440'-3	-63.45	29	80
5p 1/2	8.496'+1	3.000'-2	-153.5	10	76
5p 3/2	1.771'+2	3.258'-2	-156.7	21	76
6p 1/2	6.845'+1	2.328'-1	-476.3	8	52
6p 3/2	1.431'+2	2.589'-1	-491.3	17	50
7p 1/2	3.516'+0	4.963'-1	3068	1	0
7p 3/2	4.902'+0	1.105'+0	2742	1	0

	t	E	n*	cut	
8s 1/2	0.0170	2002340	7.006	0.025	
to	A	f	lambda	b	c
4p 1/2	7.069'+1	3.397'-3	-56.62	12	83
4p 3/2	1.499'+2	3.735'-3	-57.65	26	82
5p 1/2	4.993'+1	1.140'-2	-123.4	8	82
5p 3/2	1.039'+2	1.226'-2	-125.5	18	82
6p 1/2	3.687'+1	4.066'-2	-271.2	6	78
6p 3/2	7.621'+1	4.353'-2	-276.0	13	77
7p 1/2	3.248'+1	3.059'-1	-792.6	6	51
7p 3/2	6.767'+1	3.392'-1	-817.7	12	49

	t	E	n*	cut	
4p 1/2	0.123	236085.0	3.124	0.350	
to	A	f	lambda	b	c
4d 3/2	5.003'+2	8.758'-1	241.6	86	0
5d 3/2	1.020'+2	2.368'-2	88.00	24	84

	t	E	n*	cut	
4p 3/2	0.0833	267632.0	3.146	0.375	
to	A	f	lambda	b	c
4d 3/2	8.076'+1	8.282'-2	261.5	14	0
4d 5/2	5.058'+2	7.571'-1	258.0	100	0
5d 3/2	2.960'+1	3.635'-3	90.52	7	80
5d 5/2	1.619'+2	2.970'-2	90.32	38	81

	t	E	n*	cut	
5p 1/2	0.0114	1192036	4.150	0.375	
to	A	f	lambda	b	c
4d 3/2	5.254'+2	1.340'-1	-184.5	60	44
5d 3/2	1.300'+2	1.198'+0	554.4	31	0

	t	E	n*	cut	
5p 3/2	0.0127	1205254	4.173	0.425	
to	A	f	lambda	b	c
4d 3/2	5.061'+1	2.461'-2	-180.1	6	47
4d 5/2	4.578'+2	1.513'-1	-181.8	58	46
5d 3/2	2.123'+1	1.139'-1	598.2	5	0
5d 5/2	1.328'+2	1.039'+0	589.7	31	0

	t	E	n*	cut	
6p 1/2	0.0138	1633615	5.163	0.400	
to	A	f	lambda	b	c
4d 3/2	2.093'+2	1.622'-2	-101.7	29	77
5d 3/2	2.185'+2	2.400'-1	-382.8	30	41

	t	E	n*	cut	
6p 3/2	0.0152	1640046	5.183	0.425	
to	A	f	lambda	b	c
4d 3/2	2.033'+1	3.109'-3	-101.0	3	77
4d 5/2	1.838'+2	1.894'-2	-101.5	28	77
5d 3/2	2.136'+1	4.472'-2	-373.6	3	43
5d 5/2	1.926'+2	2.736'-1	-377.1	29	43

	t	E	n*	cut	
7p 1/2	0.0241	1876170	6.173	0.400	
to	A	f	lambda	b	c
4d 3/2	1.099'+2	5.478'-3	-81.55	26	83
5d 3/2	9.860'+1	2.912'-2	-198.5	24	77

	t	E	n*	cut	
7p 3/2	0.0270	1880050	6.194	0.450	
to	A	f	lambda	b	c
4d 3/2	1.062'+1	1.052'-3	-81.30	3	83
4d 5/2	9.614'+1	6.405'-3	-81.65	26	83
5d 3/2	9.732'+0	5.662'-3	-197.0	3	78
5d 5/2	8.756'+1	3.429'-2	-197.9	24	78

	t	E	n*	cut	
4d 3/2	0.0172	649976.0	3.466	3.300	
to	A	f	lambda	b	c
4f 5/2	5.885'+2	8.981'-1	260.5	94	0
5f 5/2	2.506'+2	7.106'-2	112.3	58	71
6f 5/2	2.833'+2	4.668'-2	85.60	82	69

	t	E	n*	cut	
4d 5/2	0.0198	655242.0	3.471	3.325	
to	A	f	lambda	b	c
4f 5/2	4.048'+1	4.234'-2	264.1	6	0
4f 7/2	6.079'+2	8.472'-1	264.0	100	0
5f 5/2	1.882'+1	3.600'-3	113.0	4	70
5f 7/2	2.810'+2	7.167'-2	113.0	64	70
6f 5/2	2.085'+1	2.311'-3	85.98	6	68
6f 7/2	3.119'+2	4.609'-2	85.98	88	68

	t	E	n*	cut	
5d 3/2	0.0240	1372413	4.487	3.100	
to	A	f	lambda	b	c
4f 5/2	1.346'+2	1.173'-1	-295.4	32	46
5f 5/2	1.536'+2	1.223'+0	595.1	35	0
6f 5/2	2.716'+1	3.073'-2	224.3	8	85

	t	E	n*	cut	
5d 5/2	0.0233	1374830	4.492	3.100	
to	A	f	lambda	b	c
4f 5/2	6.396'+0	8.247'-3	-293.3	1	47
4f 7/2	1.279'+2	1.238'-1	-293.4	30	47
5f 5/2	1.055'+1	5.766'-2	603.8	2	0
5f 7/2	1.586'+2	1.154'+0	603.3	36	0
6f 5/2	2.127'+0	1.622'-3	225.5	1	85
6f 7/2	3.169'+1	3.220'-2	225.5	9	85

	t	E	n*	cut	
4f 5/2	0.0159	1033850	3.910	9.700	
to	A	f	lambda	b	c
5g 7/2	1.848'+3	1.250'+0	183.9	96	0
6g 7/2	7.380'+2	2.264'-1	123.9	62	42
7g 7/2	3.825'+2	8.190'-2	103.5	49	56

