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CALCULATED ELECTRON EXCITATION CROSS SECTIONS FOR EXCITED STATE–EXCITED STATE TRANSITIONS IN ALKALI ATOMS

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Electron excitation cross sections for optically allowed excited state–excited state transitions in lithium, sodium, potassium, rubidium, and cesium have been calculated in the first Born approximation. An analytical Coulomb approximation is used to evaluate the transition matrix element of the valence electron. Cross sections are given for incident electron energies from 1.02 to 1000 in threshold units. The accuracy of the calculation is tested by comparing oscillator strengths computed in the Coulomb approximation with other published values.

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CONTENTS

INTRODUCTION

Electron collisions with excited atoms are crucial for a qualitative understanding and quantitative modeling of low- and high-temperature plasmas.[1] Low-temperature plasmas ($kT \leq$ a few eV) are important in a number of critical applications such as plasma processing of microelectronic structures, erosion of wall materials in magnetically confined fusion machines or at the skin of spacecraft, and commercial lighting. Astrophysical low-temperature plasmas are encountered in the atmospheres of most stars in the Milky Way and in interstellar regions with maser activity, presumed to be sites of active star formation. High-temperature plasmas, on the other hand, still involve the physics of isolated atoms and their collisional and radiative interactions, provided the electron densities are low ($N_e < 10^{14}$ cm^{-3}). Examples of high-temperature, low-density plasmas that involve electron collisions with excited atoms are the solar corona and magnetically confined fusion plasmas.

Because of their great practical importance, an increasing number of experiments have been carried out to study electron collisions with excited atoms. With respect to short-lived excited states, connected to a lower state by an optically allowed transition, so far mostly collisions with the laser-excited 3P state of sodium have been investigated. Much of this work[2–6] was devoted to the superelastic process Na $3^2P \rightarrow 3^2S$, which is the reverse of the resonant transition Na $3^2S \rightarrow 3^2P$. Similarly, superelastic Ba $6s6p\ ^1P \rightarrow 6s^2\ ^1S$ electron scattering has been studied.[7] Although such experiments can contribute significantly to our understanding of atom–electron collisions, they belong conceptually to the field of electron collisions with ground-state atoms rather than excited atoms. "Electron collisions with excited atoms" refers truly to elastic scattering on an excited atom or to excited state → excited state or excited state → continuum state inelastic scattering.

Work of this type has been done at New York University by Jaduszliwer et al.,[8,9] who measured the total cross section for electron scattering on $3^2P_{3/2}$ sodium atoms and by Zuo et al.,[10] who measured the elastic differential cross section for the same process. At the University of Colorado, Stumpf and Gallagher[11] measured the electron excitation cross section for the sodium 3^2D state from the laser-excited $3^2P_{3/2}$ state. Moores et al.[12] employed a four-state ($3s$–$3p$–$3d$–$4s$) close-coupling approximation to obtain angular-integrated excited state–excited state cross sections below the ionization threshold of sodium. Their results compare favorably to the experimental data of Stumpf and Gallagher.[11] Other theoretical work has been done by Flannery and McCann,[13] who studied $nl \rightarrow nl'$ transitions in hydrogen in first Born approximation. Two experiments have been reported for second-column elements; Trajmar et al.[14] studied electron impact ionization of laser-excited Ba $6s6p\ ^1P$ atoms and Lin and

co-workers[15] measured electron excitation cross sections for higher triplet levels of helium from the metastable 2^3S state.

An experimental program has been started[16] at the University of Idaho to measure electron cross sections for excitation of higher states of the heavy alkali atoms rubidium and cesium from a laser-excited P state. As part of this program we present in this paper a database of theoretical excited state–excited state cross sections for the alkalis, lithium through cesium, calculated in first Born approximation. Alkalis are chosen because of their relatively simple atomic structure. Given the present lack of data for excited state collisions, the Born approximation seems to be a reasonable choice: it is simple enough to allow calculations for a large number of transitions and it becomes exact at sufficiently high energies. In the alkalis, all cross sections measured so far[11,17–20] converge to the Born approximation within a few percentage points at about 100 times threshold energy. The Coulomb approximation, commonly used in spectroscopy to calculate oscillator strengths[21,22] and radial matrix elements of higher multipole moments,[23] is employed in this paper to describe the atomic target. An analytical formula is derived for the differential cross section, and angle-integrated cross sections are obtained by numerical integration.

In the remainder of this Introduction we give a brief summary of formulas needed to calculate excited state–excited state cross sections in Born approximation, describe the Coulomb approximation as applied to the evaluation of Born matrix elements, and discuss results and accuracies. With the exception of Eq. (20), atomic units are used in this Introduction.

The Born Approximation

If the excited states of the optical or valence electron in an alkali atom are described as single-electron states in a spherically symmetric potential, the scattering amplitude in first Born approximation is given as[24]

$$f_{\gamma\gamma'}(\theta, \phi) = -\frac{2}{k^2}\langle \psi_{\gamma'} | \exp(i\vec{k}\cdot\vec{r}) | \psi_\gamma \rangle, \qquad (1)$$

where $\vec{r} = (r, \theta, \phi)$ is the position of the atomic valence electron and $\vec{k} = \vec{k}_\gamma - \vec{k}_{\gamma'}$ is the momentum transfer, $\vec{k}_\gamma$ the incoming momentum, and $\vec{k}_{\gamma'}$ the outgoing momentum of the scattered electron. Thus $k_\gamma = (2T)^{1/2}$ and $k_{\gamma'} = \{2[T - (E_{\gamma'} - E_\gamma)]\}^{1/2}$, where T is the kinetic energy of the incoming electron and E_γ and $E_{\gamma'}$ are the energies of the initial and final atomic states. The initial- and final-state atomic wave functions are ψ_γ and $\psi_{\gamma'}$. These wave functions have the form

$$\psi_\gamma = R_{nl}(r)\, Y_{lm}(\theta, \phi), \qquad (2)$$

where $R_{nl}(r)$ are radial wave functions and $Y_{lm}(\theta, \phi)$ are spherical harmonics.

By expanding $\exp(i\vec{k}\cdot\vec{r})$ in terms of spherical harmonics, inserting ψ_γ and $\psi_{\gamma'}$ from Eq. (2) into Eq. (1), and carrying out the integration over the coordinates of the atomic electron, one obtains

$$f_{\gamma\gamma'}(\theta, \phi) = -\frac{8\pi}{k^2}\sum_{\lambda\mu} i^\lambda Y^*_{\lambda\mu}(\hat{k})\langle R_{n'l'} | j_\lambda(kr) | R_{nl}\rangle \times (-1)^{m'}\left[\frac{(2l'+1)(2\lambda+1)(2l+1)}{4\pi}\right]^{1/2} \times \begin{pmatrix} l' & \lambda & l \\ -m' & \mu & m \end{pmatrix}\begin{pmatrix} l' & \lambda & l \\ 0 & 0 & 0 \end{pmatrix}. \qquad (3)$$

λ and μ are quantum numbers of the collision-coupled angular momentum, $|l - l'| < \lambda < |l + l'|$, $\mu = -\lambda, -\lambda + 1, \ldots, +\lambda$, $\hat{k}$ is the unit vector in the direction of momentum transfer $\vec{k}$, and j_λ is a spherical Bessel function.

Inserting Eq. (3) into the definition of the differential cross section,

$$\sigma_{\gamma\gamma'}(\theta) = \frac{k_{\gamma'}}{k_\gamma}\,|f_{\gamma\gamma'}(\theta, \phi)|^2, \qquad (4)$$

yields

$$\sigma_{\gamma\gamma'}(\theta) = \frac{16\pi k_{\gamma'}}{k^4 k_\gamma}\sum_{\substack{\lambda,\lambda' \\ \mu,\mu'}} i^{\lambda+\lambda'}(-1)^{\lambda'} Y^*_{\lambda\mu}(\hat{k}) Y_{\lambda'\mu'}(\hat{k}) \times \langle R_{n'l'} | j_\lambda(kr) | R_{nl}\rangle\langle R_{n'l'} | j_{\lambda'}(kr) | R_{nl}\rangle (2l+1) \times (2l'+1)[(2\lambda+1)(2\lambda'+1)]^{1/2}\begin{pmatrix} l' & \lambda & l \\ -m' & \mu & m \end{pmatrix} \times \begin{pmatrix} l' & \lambda & l \\ 0 & 0 & 0 \end{pmatrix}\begin{pmatrix} l' & \lambda' & l \\ -m' & \mu' & m \end{pmatrix}\begin{pmatrix} l' & \lambda' & l \\ 0 & 0 & 0 \end{pmatrix}. \qquad (5)$$

This is the general expression for the differential cross section for electron impact excitation of the state $\gamma' = n'l'm'$ from the initial state $\gamma = nlm$. Averaging over initial and summing over final magnetic substates give the differential cross section for a transition $nl \to nl'$,

$$\sigma(nl \to n'l'; \theta) = \frac{4k_{\gamma'}}{k^4 k_\gamma}(2l'+1)\sum_\lambda (2\lambda+1) \times |\langle R_{n'l'} | j_\lambda(kr) | R_{nl}\rangle|^2 \begin{pmatrix} l' & \lambda & l \\ 0 & 0 & 0 \end{pmatrix}^2, \qquad (6)$$

or, in terms of momentum transfer k,

$$\sigma(nl \to n'l'; k) = \frac{8\pi}{k^3 k_\gamma^2}(2l'+1)\sum_\lambda (2\lambda+1) \times |\langle R_{n'l'} | j_\lambda(kr) | R_{nl}\rangle|^2 \begin{pmatrix} l' & \lambda & l \\ 0 & 0 & 0 \end{pmatrix}^2. \qquad (7)$$

The total cross section is then evaluated as

$$Q(nl \rightarrow n'l') = \int_{k_{min}}^{k_{max}} \sigma(nl \rightarrow n'l'; k)dk \qquad (8)$$

with $k_{min} = |k_\gamma - k_{\gamma'}|$ (forward scattering, $\theta = 0$) and $k_{max} = k_\gamma + k_{\gamma'}$ (backward scattering, $\theta = \pi$).

The Coulomb Approximation

In order to calculate the differential cross section given by Eq. (7) the radial transition integral

$$\langle R_{n'l'}|j_\lambda(kr)|R_{nl}\rangle = \int_0^\infty R_{n'l'} j_\lambda(kr) R_{nl} r^2 dr = \int_0^\infty u_{n'l'} j_\lambda(kr) u_{nl}\, dr \qquad (9)$$

must be evaluated. In the Coulomb approximation, introduced by Bates and Damgaard[21] to calculate oscillator strengths, the radial wave equation is written as

$$\left(\frac{d^2}{dr^2} - \frac{1}{\nu^2} + \frac{2}{r} - \frac{l(l+1)}{r^2}\right) u_{nl}(r) = 0. \qquad (10)$$

where ν is the effective quantum number of the state n, l and the radial wave functions u_{nl} are taken as the asymptotic solutions of (10):

$$u_{nl}(r) = N_{nl} \exp\left(-\frac{r}{\nu}\right)\left(\frac{2r}{\nu}\right)^\nu \sum_{t=0}^{\infty} a_t r^{-t}. \qquad (11)$$