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              t         E         n*          cut
  4f 7/2   0.0165   1033968    3.910       9.700
to            A         f        lambda      b   c
  5g 7/2 6.843'+1 3.472'-2    184.0       4   0
  5g 9/2 1.934'+3 1.226'+0    184.0     100   0
  6g 7/2 2.732'+1 6.288'-3    123.9       2  42
  6g 9/2 7.649'+2 2.201'-1    123.9      64  42
  7g 7/2 1.416'+1 2.274'-3    103.5       2  56
  7g 9/2 3.964'+2 7.958'-2    103.5      51  56

              t         E         n*          cut
  5f 5/2   0.0231   1540440    4.888       8.325
to            A         f        lambda      b   c
  5g 7/2 1.276'+0 1.852'-1     2695       0  10
  6g 7/2 4.051'+2 8.963'-1    332.7      34  23
  7g 7/2 2.450'+2 2.318'-1    217.6      32  53

              t         E         n*          cut
  5f 7/2   0.0227   1540574    4.889       8.325
to            A         f        lambda      b   c
  5g 7/2 4.672'-2 5.125'-3     2705       0  10
  5g 9/2 1.290'+0 1.768'-1     2705       0  10
  6g 7/2 1.501'+1 2.493'-2    332.9       1  23
  6g 9/2 4.202'+2 8.725'-1    332.9      35  23
  7g 7/2 9.071'+0 6.440'-3    217.6       1  53
  7g 9/2 2.540'+2 2.254'-1    217.6      33  53

              t         E         n*          cut
  6f 5/2   0.0289   1818244    5.879       7.850
to            A         f        lambda      b   c
  5g 7/2 1.220'+1 2.368'-2   -415.5       4  80
  6g 7/2 9.040'-1 3.488'-1     4393       0   3
  7g 7/2 1.204'+2 7.276'-1    549.9      16  40

              t         E         n*          cut
  6f 7/2   0.0281   1818317    5.879       7.850
to            A         f        lambda      b   c
  5g 7/2 3.381'-1 8.744'-4   -415.3       0  80
  5g 9/2 1.226'+1 2.537'-2   -415.3       3  80
  6g 7/2 3.315'-2 9.656'-3     4407       0   3
  6g 9/2 9.283'-1 3.379'-1     4407       0   3
  7g 7/2 4.462'+0 2.024'-2    550.1       1  40
  7g 9/2 1.249'+2 7.085'-1    550.1      16  40

              t         E         n*          cut
  5g 7/2  0.00521   1577546    4.992      11.650

              t         E         n*          cut
  5g 9/2  0.00517   1577546    4.992       6.175

              t         E         n*          cut
  6g 7/2  0.00843   1841006    5.989       5.875

              t         E         n*          cut
  6g 9/2  0.00843   1841006    5.989       5.875

              t         E         n*          cut
  7g 7/2   0.0129   2000101    6.988       5.750

              t         E         n*          cut
  7g 9/2   0.0129   2000101    6.988       5.750


2 Tc XV (2 Cu I  sequence)
Ionisation Potential   2 736 100.00

                        E         n*          cut
  4s 1/2                0        3.004       0.025
to            A         f        lambda      b   c
  4p 1/2 8.966'+1 2.127'-1    397.8x    100   0
  4p 3/2 1.369'+2 4.937'-1    346.7x    100   0
  5p 1/2 4.686'+2 4.040'-2    75.83x     40  71
  5p 3/2 3.566'+2 6.004'-2    74.93x     34  75

              t         E         n*          cut
  5s 1/2  0.00529  1208300x    4.020       0.025
to            A         f        lambda      b   c
  4p 1/2 6.020'+2 9.857'-2   -104.5x     32  55
  4p 3/2 1.289'+3 1.142'-1   -108.7x     68  52
  5p 1/2 2.437'+1 2.997'-1    905.8x      2   0
  5p 3/2 3.652'+1 6.875'-1    792.4x      3   0

              t         E         n*          cut
  4p 1/2    0.112 251400.0x    3.152       0.400
to            A         f        lambda      b   c
  4d 3/2 6.098'+2 8.748'-1    218.7x     86   0
  5d 3/2 1.852'+2 3.481'-2    79.18x     32  81

              t         E         n*          cut
  4p 3/2   0.0730 288400.0x    3.176       0.425
to            A         f        lambda      b   c
  4d 3/2 9.699'+1 8.235'-2    238.0x     14   0
  4d 5/2 6.093'+2 7.536'-1    234.5x    100   0
  5d 3/2 5.121'+1 5.109'-3    81.57x      9  77
  5d 5/2 2.826'+2 4.208'-2    81.37x     46  78

              t         E         n*          cut
  5p 1/2  0.00854  1318700x    4.174       0.425
to            A         f        lambda      b   c
  4d 3/2 6.784'+2 1.366'-1   -163.9x     58  44
  5d 3/2 1.481'+2 1.161'+0    511.2x     25   0
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              t         E         n*          cut
  5p 3/2  0.00954  1334500x    4.197       0.450
to            A         f        lambda      b   c
  4d 3/2 6.520'+1 2.495'-2   -159.8x      6  47
  4d 5/2 5.899'+2 1.535'-1   -161.4x     56  46
  5d 3/2 2.360'+1 1.094'-1    556.2x      4   0
  5d 5/2 1.487'+2 1.001'+0    547.0x     24   0

              t         E         n*          cut
  4d 3/2   0.0141 708600.0x    3.490       3.400
to            A         f        lambda      b   c
  4f 5/2 6.024'+2 8.325'-1    247.9x     94   0
  5f 5/2 4.345'+2 9.929'-2    100.8x     66  66

              t         E         n*          cut
  4d 5/2   0.0164 714800.0x    3.495       3.425
to            A         f        lambda      b   c
  4f 5/2 4.122'+1 3.917'-2    251.8x      6   0
  4f 7/2 6.182'+2 7.833'-1    251.8x    100   0
  5f 5/2 3.240'+1 4.998'-3    101.4x      5  65
  5f 7/2 4.860'+2 9.997'-2    101.4x     72  65

              t         E         n*          cut
  5d 3/2   0.0171  1514300x    4.495       3.125
to            A         f        lambda      b   c
  4f 5/2 1.781'+2 1.100'-1   -248.6x     30  48
  5f 5/2 1.838'+2 1.191'+0    536.8x     28   0

              t         E         n*          cut
  5d 5/2   0.0164  1517300x    4.501       3.150
to            A         f        lambda      b   c
  4f 5/2 8.448'+0 7.710'-3   -246.7x      1  48
  4f 7/2 1.690'+2 1.157'-1   -246.7x     28  48
  5f 5/2 1.256'+1 5.607'-2    545.6x      2   0
  5f 7/2 1.885'+2 1.121'+0    545.6x     28   0

              t         E         n*          cut
  4f 5/2   0.0155  1112000x    3.899       9.850
to            A         f        lambda      b   c
  5g 7/2 2.500'+3 1.239'+0    157.5x     96   0

              t         E         n*          cut
  4f 7/2   0.0162  1112000x    3.899       9.850
to            A         f        lambda      b   c
  5g 7/2 9.260'+1 3.443'-2    157.5x      4   0
  5g 9/2 2.602'+3 1.209'+0    157.5x    100   0

              t         E         n*          cut
  5f 5/2   0.0151  1700600x    4.883       8.350
to            A         f        lambda      b   c
  5g 7/2 2.199'+0 2.042'-1     2155x      0   9

              t         E         n*          cut
  5f 7/2   0.0148  1700600x    4.883       8.350
to            A         f        lambda      b   c
  5g 7/2 8.146'-2 5.673'-3     2155x      0   9
  5g 9/2 2.267'+0 1.973'-1     2155x      0  10

              t         E         n*          cut
  5g 7/2  0.00385  1747000x    4.996      10.575

              t         E         n*          cut
  5g 9/2  0.00384  1747000x    4.996       5.525