The expansion coefficients are given by

$$a_t = a_{t-1} \frac{\nu}{2t}[l(l+1) - (\nu - t)(\nu - t + 1)], \qquad a_0 = 1, \qquad (12)$$

and the normalization factor is

$$N_{nl} = [\nu^2 \Gamma(\nu + l + 1)\Gamma(\nu - l)]^{-1/2}. \qquad (13)$$

We employ the Coulomb approximation to evaluate the Born transition integral (9). Thus, inserting (11) into (9) and abbreviating $\alpha = 1/\nu + 1/\nu'$

$$\langle R_{n'l'}|j_\lambda(kr)|R_{nl}\rangle = N_{nl}N_{n'l'}\left(\frac{2}{\nu}\right)^\nu\left(\frac{2}{\nu'}\right)^{\nu'} \times \sum_{t,t'=0}^{\infty} a_t a_{t'} \int_0^\infty \exp(-\alpha r) r^{\nu+\nu'-t-t'} j_\lambda(kr)\, dr. \qquad (14)$$

The Laplace transformation can be carried out and the radial transition integral for the Born approximation becomes

$$\langle R_{n'l'}|j_\lambda(kr)|R_{nl}\rangle = N_{nl}N_{n'l'}\left(\frac{2}{\nu}\right)^\nu\left(\frac{2}{\nu'}\right)^{\nu'}\left(\frac{\pi}{2k}\right)^{1/2} \times \sum_{t,t'=0}^{\infty} a_t a_{t'} \frac{\Gamma(\lambda + 1 + \nu + \nu' - t - t')(k/2)^{\lambda+1/2}}{(\alpha^2 + k^2)^{(1/2)(\lambda+1+\nu+\nu'-t-t')}\Gamma(\lambda + 3/2)} \times F\left(\frac{1}{2}(\lambda + 1 + \nu + \nu' - t - t'), \frac{1}{2}(\lambda + 1 - \nu - \nu' + t + t'), \left(\lambda + \frac{3}{2}\right); \frac{k^2}{(\alpha^2 + k^2)}\right), \qquad (15)$$

where F is a hypergeometric function. The wave functions u_{nl} defined by Eqs. (11)–(13) diverge at $r = 0$. Bates and Damgaard[21] have shown, however, that the transition integral for the oscillator strength

$$\langle R_{nl}|r|R_{n'l'}\rangle = N_{nl}N_{n'l'}\left(\frac{2}{\nu}\right)^\nu\left(\frac{2}{\nu'}\right)^{\nu'} \times \sum_{t,t'=0}^{\infty} a_t a_{t'} \int_0^\infty \exp(-\alpha r) r^{\nu+\nu'-t-t'+1} dr = N_{nl}N_{n'l'}\left(\frac{2}{\nu}\right)^\nu\left(\frac{2}{\nu'}\right)^{\nu'} \times \sum_{t,t'=0}^{\infty} a_t a_{t'} \frac{\Gamma(\nu + \nu' - t - t' + 2)}{\alpha^{\nu+\nu'-t-t'+2}} \qquad (16)$$

can be evaluated with sufficient accuracy if powers of r less than 2 are neglected. Hence they restrict the summation in Eq. (16) to terms with

$$t + t' \leq \nu + \nu' - 1. \qquad (17)$$

Comparing (14) with (16) and invoking the series expansion of the spherical Bessel function, $j_\lambda(kr) = (kr)^\lambda/(2\lambda + 1)!! + \textit{higher powers of } r$, we therefore employ the cutoff criterion

$$t + t' \leq \nu + \nu' + \lambda - 2 \qquad (18)$$

to evaluate the transition integral for the Born approximation.

Results and Accuracy

Tables IA–IE list Born cross sections for excited state–excited state transitions in alkali atoms. Energies are given in threshold units and cross sections are in units of πa_0^2. Threshold energies E_t in eV are listed immediately below each transition. All cross sections are given as $Q(nl \rightarrow n'l')$ with nl and $n'l'$ designating the initial and final atomic states, respectively. In some cases, the energy of the initial state is higher than that of the final state and the tabulated cross section is superelastic. If this is the case, the threshold energy E_t is given with a minus sign. Cross sections $Q(nl \rightarrow n'l')$ and $Q(n'l' \rightarrow nl)$ are related by detailed balance, $Q(nl \rightarrow n'l') = Q(n'l' \rightarrow nl)(2l' + 1)/(2l + 1)$. Energy levels and ionization potentials are taken from the NBS tables by Moore.[25] For rubidium Moore lists two ionization potentials, 33691.02 cm^{-1} for

the isotope ^{85}Rb and 33691.10 cm^{-1} for ^{87}Rb. The cross sections listed in Table ID are calculated with the latter ionization potential and we have verified that the relative variation of the cross sections is no more than 0.05% when switching these ionization potentials. Where the Moore tables list energy levels with specified total angular momentum J we have taken the statistical average to obtain the energy level nl.