2 Ru XVI (2 Cu I  sequence)
Ionisation Potential   3 039 800.00

                        E         n*          cut
  4s 1/2                0        3.040       0.025
to            A         f        lambda      b   c
  4p 1/2 9.871'+1 2.078'-1    374.7x    100   0
  4p 3/2 1.565'+2 4.886'-1    322.7x    100   0
  5p 1/2 5.954'+2 4.237'-2    68.90x     41  71
  5p 3/2 4.481'+2 6.218'-2    68.03x     34  75

              t         E         n*          cut
  5s 1/2  0.00433  1332700x    4.057       0.025
to            A         f        lambda      b   c
  4p 1/2 7.323'+2 9.665'-2   -93.83x     32  55
  4p 3/2 1.579'+3 1.131'-1   -97.77x     68  52
  5p 1/2 2.758'+1 2.935'-1    842.5x      2   0
  5p 3/2 4.285'+1 6.815'-1    728.3x      3   0

              t         E         n*          cut
  4p 1/2    0.101 266900.0x    3.183       0.450
to            A         f        lambda      b   c
  4d 3/2 6.920'+2 8.582'-1    203.4x     87   0
  5d 3/2 2.655'+2 4.090'-2    71.68x     35  79

              t         E         n*          cut
  4p 3/2   0.0639 309900.0x    3.208       0.500
to            A         f        lambda      b   c
  4d 3/2 1.078'+2 8.024'-2    222.9x     13   0
  4d 5/2 6.810'+2 7.359'-1    219.2x    100   0
  5d 3/2 7.273'+1 5.966'-3    73.96x     10  75
  5d 5/2 4.016'+2 4.914'-2    73.77x     51  76
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              t         E         n*          cut
  5p 1/2  0.00681  1451400x    4.205       0.475
to            A         f        lambda      b   c
  4d 3/2 8.460'+2 1.321'-1   -144.3x     58  45
  5d 3/2 1.676'+2 1.134'+0    475.1x     22   0

              t         E         n*          cut
  5p 3/2  0.00768  1470000x    4.230       0.525
to            A         f        lambda      b   c
  4d 3/2 8.068'+1 2.390'-2   -140.6x      6  48
  4d 5/2 7.312'+2 1.475'-1   -142.1x     56  47
  5d 3/2 2.605'+1 1.060'-1    521.1x      3   0
  5d 5/2 1.652'+2 9.721'-1    511.5x     21   0

              t         E         n*          cut
  4d 3/2   0.0125 758600.0x    3.509       3.475
to            A         f        lambda      b   c
  4f 5/2 6.583'+2 7.922'-1    231.3x     94   0
  5f 5/2 6.425'+2 1.186'-1    90.59x     71  63

              t         E         n*          cut
  4d 5/2   0.0147 766100.0x    3.515       3.500
to            A         f        lambda      b   c
  4f 5/2 4.475'+1 3.718'-2    235.4x      6   0
  4f 7/2 6.713'+2 7.436'-1    235.4x    100   0
  5f 5/2 4.785'+1 5.967'-3    91.21x      5  62
  5f 7/2 7.177'+2 1.193'-1    91.21x     77  62

              t         E         n*          cut
  5d 3/2   0.0132  1661900x    4.515       3.200
to            A         f        lambda      b   c
  4f 5/2 2.265'+2 1.021'-1   -212.3x     30  50
  5f 5/2 2.051'+2 1.146'+0    498.5x     23   0

              t         E         n*          cut
  5d 5/2   0.0126  1665500x    4.521       3.225
to            A         f        lambda      b   c
  4f 5/2 1.072'+1 7.134'-3   -210.7x      1  51
  4f 7/2 2.144'+2 1.070'-1   -210.7x     27  51
  5f 5/2 1.394'+1 5.386'-2    507.6x      2   0
  5f 7/2 2.091'+2 1.077'+0    507.6x     23   0

              t         E         n*          cut
  4f 5/2   0.0142  1190900x    3.898       9.850
to            A         f        lambda      b   c
  5g 7/2 3.246'+3 1.238'+0    138.1x     96   0

              t         E         n*          cut
  4f 7/2   0.0149  1190900x    3.898       9.850
to            A         f        lambda      b   c
  5g 7/2 1.202'+2 3.438'-2    138.1x      4   0
  5g 9/2 3.373'+3 1.205'+0    138.1x    100   0

              t         E         n*          cut
  5f 5/2   0.0110  1862500x    4.885       8.350
to            A         f        lambda      b   c
  5g 7/2 2.802'+0 2.032'-1     1905x      0  10

              t         E         n*          cut
  5f 7/2   0.0108  1862500x    4.885       8.350
to            A         f        lambda      b   c
  5g 7/2 1.038'-1 5.646'-3     1905x      0  10
  5g 9/2 2.895'+0 1.968'-1     1905x      0  10

              t         E         n*          cut
  5g 7/2  0.00297  1915000x    4.998      10.025

              t         E         n*          cut
  5g 9/2  0.00296  1915000x    4.998       5.200


2 Rh XVII (2 Cu I  sequence)
Ionisation Potential   3 358 400.00

                        E         n*          cut
  4s 1/2                0        3.073       0.025
to            A         f        lambda      b   c
  4p 1/2 1.079'+2 2.029'-1    354.1x    100   0
  4p 3/2 1.778'+2 4.836'-1    301.2x    100   0
  5p 1/2 7.462'+2 4.426'-2    62.90x     41  71
  5p 3/2 5.553'+2 6.412'-2    62.05x     35  75

              t         E         n*          cut
  5s 1/2  0.00358  1462600x    4.090       0.025
to            A         f        lambda      b   c
  4p 1/2 8.813'+2 9.486'-2   -84.73x     32  56
  4p 3/2 1.912'+3 1.121'-1   -88.45x     68  53
  5p 1/2 3.104'+1 2.876'-1    786.2x      2   0
  5p 3/2 5.000'+1 6.763'-1    671.6x      3   0

              t         E         n*          cut
  4p 1/2   0.0926 282400.0x    3.211       0.500
to            A         f        lambda      b   c
  4d 3/2 7.584'+2 8.342'-1    191.5x     87   0
  5d 3/2 3.706'+2 4.731'-2    65.24x     38  78
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```
                t          E         n*          cut
 4p 3/2   0.0563 332000.0x  3.237      0.550
to              A          f         lambda    b   c
 4d 3/2 1.151'+2 7.732'-2   211.6x  13   0
 4d 5/2 7.321'+2 7.108'-1   207.8x 100   0
 5d 3/2 1.007'+2 6.866'-3   67.43x  10  74
 5d 5/2 5.542'+2 5.633'-2   67.23x  55  75

                t          E         n*          cut
 5p 1/2  0.00551   1589800x  4.235      0.525
to              A          f         lambda    b   c
 4d 3/2 1.037'+3 1.261'-1  -127.3x  57  47
 5d 3/2 1.873'+2 1.107'+0   443.9x  19   0

                t          E         n*          cut
 5p 3/2  0.00628   1611500x  4.261      0.575
to              A          f         lambda    b   c
 4d 3/2 9.798'+1 2.256'-2  -123.9x   6  50
 4d 5/2 8.898'+2 1.396'-1  -125.3x  56  49
 5d 3/2 2.836'+1 1.026'-1   491.2x   3   0
 5d 5/2 1.814'+2 9.429'-1   480.8x  18   0

                t          E         n*          cut
 4d 3/2   0.0114 804500.0x  3.524      3.550
to              A          f         lambda    b   c
 4f 5/2 7.344'+2 7.618'-1   214.8x  94   0
 5f 5/2 8.983'+2 1.345'-1   81.60x  74  61

                t          E         n*          cut
 4d 5/2   0.0137 813300.0x  3.530      3.575
to              A          f         lambda    b   c
 4f 5/2 4.968'+1 3.569'-2   218.9x   6   1
 4f 7/2 7.451'+2 7.138'-1   218.9x 100   1
 5f 5/2 6.682'+1 6.767'-3   82.19x   6  60
 5f 7/2 1.002'+3 1.353'-1   82.19x  81  60

                t          E         n*          cut
 5d 3/2   0.0103   1815100x  4.533      3.275
to              A          f         lambda    b   c
 4f 5/2 2.827'+2 9.514'-2  -183.5x  29  52
 5f 5/2 2.265'+2 1.103'+0   465.3x  19   0

                t          E         n*          cut
 5d 5/2  0.00985   1819500x  4.540      3.275
to              A          f         lambda    b   c
 4f 5/2 1.333'+1 6.621'-3  -182.0x   1  53
 4f 7/2 2.666'+2 9.932'-2  -182.0x  26  53
 5f 5/2 1.527'+1 5.168'-2   475.1x   1   0
 5f 7/2 2.291'+2 1.034'+0   475.1x  19   0

                t          E         n*          cut
 4f 5/2   0.0128   1270100x  3.897      9.875
to              A          f         lambda    b   c
 5g 7/2 4.141'+3 1.237'+0   122.3x  96   0

                t          E         n*          cut
 4f 7/2   0.0134   1270100x  3.897      9.875
to              A          f         lambda    b   c
 5g 7/2 1.534'+2 3.437'-2   122.3x   4   0
 5g 9/2 4.309'+3 1.207'+0   122.3x 100   0

                t          E         n*          cut
 5f 5/2  0.00829   2030000x  4.886      8.350
to              A          f         lambda    b   c
 5g 7/2 3.336'+0 1.983'-1     1724x   0  10

                t          E         n*          cut
 5f 7/2  0.00812   2030000x  4.886      8.350
to              A          f         lambda    b   c
 5g 7/2 1.236'-1 5.507'-3     1724x   0  10
 5g 9/2 3.439'+0 1.916'-1     1724x   0  10

                t          E         n*          cut
 5g 7/2  0.00233   2088000x  4.996     10.550

                t          E         n*          cut
 5g 9/2  0.00232   2088000x  4.996      5.500
```

2 Pd XVIII (2 Cu I sequence)
Ionisation Potential   3 692 600.00

```
                           E         n*          cut
 4s 1/2                    0         3.103      0.025
to              A          f         lambda    b   c
 4p 1/2 1.174'+2 1.982'-1   335.6x 100   0
 4p 3/2 2.013'+2 4.790'-1   281.7x 100   0
 5p 1/2 9.490'+2 4.743'-2   57.74   42  70
 5p 3/2 7.071'+2 6.872'-2   56.93   36  74

                t          F         n*          cut
 5s 1/2  0.00298   1597700x  4.120      0.025
to              A          f         lambda    b   c
 4p 1/2 1.054'+3 9.357'-2  -76.94   31  57
 4p 3/2 2.302'+3 1.117'-1  -80.47   69  53
 5p 1/2 3.345'+1 2.783'-1   745.0x   1   0
 5p 3/2 5.570'+1 6.620'-1   629.6x   3   0
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```
                t          E         n*          cut
 4p 1/2   0.0852 298000.0x  3.236      0.550
to              A          f         lambda    b   c
 4d 3/2 8.244'+2 8.101'-1   181.0x  87   0
 5d 3/2 5.099'+2 5.444'-2   59.67   41  77

                t          E         n*          cut
 4p 3/2   0.0497 355000.0x  3.264      0.600
to              A          f         lambda    b   c
 4d 3/2 1.217'+2 7.437'-2   201.9x  13   0
 4d 5/2 7.763'+2 6.840'-1   197.9x 100   0
 5d 3/2 1.376'+2 7.870'-3   61.77   11  72
 5d 5/2 7.606'+2 6.486'-2   61.58   58  73

                t          F         n*          cut
 5p 1/2  0.00446   1731930   4.258      0.575
to              A          f         lambda    b   c
 4d 3/2 1.260'+3 1.216'-1  -113.4x  56  48
 5d 3/2 2.118'+2 1.085'+0   413.3x  17   0

                t          E         n*          cut
 5p 3/2  0.00512   1756540   4.285      0.625
to              A          f         lambda    b   c
 4d 3/2 1.182'+2 2.158'-2  -110.4x   6  51
 4d 5/2 1.073'+3 1.335'-1  -111.6x  55  50
 5d 3/2 3.149'+1 9.991'-2   460.1x   3   0
 5d 5/2 2.023'+2 9.203'-1   449.7x  16   0

                t          E         n*          cut
 4d 3/2   0.0106 850400.0x  3.537      3.600
to              A          f         lambda    b   c
 4f 5/2 7.896'+2 7.247'-1   202.0x  94   1
 5f 5/2 1.182'+3 1.446'-1   73.76   77  60

                t          E         n*          cut
 4d 5/2   0.0129 860200.0x  3.543      3.600
to              A          f         lambda    b   c
 4f 5/2 5.318'+1 3.387'-2   206.1x   6   1
 4f 7/2 7.978'+2 6.774'-1   206.1x 100   1
 5f 5/2 8.768'+1 7.256'-3   74.30    6  59
 5f 7/2 1.315'+3 1.451'-1   74.30   83  59

                t          E         n*          cut
 5d 3/2  0.00809   1973900x  4.548      3.325
to              A          f         lambda    b   c
 4f 5/2 3.457'+2 8.748'-2  -159.1x  28  54
 5f 5/2 2.578'+2 1.075'+0   430.7x  17   0

                t          E         n*          cut
 5d 5/2  0.00767   1978900x  4.555      3.350
to              A          f         lambda    b   c
 4f 5/2 1.626'+1 6.075'-3  -157.9x   1  55
 4f 7/2 3.252'+2 9.112'-2  -157.9x  25  55
 5f 5/2 1.733'+1 5.033'-2   440.1x   1   0
 5f 7/2 2.599'+2 1.007'+0   440.1x  17   0

                t          E         n*          cut
 4f 5/2   0.0119   1345400   3.892      9.925
to              A          f         lambda    b   c
 5g 7/2 5.249'+3 1.233'+0   108.4x  96   0

                t          E         n*          cut
 4f 7/2   0.0125   1345400   3.892      9.925
to              A          f         lambda    b   c
 5g 7/2 1.944'+2 3.424'-2   108.4x   4   0
 5g 9/2 5.466'+3 1.203'+0   108.4x 100   0

                t          E         n*          cut
 5f 5/2  0.00647   2206100x  4.891      8.325
to              A          f         lambda    b   c
 5g 7/2 3.597'+0 1.877'-1     1616x   0  10

                t          E         n*          cut
 5f 7/2  0.00635   2206100x  4.891      8.325
to              A          f         lambda    b   c
 5g 7/2 1.332'-1 5.213'-3     1616x   0  10
 5g 9/2 3.704'+0 1.812'-1     1616x   0  10

                t          E         n*          cut
 5g 7/2  0.00184   2268000x  4.996     10.750

                t          E         n*          cut
 5g 9/2  0.00183   2268000x  4.996      5.625
```

2 Ag XIX (2 Cu I sequence)
Ionisation Potential   4 041 100.00