A few remarks concerning numerical issues follow. The Γ function has been approximated as a polynomial with an accuracy of 3×10^{-7} and the hypergeometric function has been implemented as a series expansion with an accuracy of 1×10^{-7}. The integration of the differential cross section according to Eq. (8) has been performed numerically using an $x = 1/k$ transform. Each cross section is evaluated using 1000 integration points. At the highest impact energy listed in the tables, 1000 threshold units, all cross sections agreed within five significant figures with an evaluation using 2000 integration points. In addition, the numerical reliability of the presented cross sections has been tested by extracting absorption oscillator strengths from the calculated cross sections and by comparing them to absorption oscillator strengths calculated from the definition

$$f(nl \rightarrow n'l') = \max(l, l') \frac{2}{3(2l+1)} \times |E_{n'l'} - E_{nl}| |\langle R_{n'l'}|r|R_{nl}\rangle|^2 \quad (19)$$

using the transition integral in Eq. (16). Oscillator strengths were derived from the calculated cross sections using the Fano expression[26]

$$Q(nl \rightarrow n'l') = \frac{4f(nl \rightarrow n'l')}{E_t E} \ln(4cE), \quad (20)$$

where E_t and E are the threshold energy of the transition $nl \rightarrow n'l'$ and the impact energy in Rydbergs and the cross section Q is in units of πa_0^2. Thus $f(nl \rightarrow n'l')$ = Slope $\times E_t/4$, where "Slope" is the slope of $Q(nl \rightarrow n'l') \times E$ vs $\ln(E)$. Cross sections at 1000 and 700 threshold units were used to calculate the slope. Comparison of oscillator strengths obtained by Eqs. (19) and (20) checks the numerical accuracy of the hypergeometric function and the integration procedure in our cross section calculation. This is a rather severe test, since it is the *slope* of $Q \times E$ vs $\ln(E)$ that yields the oscillator strength. Agreement between oscillator strengths obtained by Eq. (19) and Eq. (20) is as follows: Of the 120 transitions considered here, 53 agreed within 0.1%, 111 within 0.5%, and 117 within 1%. Only three transitions, Li($4p \rightarrow 3s$), Na($5p \rightarrow 3d$), and K($5p \rightarrow 6d$) disagree by more than 1% (13%, 4%, 33%, respectively). In these three cases the oscillator strength is of the order of 10^{-4} or smaller and it is clear that cross sections calculated to be numerically accurate to within four significant figures cannot produce correctly such small oscillator strengths.

The question is now, how accurate are the calculated Born cross sections in terms of the chosen description of the atomic target? Since there are no absolute excited state–excited state cross section measurements or other Born calculations with which we could compare our results, we rest our discussion on a comparison of oscillator strengths. Table II lists absorption oscillator strengths for the excited state–excited state transitions for which we have calculated cross sections in first Born approximation. Oscillator strengths using the transition integral in Eq. (16) are given as analytical Coulomb approximations and are compared with the numerical Coulomb approximation of Lindgard and Nielsen,[27] the model potential approach of Theodosiou,[28] and experimental and other values compiled by Wiese et al.[29,30] For the heavy alkalis, rubidium and cesium, the experimental data base is very sparse and so comparison is made only with the two sets of theoretical values. The numerical Coulomb approximation of Lindgard and Nielsen[27] utilizes the same wave equation (10), but not the asymptotic solutions (11)–(13). Rather, the Schrödinger equation is integrated inward to a cutoff radius chosen such that the proper expectation value for the radial coordinate is obtained. The model potential approach of Theodosiou[28] consists of numerically integrating a one-electron radial Schrödinger equation with a core, polarization, and spin-orbit potential. The core potential is constructed from Hartree–Fock orbitals for Li, Na, and K while in the case of Rb and Cs, Hartree potentials are used. Thus the degree of sophistication and computational effort increases from left to right in the theoretical columns in Table II. As can be seen from this table, the overall agreement between the three theoretical approaches and the compiled data is good, for most transitions within a few percentage points, which is also a reasonable accuracy for an oscillator strength experiment. Table II clearly shows that the simple description of the atomic target in our Born calculations does not cause any obvious systematic errors. Furthermore, Table II allows a quick recalibration of our Born cross sections to other atomic target descriptions. If one feels, for instance, that $f = 0.1721$ as given by Theodosiou is a better value for the oscillator strength of the $3p \rightarrow 4s$ transition in sodium than $f = 0.1649$ obtained in the analytical Coulomb approximation then one divides the Born cross section $Q(3p \rightarrow 4s)$ by 0.1649 and multiplies it by 0.1721. According to Eq. (20) one thus obtains a cross section that is exact at high energies and a better approximation at low energies for the new target description.

In conclusion, the Born cross sections presented in this paper provide a first theoretical database for optically allowed excited state–excited state transitions in alkali at-

oms. Extension of these calculations to optically forbidden transitions is straightforward. Transitions involving higher principal quantum numbers can also be treated. However, when going to higher effective quantum numbers, say $\nu > 10$, numerical issues must be considered carefully. We note that van Regemorter et al.[22] have discussed the numerical treatment of the radial transition integral (16) for high effective quantum numbers.

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EXPLANATION OF TABLES

TABLE IA. Electron Excitation Cross Sections for Excited State–Excited State Transitions in Lithium

TABLE IB. Electron Excitation Cross Sections for Excited State–Excited State Transitions in Sodium

TABLE IC. Electron Excitation Cross Sections for Excited State–Excited State Transitions in Potassium

TABLE ID. Electron Excitation Cross Sections for Excited State–Excited State Transitions in Rubidium

TABLE IE. Electron Excitation Cross Sections for Excited State–Excited State Transitions in Cesium

The tables give cross section Q in units of $\pi a_0^2 = 8.79735 \times 10^{-17}$ cm^2 for the transitions indicated; 6.516 (−1) means cross section Q equals $6.516 \times 10^{-1}\ \pi a_0^2$

2p → 3d, etc.	Transition: The first listed state is the initial state for electron impact
E_t	Threshold energy in eV: A minus sign indicates a superelastic collision
E/E_t	Energy in threshold units

TABLE II. Absorption Oscillator Strengths for Excited State–Excited State Transitions in Alkali Atoms

All oscillator strengths are for absorption, even if the first listed state is higher in energy; 1.148 (−1) means absorption oscillator strength equals 1.148×10^{-1}

Trans.	Transition (transitions are listed as 2p–3d, etc., as in Tables IA–IE)
Anal. C. A.	Analytical Coulomb approximation (Eq. (16))
Num. C. A.	Numerical Coulomb approximation of Lindgard and Nielsen[27]
Model Pot.	Model potential approximation of Theodosiou[28]
Experim.	Experimental or other reference values as listed by Wiese et al.[29,30]

TABLE IA. Electron Excitation Cross Sections for Excited State-Excited State Transitions in Lithium

See page 157 for Explanation of Tables

E/E$_t$	Q(2p → 3s)	Q(2p → 4s)	Q(2p → 5s)	Q(2p → 6s)
	E$_t$=1.525	E$_t$=2.493	E$_t$=2.901	E$_t$=3.110
1.02	1.305 (+0)	6.483 (−2)	1.573 (−2)	6.332 (−3)
1.04	1.938 (+0)	1.059 (−1)	2.731 (−2)	1.139 (−2)
1.08	2.964 (+0)	1.831 (−1)	5.029 (−2)	2.169 (−2)
1.16	4.648 (+0)	3.230 (−1)	9.293 (−2)	4.091 (−2)
1.32	7.205 (+0)	5.362 (−1)	1.568 (−1)	6.937 (−2)
1.64	1.024 (+1)	7.595 (−1)	2.198 (−1)	9.657 (−2)
2.28	1.237 (+1)	8.670 (−1)	2.455 (−1)	1.068 (−1)
3.56	1.232 (+1)	8.033 (−1)	2.226 (−1)	9.588 (−2)
6.12	1.032 (+1)	6.283 (−1)	1.709 (−1)	7.301 (−2)
11.24	7.565 (+0)	4.347 (−1)	1.165 (−1)	4.945 (−2)
21.48	5.052 (+0)	2.772 (−1)	7.344 (−2)	3.101 (−2)
41.96	3.167 (+0)	1.677 (−1)	4.402 (−2)	1.852 (−2)
50.00	2.786 (+0)	1.463 (−1)	3.834 (−2)	1.611 (−2)
75.00	2.054 (+0)	1.062 (−1)	2.771 (−2)	1.162 (−2)
100.00	1.646 (+0)	8.422 (−2)	2.192 (−2)	9.185 (−3)
150.00	1.196 (+0)	6.044 (−2)	1.568 (−2)	6.561 (−3)
250.00	7.920 (−1)	3.950 (−2)	1.021 (−2)	4.266 (−3)
400.00	5.379 (−1)	2.654 (−2)	6.843 (−3)	2.856 (−3)
700.00	3.366 (−1)	1.643 (−2)	4.224 (−3)	1.761 (−3)
1000.00	2.486 (−1)	1.207 (−2)	3.097 (−3)	1.290 (−3)

E/E$_t$	Q(4p → 3s)	Q(4p → 4s)	Q(4p → 5s)	Q(4p → 6s)
	E$_t$=−1.149	E$_t$=−0.1807	E$_t$=0.2269	E$_t$=0.4362
1.02	5.580 (+0)	1.261 (+3)	9.070 (+0)	3.821 (+0)
1.04	7.605 (+0)	1.770 (+3)	2.195 (+1)	4.964 (+0)
1.08	1.003 (+1)	2.465 (+3)	5.379 (+1)	6.364 (+0)
1.16	1.248 (+1)	3.373 (+3)	1.273 (+2)	9.178 (+0)
1.32	1.412 (+1)	4.443 (+3)	2.781 (+2)	1.718 (+1)
1.64	1.384 (+1)	5.419 (+3)	5.311 (+2)	3.311 (+1)
2.28	1.127 (+1)	5.820 (+3)	8.241 (+2)	4.978 (+1)
3.56	7.670 (+0)	5.345 (+3)	9.923 (+2)	5.524 (+1)
6.12	4.566 (+0)	4.232 (+3)	9.475 (+2)	4.793 (+1)
11.24	2.503 (+0)	2.983 (+3)	7.581 (+2)	3.518 (+1)
21.48	1.312 (+0)	1.937 (+3)	5.368 (+2)	2.374 (+1)
41.96	6.715 (−1)	1.190 (+3)	3.501 (+2)	1.538 (+1)
50.00	5.636 (−1)	1.042 (+3)	3.108 (+2)	1.361 (+1)
75.00	3.757 (−1)	7.619 (+2)	2.330 (+2)	9.941 (+0)
100.00	2.818 (−1)	6.071 (+2)	1.886 (+2)	7.964 (+0)
150.00	1.879 (−1)	4.383 (+2)	1.387 (+2)	5.820 (+0)
250.00	1.127 (−1)	2.883 (+2)	9.308 (+1)	3.901 (+0)
400.00	7.046 (−2)	1.948 (+2)	6.384 (+1)	2.366 (+0)
700.00	4.027 (−2)	1.212 (+2)	4.034 (+1)	1.473 (+0)
1000.00	2.819 (−2)	8.927 (+1)	2.996 (+1)	1.085 (+0)