```
                           E         n*          cut
 4s 1/2                    0         3.131      0.025
to              A          f         lambda    b   c
 4p 1/2 1.272'+2 1.938'-1   318.8x 100   0
 4p 3/2 2.275'+2 4.752'-1   263.9x 100   0
 5p 1/2 1.161'+3 4.916'-2   53.15   43  70
 5p 3/2 8.561'+2 7.038'-2   52.36   37  74
```

```
                t          E         n*          cut
 5s 1/2  0.00251   1738900x  4.148      0.025
to              A          f         lambda    b   c
 4p 1/2 1.245'+3 9.190'-2  -70.17   31  57
 4p 3/2 2.737'+3 1.109'-1  -73.53   69  54
 5p 1/2 3.705'+1 2.728'-1   700.7x   1   0
 5p 3/2 6.405'+1 6.571'-1   584.9x   3   0

                t          E         n*          cut
 4p 1/2   0.0786 313700.0x  3.260      0.600
to              A          f         lambda    b   c
 4d 3/2 8.770'+2 7.823'-1   172.5x  87   0
 5d 3/2 6.865'+2 6.186'-2   54.82   44  75

                t          E         n*          cut
 4p 3/2   0.0440 378900.0x  3.289      0.650
to              A          f         lambda    b   c
 4d 3/2 1.255'+2 7.103'-2   194.3x  13   0
 4d 5/2 8.058'+2 6.554'-1   190.2x 100   0
 5d 3/2 1.841'+2 8.923'-3   56.85   12  71
 5d 5/2 9.926'+2 7.153'-2   56.61   61  72

                t          E         n*          cut
 5p 1/2  0.00371   1881610   4.283      0.600
to              A          f         lambda    b   c
 4d 3/2 1.500'+3 1.152'-1  -101.2x  56  50
 5d 3/2 2.309'+2 1.055'+0   390.3x  15   0

                t          E         n*          cut
 5p 3/2  0.00430   1909860   4.311      0.675
to              A          f         lambda    b   c
 4d 3/2 1.392'+2 2.020'-2  -98.39x   6  53
 4d 5/2 1.268'+3 1.255'-1  -99.49x  54  52
 5d 3/2 3.335'+1 9.624'-2   438.7x   2   0
 5d 5/2 2.210'+2 8.958'-1   424.6x  14   0

                t          E         n*          cut
 4d 3/2  0.00998 893500.0x  3.548      3.625
to              A          f         lambda    b   c
 4f 5/2 8.776'+2 7.000'-1   188.3x  94   1
 5f 5/2 1.685'+3 1.718'-1   67.33   81  56

                t          E         n*          cut
 4d 5/2   0.0124 904700.0x  3.554      3.650
to              A          f         lambda    b   c
 4f 5/2 5.894'+1 3.270'-2   192.4x   6   1
 4f 7/2 8.840'+2 6.540'-1   192.4x 100   1
 5f 5/2 1.248'+2 8.608'-3   67.84    6  55
 5f 7/2 1.871'+3 1.722'-1   67.84   88  55

                t          E         n*          cut
 5d 3/2  0.00644   2137800x  4.562      3.375
to              A          f         lambda    b   c
 4f 5/2 4.177'+2 8.206'-2  -140.2x  27  55
 5f 5/2 2.602'+2 1.008'+0   415.1x  12   0

                t          E         n*          cut
 5d 5/2  0.00616   2145400x  4.571      3.400
to              A          f         lambda    b   c
 4f 5/2 1.950'+1 5.624'-3  -138.7x   1  56
 4f 7/2 3.899'+2 8.437'-2  -138.7x  24  56
 5f 5/2 1.697'+1 4.674'-2   428.6x   1   0
 5f 7/2 2.545'+2 9.348'-1   428.6x  12   0

                t          E         n*          cut
 4f 5/2   0.0107   1424500x  3.891      9.950
to              A          f         lambda    b   c
 5g 7/2 6.534'+3 1.232'+0   97.13x  96   0

                t          E         n*          cut
 4f 7/2   0.0113   1424500x  3.891      9.950
to              A          f         lambda    b   c
 5g 7/2 2.420'+2 3.423'-2   97.13x   4   0
 5g 9/2 6.801'+3 1.203'+0   97.13x 100   0

                t          E         n*          cut
 5f 5/2  0.00479   2378700x  4.882      8.350
to              A          f         lambda    b   c
 5g 7/2 5.864'+0 2.067'-1     1328x   0   9

                t          E         n*          cut
 5f 7/2  0.00470   2378700x  4.882      8.350
to              A          f         lambda    b   c
 5g 7/2 2.172'-1 5.743'-3     1328x   0   9
 5g 9/2 6.041'+0 1.997'-1     1328x   0  10

                t          E         n*          cut
 5g 7/2  0.00147   2454000x  4.996     10.650

                t          F         n*          cut
 5g 9/2  0.00147   2454000x  4.996      5.575
```

2 Cd XX (2 Cu I sequence)
Ionisation Potential   4 412 600.00

```
                           E         n*          cut
 4s 1/2                    0         3.154      0.025
to              A          f         lambda    b   c
 4p 1/2 1.367'+2 1.888'-1   303.5x 100   0
 4p 3/2 2.548'+2 4.696'-1   247.9x 100   0
 5p 1/2 1.491'+3 5.392'-2   49.12   45  68
 5p 3/2 1.099'+3 7.700'-2   48.35   38  72
```

```
             t          E          n*          cut
 5s 1/2  0.00209   1885500x   4.168        0.025
to           A          f         lambda      b    c
 4p 1/2 1.490'+3 9.226'-2   -64.27      31   57
 4p 3/2 3.288'+3 1.122'-1   -67.47      69   54
 5p 1/2 3.975'+1 2.638'-1    665.4x      1    0
 5p 3/2 7.190'+1 6.456'-1    547.2x      3    0

             t          E          n*          cut
 4p 1/2    0.0731 329500.0x   3.279        0.625
to           A          f         lambda      b    c
 4d 3/2 9.718'+2 7.664'-1    162.2x     88    0
 5d 3/2 9.389'+2 7.175'-2    50.48      47   74

             t          E          n*          cut
 4p 3/2    0.0392 403400.0x   3.309        0.675
to           A          f         lambda      b    c
 4d 3/2 1.355'+2 6.900'-2    184.3x     12    0
 4d 5/2 8.749'+2 6.379'-1    180.1x    100    0
 5d 3/2 2.489'+2 1.026'-2    52.44      13   69
 5d 5/2 1.395'+3 8.577'-2    52.28      66   70

             t          E          n*          cut
 5p 1/2  0.00299   2035790    4.297        0.650
to           A          f         lambda      b    c
 4d 3/2 1.809'+3 1.142'-1   -91.77x     54   50
 5d 3/2 2.599'+2 1.034'+0    364.3x     13    0

             t          E          n*          cut
 5p 3/2  0.00350   2068250    4.327        0.700
to           A          f         lambda      b    c
 4d 3/2 1.668'+2 1.986'-2   -89.11x      6   53
 4d 5/2 1.522'+3 1.236'-1   -90.13x     53   53
 5d 3/2 3.653'+1 9.349'-2    413.1x      2    0
 5d 5/2 2.356'+2 8.624'-1    403.5x     11    0

             t          E          n*          cut
 4d 3/2  0.00903 946100.0x   3.558        3.675
to           A          f         lambda      b    c
 4f 5/2 9.530'+2 6.733'-1    177.2x     94    1
 5f 5/2 2.313'+3 1.984'-1    61.76      83   54

             t          E          n*          cut
 4d 5/2    0.0114 958800.0x   3.565        3.700
to           A          f         lambda      b    c
 4f 5/2 6.370'+1 3.140'-2    181.3x      6    1
 4f 7/2 9.555'+2 6.280'-1    181.3x    100    1
 5f 5/2 1.708'+2 9.920'-3    62.25       6   53
 5f 7/2 2.561'+3 1.984'-1    62.25      90   53

             t          E          n*          cut
 5d 3/2  0.00503   2310300x   4.569        3.400
to           A          f         lambda      b    c
 4f 5/2 5.038'+2 7.868'-2   -125.0x     25   56
 5f 5/2 2.791'+2 9.654'-1    392.2x     10    0

             t          E          n*          cut
 5d 5/2  0.00470   2316100x   4.576        3.425
to           A          f         lambda      b    c
 4f 5/2 2.364'+1 5.458'-3   -124.1x      1   57
 4f 7/2 4.728'+2 8.187'-2   -124.1x     22   57
 5f 5/2 1.867'+1 4.507'-2    401.3x      1    0
 5f 7/2 2.801'+2 9.015'-1    401.3x     10    0

             t          E          n*          cut
 4f 5/2  0.00984   1510300x   3.889        9.975
to           A          f         lambda      b    c
 5g 7/2 8.052'+3 1.231'+0    87.44x     96    0

             t          E          n*          cut
 4f 7/2    0.0105   1510300x   3.889        9.975
to           A          f         lambda      b    c
 5g 7/2 2.982'+2 3.418'-2    87.44x      4    0
 5g 9/2 8.383'+3 1.201'+0    87.44x    100    0

             t          E          n*          cut
 5f 5/2  0.00360   2565300x   4.875        8.375
to           A          f         lambda      b    c
 5g 7/2 8.706'+0 2.212'-1     1127x      0    9

             t          E          n*          cut
 5f 7/2  0.00352   2565300x   4.875        8.375
to           A          f         lambda      b    c
 5g 7/2 3.224'-1 6.144'-3     1127x      0    9
 5g 9/2 8.968'+0 2.136'-1     1127x      0   10

             t          E          n*          cut
 5g 7/2  0.00120   2654000x   4.996       10.675

             t          E          n*          cut
 5g 9/2  0.00119   2654000x   4.996        5.575
```

```
2 In XXI (2 Cu I  sequence)
Ionisation Potential   4 791 700.00

                        E          n*          cut
 4s 1/2                 0         3.178        0.025
to           A          f         lambda      b    c
 4p 1/2 1.470'+2 1.847'-1    289.5x    100    0
 4p 3/2 2.874'+2 4.672'-1    232.8x    100    0
 5p 1/2 1.867'+3 5.829'-2    45.64      46   67
 5p 3/2 1.379'+3 8.330'-2    44.89      40   72
```

```
             t          E          n*          cut
 5s 1/2  0.00178   2036900x   4.191        0.025
to           A          f         lambda      b    c
 4p 1/2 1.740'+3 9.120'-2   -59.12      31   58
 4p 3/2 3.870'+3 1.123'-1   -62.21      69   54
 5p 1/2 3.984'+1 2.508'-1    648.0x      1    0
 5p 3/2 7.587'+1 6.248'-1    524.1x      2    0

             t          E          n*          cut
 4p 1/2    0.0680 345400.0x   3.299        0.650
to           A          f         lambda      b    c
 4d 3/2 1.074'+3 7.536'-1    153.0x     88    0
 5d 3/2 1.235'+3 8.093'-2    46.76      50   72

             t          E          n*          cut
 4p 3/2    0.0348 429500.0x   3.331        0.725
to           A          f         lambda      b    c
 4d 3/2 1.454'+2 6.720'-2    175.6x     12    0
 4d 5/2 9.448'+2 6.228'-1    171.2x    100    0
 5d 3/2 3.258'+2 1.157'-2    48.67      13   67
 5d 5/2 1.784'+3 9.417'-2    48.45      68   69

             t          E          n*          cut
 5p 1/2  0.00246   2191210    4.314        0.675
to           A          f         lambda      b    c
 4d 3/2 2.157'+3 1.137'-1   -83.88x     53   50
 5d 3/2 2.909'+2 1.016'+0    341.3x     12    0

             t          E          n*          cut
 5p 3/2  0.00289   2227720    4.344        0.725
to           A          f         lambda      b    c
 4d 3/2 1.980'+2 1.966'-2   -81.39x      6   54
 4d 5/2 1.808'+3 1.226'-1   -82.36x     52   53
 5d 3/2 4.001'+1 9.118'-2    389.9x      2    0
 5d 5/2 2.670'+2 8.513'-1    376.5x     10    0

             t          E          n*          cut
 4d 3/2  0.00820 999000.0x   3.572        3.725
to           A          f         lambda      b    c
 4f 5/2 9.892'+2 6.399'-1    169.6x     94    1
 5f 5/2 2.937'+3 2.135'-1    56.85      84   52

             t          E          n*          cut
 4d 5/2    0.0106   1013600x   3.579        3.750
to           A          f         lambda      b    c
 4f 5/2 6.564'+1 2.977'-2    173.9x      6    1
 4f 7/2 9.846'+2 5.953'-1    173.9x    100    1
 5f 5/2 2.168'+2 1.068'-2    57.33       6   51
 5f 7/2 3.252'+3 2.136'-1    57.33      91   51

             t          E          n*          cut
 5d 3/2  0.00402   2484200x   4.580        3.425
to           A          f         lambda      b    c
 4f 5/2 5.959'+2 7.425'-2   -111.7x     24   58
 5f 5/2 3.154'+2 9.462'-1    365.2x      9    0

             t          E          n*          cut
 5d 5/2  0.00380   2493300x   4.589        3.475
to           A          f         lambda      b    c
 4f 5/2 2.772'+1 5.077'-3   -110.5x      1   59
 4f 7/2 5.543'+2 7.615'-2   -110.5x     21   59
 5f 5/2 2.045'+1 4.377'-2    377.8x      1    0
 5f 7/2 3.068'+2 8.754'-1    377.8x      9    0

             t          E          n*          cut
 4f 5/2  0.00948   1588600x   3.887       10.000
to           A          f         lambda      b    c
 5g 7/2 9.827'+3 1.229'+0    79.09x     96    0

             t          E          n*          cut
 4f 7/2    0.0102   1588600x   3.887       10.000
to           A          f         lambda      b    c
 5g 7/2 3.640'+2 3.413'-2    79.09x      4    0
 5g 9/2 1.023'+4 1.199'+0    79.09x    100    0