E/E$_t$	Q(3p → 3s)	Q(3p → 4s)	Q(3p → 5s)	Q(3p → 6s)
	E$_t$=−0.4611	E$_t$=0.5067	E$_t$=0.9143	E$_t$=1.124
1.02	2.317 (+2)	3.898 (+0)	1.978 (−1)	9.436 (−2)
1.04	3.213 (+2)	7.723 (+0)	4.750 (−1)	1.820 (−1)
1.08	4.377 (+2)	1.630 (+1)	1.120 (+0)	3.664 (−1)
1.16	5.768 (+2)	3.440 (+1)	2.442 (+0)	7.234 (−1)
1.32	7.181 (+2)	6.693 (+1)	4.678 (+0)	1.319 (+0)
1.64	8.184 (+2)	1.114 (+2)	7.543 (+0)	2.085 (+0)
2.28	8.254 (+2)	1.517 (+2)	9.736 (+0)	2.628 (+0)
3.56	7.213 (+2)	1.662 (+2)	9.847 (+0)	2.585 (+0)
6.12	5.507 (+2)	1.490 (+2)	8.115 (+0)	2.076 (+0)
11.24	3.781 (+2)	1.144 (+2)	5.788 (+0)	1.450 (+0)
21.48	2.409 (+2)	7.884 (+1)	3.760 (+0)	9.273 (−1)
41.96	1.460 (+2)	5.051 (+1)	2.302 (+0)	5.610 (−1)
50.00	1.275 (+2)	4.463 (+1)	2.014 (+0)	4.895 (−1)
75.00	9.264 (+1)	3.322 (+1)	1.469 (+0)	3.550 (−1)
100.00	7.354 (+1)	2.676 (+1)	1.169 (+0)	2.814 (−1)
150.00	5.285 (+1)	1.957 (+1)	8.416 (−1)	2.018 (−1)
250.00	3.459 (+1)	1.306 (+1)	5.521 (−1)	1.318 (−1)
400.00	2.328 (+1)	8.916 (+0)	3.722 (−1)	8.852 (−2)
700.00	1.443 (+1)	5.609 (+0)	2.311 (−1)	5.476 (−2)
1000.00	1.060 (+1)	4.156 (+0)	1.700 (−1)	4.019 (−2)

E/E$_t$	Q(2p → 3d)	Q(2p → 4d)	Q(2p → 5d)	Q(2p → 6d)
	E$_t$=2.031	E$_t$=2.693	E$_t$=2.999	E$_t$=3.166
1.02	9.811 (+0)	1.773 (+0)	6.516 (−1)	3.189 (−1)
1.04	1.384 (+1)	2.493 (+0)	9.155 (−1)	4.478 (−1)
1.08	1.939 (+1)	3.478 (+0)	1.275 (+0)	6.230 (−1)
1.16	2.683 (+1)	4.758 (+0)	1.736 (+0)	8.466 (−1)
1.32	3.585 (+1)	6.219 (+0)	2.249 (+0)	1.092 (+0)
1.64	4.450 (+1)	7.434 (+0)	2.648 (+0)	1.275 (+0)
2.28	4.888 (+1)	7.751 (+0)	2.706 (+0)	1.290 (+0)
3.56	4.601 (+1)	6.889 (+0)	2.354 (+0)	1.111 (+0)
6.12	3.728 (+1)	5.289 (+0)	1.773 (+0)	8.287 (−1)
11.24	2.677 (+1)	3.632 (+0)	1.199 (+0)	5.558 (−1)
21.48	1.763 (+1)	2.310 (+0)	7.528 (−1)	3.470 (−1)
41.96	1.095 (+1)	1.396 (+0)	4.506 (−1)	2.067 (−1)
50.00	9.611 (+0)	1.219 (+0)	3.924 (−1)	1.798 (−1)
75.00	7.060 (+0)	8.842 (−1)	2.835 (−1)	1.296 (−1)
100.00	5.642 (+0)	7.014 (−1)	2.242 (−1)	1.024 (−1)
150.00	4.088 (+0)	5.034 (−1)	1.604 (−1)	7.311 (−2)
250.00	2.699 (+0)	3.291 (−1)	1.044 (−1)	4.752 (−2)
400.00	1.829 (+0)	2.212 (−1)	7.000 (−2)	3.180 (−2)
700.00	1.142 (+0)	1.370 (−1)	4.321 (−2)	1.960 (−2)
1000.00	8.423 (−1)	1.006 (−1)	3.168 (−2)	1.436 (−2)

TABLE IA. Electron Excitation Cross Sections for Excited State–Excited State Transitions in Lithium

See page 157 for Explanation of Tables

E/E_t	$Q(3p \rightarrow 3d)$	$Q(3p \rightarrow 4d)$	$Q(3p \rightarrow 5d)$	$Q(3p \rightarrow 6d)$
	$E_t = 0.04435$	$E_t = 0.7065$	$E_t = 1.013$	$E_t = 1.179$
1.02	1.362 (+4)	1.429 (+1)	3.139 (+0)	1.244 (+0)
1.04	1.880 (+4)	2.013 (+1)	4.368 (+0)	1.719 (+0)
1.08	2.536 (+4)	2.847 (+1)	6.079 (+1)	2.375 (+0)
1.16	3.280 (+4)	4.111 (+1)	8.678 (+0)	3.379 (+0)
1.32	3.942 (+4)	6.209 (+1)	1.308 (+1)	5.098 (+0)
1.64	4.230 (+4)	9.575 (+1)	1.975 (+1)	7.605 (+0)
2.28	3.907 (+4)	1.347 (+2)	2.611 (+1)	9.760 (+0)
3.56	3.072 (+4)	1.566 (+2)	2.800 (+1)	1.011 (+1)
6.12	2.106 (+4)	1.485 (+2)	2.455 (+1)	8.592 (+0)
11.24	1.315 (+4)	1.189 (+2)	1.846 (+1)	6.304 (+0)
21.48	7.766 (+3)	8.450 (+1)	1.250 (+1)	4.191 (+0)
41.96	4.432 (+3)	5.532 (+1)	7.903 (+0)	2.613 (+0)
50.00	3.819 (+3)	4.910 (+1)	6.962 (+0)	2.296 (+0)
75.00	2.699 (+3)	3.688 (+1)	5.149 (+0)	1.688 (+0)
100.00	2.106 (+3)	2.987 (+1)	4.133 (+0)	1.350 (+0)
150.00	1.480 (+3)	2.200 (+1)	3.009 (+0)	9.783 (−1)
250.00	9.456 (+2)	1.478 (+1)	1.997 (+0)	6.463 (−1)
400.00	6.241 (+2)	1.015 (+1)	1.359 (+0)	4.380 (−1)
700.00	3.791 (+2)	6.416 (+0)	8.515 (−1)	2.735 (−1)
1000.00	2.754 (+2)	4.768 (+0)	6.295 (−1)	2.018 (−1)

E/E_t	$Q(4p \rightarrow 3d)$	$Q(4p \rightarrow 4d)$	$Q(4p \rightarrow 5d)$	$Q(4p \rightarrow 6d)$
	$E_t = -0.6430$	$E_t = 0.01907$	$E_t = 0.3255$	$E_t = 0.4919$
1.02	2.226 (+1)	1.263 (+5)	9.122 (+1)	1.496 (+1)
1.04	2.967 (+1)	1.742 (+5)	1.210 (+2)	1.998 (+1)
1.08	3.750 (+1)	2.348 (+5)	1.531 (+2)	2.571 (+1)
1.16	4.326 (+1)	3.031 (+5)	1.830 (+2)	3.177 (+1)
1.32	4.372 (+1)	3.631 (+5)	2.131 (+2)	3.857 (+1)
1.64	3.825 (+1)	3.874 (+5)	2.626 (+2)	5.021 (+1)
2.28	2.977 (+1)	3.553 (+5)	3.555 (+2)	6.919 (+1)
3.56	2.170 (+1)	2.780 (+5)	4.532 (+2)	8.393 (+1)
6.12	1.547 (+1)	1.909 (+5)	4.765 (+2)	8.016 (+1)
11.24	1.066 (+1)	1.201 (+5)	4.132 (+2)	6.445 (+1)
21.48	7.003 (+0)	7.146 (+4)	3.109 (+2)	4.566 (+1)
41.96	4.392 (+0)	4.107 (+4)	2.108 (+2)	2.976 (+1)
50.00	3.868 (+0)	3.544 (+4)	1.865 (+2)	2.639 (+1)
75.00	2.862 (+0)	2.514 (+4)	1.438 (+2)	1.977 (+1)
100.00	2.299 (+0)	1.965 (+4)	1.175 (+2)	1.599 (+1)
150.00	1.677 (+0)	1.385 (+4)	8.751 (+1)	1.175 (+1)
250.00	1.116 (+0)	8.878 (+3)	5.946 (+1)	7.826 (+0)
400.00	7.607 (−1)	5.873 (+3)	4.117 (+1)	5.397 (+0)
700.00	4.778 (−1)	3.579 (+3)	2.626 (+1)	3.408 (+0)
1000.00	3.538 (−1)	2.604 (+3)	1.960 (+1)	2.538 (+0)

TABLE 1B. Electron Excitation Cross Sections for Excited State–Excited State Transitions in Sodium

See page 157 for Explanation of Tables

E/E_t	$Q(3p \rightarrow 4s)$	$Q(3p \rightarrow 5s)$	$Q(3p \rightarrow 6s)$	$Q(3p \rightarrow 7s)$
	$E_t = 1.088$	$E_t = 2.013$	$E_t = 2.406$	$E_t = 2.609$
1.02	7.870 (+0)	3.400 (−1)	8.254 (−2)	3.330 (−2)
1.04	1.116 (+1)	4.962 (−1)	1.230 (−1)	5.023 (−2)
1.08	1.582 (+1)	7.357 (−1)	1.876 (−1)	7.793 (−2)
1.16	2.229 (+1)	1.095 (+0)	2.876 (−1)	1.214 (−1)
1.32	3.056 (+1)	1.562 (+0)	4.174 (−1)	1.775 (−1)
1.64	3.896 (+1)	1.976 (+0)	5.251 (−1)	2.225 (−1)
2.28	4.347 (+1)	2.075 (+0)	5.414 (−1)	2.275 (−1)
3.56	4.099 (+1)	1.798 (+0)	4.599 (−1)	1.916 (−1)
6.12	3.306 (+1)	1.332 (+0)	3.344 (−1)	1.383 (−1)
11.24	2.360 (+1)	8.829 (−1)	2.183 (−1)	8.970 (−2)
21.48	1.547 (+1)	5.444 (−1)	1.329 (−1)	5.436 (−2)
41.96	9.568 (+0)	3.207 (−1)	7.757 (−2)	3.160 (−2)
50.00	8.392 (+0)	2.783 (−1)	6.715 (−2)	2.733 (−2)
75.00	6.153 (+0)	1.995 (−1)	4.792 (−2)	1.947 (−2)
100.00	4.912 (+0)	1.570 (−1)	3.760 (−2)	1.526 (−2)
150.00	3.554 (+0)	1.116 (−1)	2.663 (−2)	1.079 (−2)
250.00	2.343 (+0)	7.216 (−2)	1.715 (−2)	6.936 (−3)
400.00	1.586 (+0)	4.809 (−2)	1.139 (−2)	4.601 (−3)
700.00	9.887 (−1)	2.951 (−2)	6.966 (−3)	2.810 (−3)
1000.00	7.289 (−1)	2.156 (−2)	5.080 (−3)	2.047 (−3)