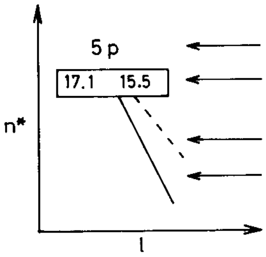
             t          E          n*          cut
 5f 5/2  0.00287   2758000x   4.878        8.375
to           A          f         lambda      b    c
 5g 7/2 9.675'+0 2.143'-1     1053x      0    9

             t          E          n*          cut
 5f 7/2  0.00281   2758000x   4.878        8.375
to           A          f         lambda      b    c
 5g 7/2 3.583'-1 5.953'-3     1053x      0    9
 5g 9/2 9.971'+0 2.070'-1     1053x      0   10

             t          E          n*          cut
 5g 7/2 9.803'-4   2853000x   4.996       10.600

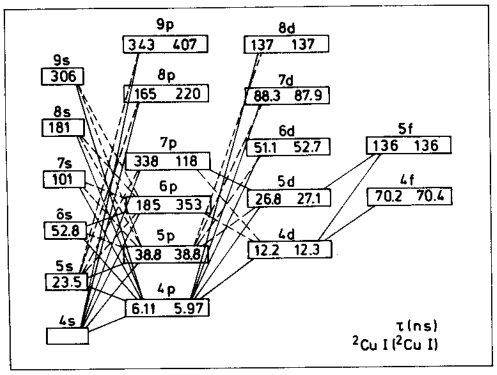
             t          E          n*          cut
 5g 9/2 9.768'-4   2853000x   4.996        5.525
```

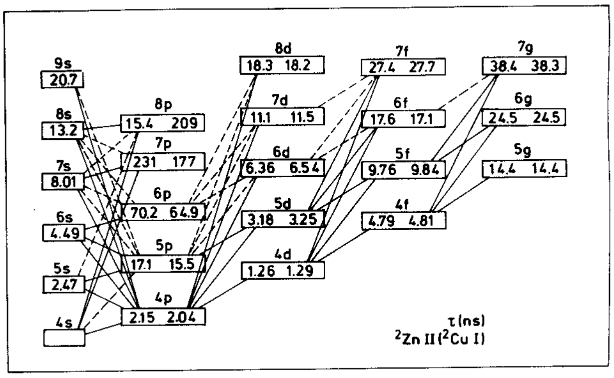
Explanation of Diagrams

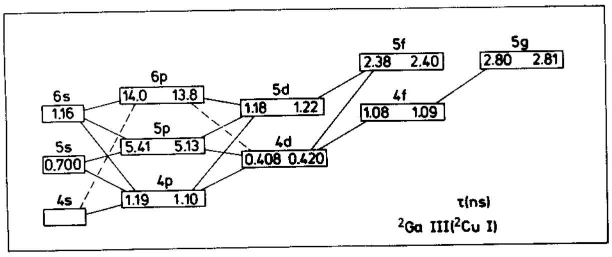


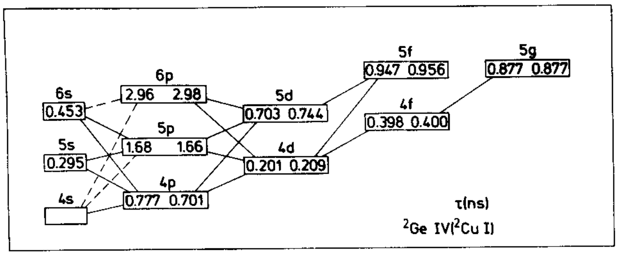
n, *l* for state *j*.
τ_j for $J = l - \frac{1}{2}$(1st value) and $J = l + \frac{1}{2}$(2nd value).
Branching, $10\% \leqslant b_{jj'} < 25\%$.
Branching, $b_{jj'} \geqslant 25\%$.

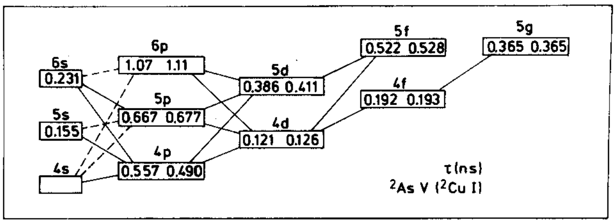
$\tau(ns)$ or $\tau(ps)$	Lifetime (mean life) in nano- or pico-seconds.
^{2}Zn II (^{2}Cu I)	Doublet singly-ionised Zn (doublet neutral Cu Sequence).

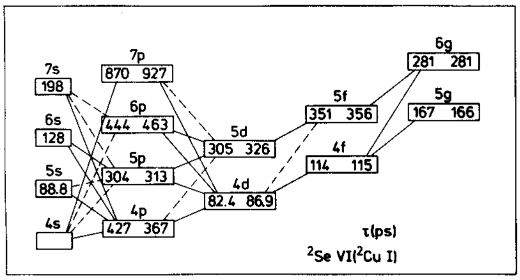


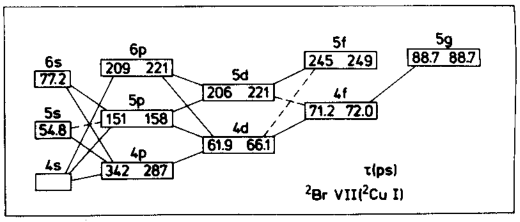


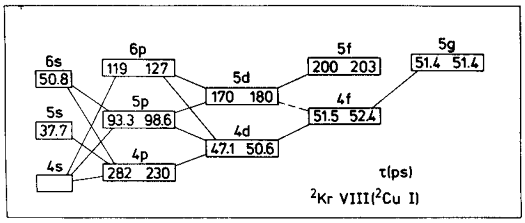


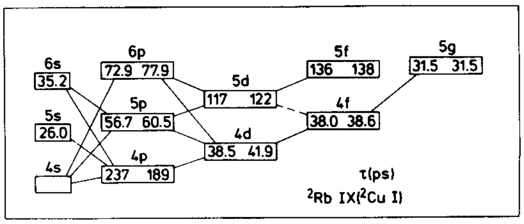


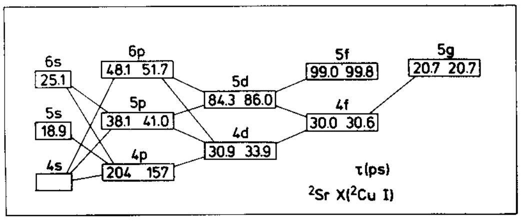


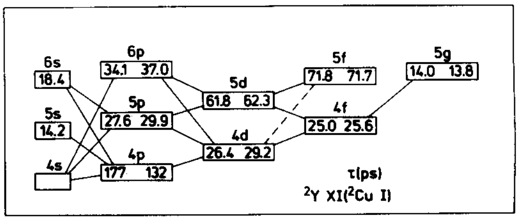


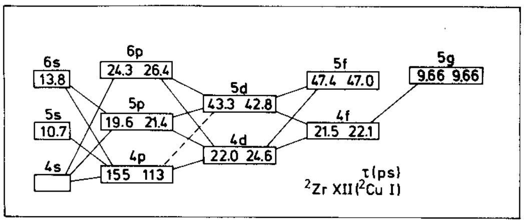








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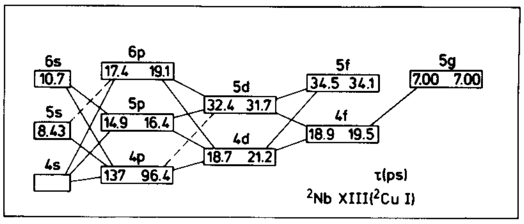
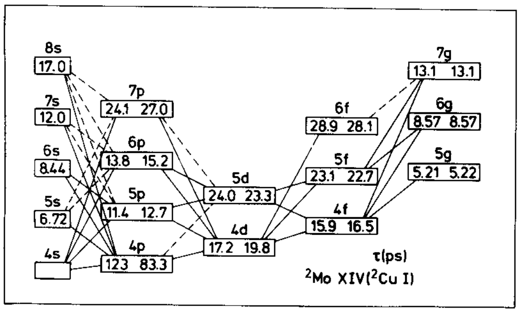
13.8
5s
10.7
4s
6p
24.3 26.4
5p
19.6 21.4
4p
155 113
5d
43.3 42.8
4d
22.0 24.6
5f
47.4 47.0
4f
21.5 22.1
5g
9.66 9.66
τ(ps)
^{2}Zr XII(^{2}Cu I)


6s
10.7
5s
8.43
4s
6p
17.4 19.1
5p
14.9 16.4
4p
137 96.4
5d
32.4 31.7
4d
18.7 21.2
5f
34.5 34.1
4f
18.9 19.5
5g
7.00 7.00
τ(ps)
^{2}Nb XIII(^{2}Cu I)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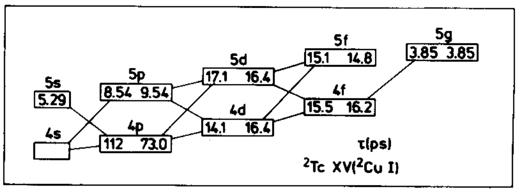
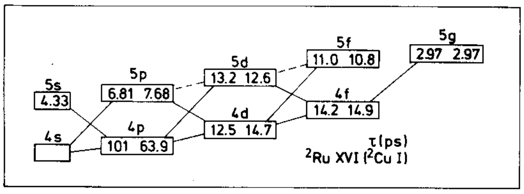
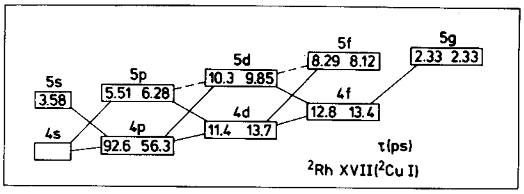
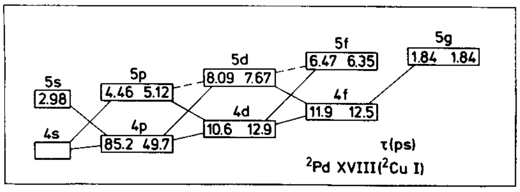
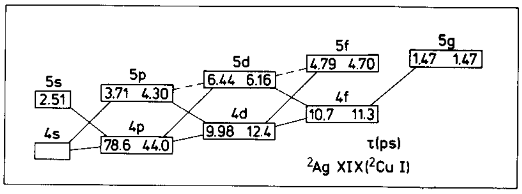
17.0
7s
12.0
6s
8.44
5s
6.72
4s
7p
24.1 27.0
6p
13.8 15.2
5p
11.4 12.7
4p
123 83.3
5d
24.0 23.3
4d
17.2 19.8
6f
28.9 28.1
5f
23.1 22.7
4f
15.9 16.5
7g
13.1 13.1
6g
8.57 8.57
5g
5.21 5.22
τ(ps)
^{2}Mo XIV(^{2}Cu I)

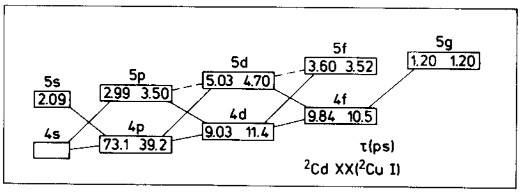

5s
5.29
4s
5p
8.54 9.54
4p
112 73.0
5d
17.1 16.4
4d
14.1 16.4
5f
15.1 14.8
4f
15.5 16.2
5g
3.85 3.85
τ(ps)
^{2}Tc XV(^{2}Cu I)

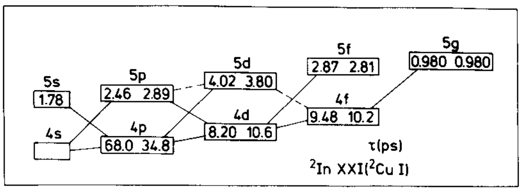

5s
4.33
4s
5p
6.81 7.68
4p
101 63.9
5d
13.2 12.6
4d
12.5 14.7
5f
11.0 10.8
4f
14.2 14.9
5g
2.97 2.97
τ(ps)
^{2}Ru XVI (^{2}Cu I)


5s
3.58
4s
5p
5.51 6.28
4p
92.6 56.3
5d
10.3 9.85
4d
11.4 13.7
5f
8.29 8.12
4f
12.8 13.4
5g
2.33 2.33
τ(ps)
^{2}Rh XVII(^{2}Cu I)


5s
2.98
4s
5p
4.46 5.12
4p
85.2 49.7
5d
8.09 7.67
4d
10.6 12.9
5f
6.47 6.35
4f
11.9 12.5
5g
1.84 1.84
τ(ps)
^{2}Pd XVIII(^{2}Cu I)


5s
2.51
4s
5p
3.71 4.30
4p
78.6 44.0
5d
6.44 6.16
4d
9.98 12.4
5f
4.79 4.70
4f
10.7 11.3
5g
1.47 1.47
τ(ps)
^{2}Ag XIX(^{2}Cu I)


5s
2.09
4s
5p
2.99 3.50
4p
73.1 39.2
5d
5.03 4.70
4d
9.03 11.4
5f
3.60 3.52
4f
9.84 10.5
5g
1.20 1.20
τ(ps)
^{2}Cd XX(^{2}Cu I)


5s
1.78
4s
5p
2.46 2.89
4p
68.0 34.8
5d
4.02 3.80
4d
8.20 10.6
5f
2.87 2.81
4f
9.48 10.2
5g
0.980 0.980
τ(ps)
^{2}In XXI(^{2}Cu I)