E/E_t	$Q(5p \rightarrow 4s)$	$Q(5p \rightarrow 5s)$	$Q(5p \rightarrow 6s)$	$Q(5p \rightarrow 7s)$
	$E_t = -1.153$	$E_t = -0.2283$	$E_t = 0.1650$	$E_t = 0.3682$
1.02	4.081 (+0)	3.675 (+2)	1.354 (+2)	1.706 (+0)
1.04	5.784 (+0)	5.382 (+2)	2.307 (+2)	1.706 (+0)
1.08	8.166 (+0)	8.046 (+2)	4.215 (+2)	1.027 (+1)
1.16	1.129 (+1)	1.223 (+3)	7.960 (+2)	2.412 (+1)
1.32	1.467 (+1)	1.828 (+3)	1.443 (+3)	5.098 (+1)
1.64	1.675 (+1)	2.524 (+3)	2.315 (+3)	8.778 (+1)
2.28	1.591 (+1)	3.006 (+3)	3.086 (+3)	1.135 (+2)
3.56	1.251 (+1)	2.988 (+3)	3.326 (+3)	1.110 (+2)
6.12	8.444 (+1)	2.504 (+3)	2.947 (+3)	8.721 (+1)
11.24	5.148 (+0)	1.837 (+3)	2.244 (+3)	5.937 (+1)
21.48	2.904 (+0)	1.227 (+3)	1.538 (+3)	3.703 (+1)
41.96	1.637 (+0)	7.692 (+2)	9.812 (+2)	2.192 (+1)
50.00	1.400 (+0)	6.566 (+2)	8.663 (+2)	1.903 (+1)
75.00	9.732 (−1)	4.959 (+2)	6.436 (+2)	1.366 (+1)
100.00	7.505 (−1)	3.997 (+2)	5.179 (+2)	1.075 (+1)
150.00	5.200 (−1)	2.904 (+2)	3.784 (+2)	7.614 (+0)
250.00	3.266 (−1)	1.924 (+2)	2.521 (+2)	4.914 (+0)
400.00	2.124 (−1)	1.307 (+2)	1.720 (+2)	3.295 (+0)
700.00	1.270 (−1)	8.177 (+1)	1.081 (+2)	2.022 (+0)
1000.00	9.143 (−2)	6.040 (+1)	8.004 (+1)	1.477 (+0)

E/E_t	$Q(4p \rightarrow 4s)$	$Q(4p \rightarrow 5s)$	$Q(4p \rightarrow 6s)$	$Q(4p \rightarrow 7s)$
	$E_t = -0.5617$	$E_t = 0.3633$	$E_t = 0.7565$	$E_t = 0.9598$
1.02	1.925 (+2)	5.494 (+1)	1.081 (+0)	1.730 (−1)
1.04	1.443 (+2)	8.245 (+1)	1.947 (+0)	4.026 (−1)
1.08	2.920 (+2)	1.280 (+2)	3.952 (+0)	9.150 (−1)
1.16	2.788 (+2)	2.042 (+2)	7.766 (+0)	1.894 (+0)
1.32	3.715 (+2)	3.208 (+2)	1.354 (+1)	3.349 (+0)
1.64	4.590 (+2)	4.599 (+2)	1.954 (+1)	4.817 (+0)
2.28	4.991 (+2)	5.603 (+2)	2.249 (+1)	5.431 (+0)
3.56	4.630 (+2)	5.649 (+2)	2.058 (+1)	4.833 (+0)
6.12	3.695 (+2)	4.781 (+2)	1.566 (+1)	3.580 (+0)
11.24	2.620 (+2)	3.530 (+2)	1.049 (+1)	2.348 (+0)
21.48	1.708 (+2)	2.368 (+2)	6.495 (+0)	1.429 (+0)
41.96	1.053 (+2)	1.489 (+2)	3.831 (+0)	8.313 (−1)
50.00	9.228 (+1)	1.311 (+2)	3.324 (+0)	7.191 (−1)
75.00	6.755 (+1)	9.677 (+1)	2.382 (+0)	5.121 (−1)
100.00	5.387 (+1)	7.758 (+1)	1.875 (+0)	4.014 (−1)
150.00	3.893 (+1)	5.643 (+1)	1.332 (+0)	2.837 (−1)
250.00	2.564 (+1)	3.741 (+1)	8.610 (+0)	1.823 (−1)
400.00	1.733 (+1)	2.543 (+1)	5.735 (+0)	1.209 (−1)
700.00	1.080 (+1)	1.592 (+1)	3.518 (+0)	7.380 (−2)
1000.00	7.957 (+0)	1.177 (+1)	2.570 (+0)	5.376 (−2)

E/E_t	$Q(3p \rightarrow 3d)$	$Q(3p \rightarrow 4d)$	$Q(3p \rightarrow 5d)$	$Q(3p \rightarrow 6d)$
	$E_t = 1.513$	$E_t = 2.180$	$E_t = 2.488$	$E_t = 2.656$
1.02	2.751 (+1)	3.489 (+0)	1.150 (+0)	5.349 (−1)
1.04	3.859 (+1)	4.871 (+0)	1.603 (+0)	7.447 (−1)
1.08	5.367 (+1)	6.708 (+0)	2.199 (+0)	1.020 (+0)
1.16	7.321 (+1)	8.977 (+0)	2.921 (+0)	1.349 (+0)
1.32	9.585 (+1)	1.134 (+1)	3.637 (+0)	1.668 (+0)
1.64	1.160 (+2)	1.294 (+1)	4.055 (+0)	1.838 (+0)
2.28	1.241 (+2)	1.278 (+1)	3.888 (+0)	1.736 (+0)
3.56	1.142 (+2)	1.077 (+1)	3.173 (+0)	1.395 (+0)
6.12	9.085 (+1)	7.882 (+0)	2.257 (+0)	9.788 (−1)
11.24	6.438 (+1)	5.205 (+0)	1.455 (+0)	6.236 (−1)
21.48	4.200 (+1)	3.209 (+0)	8.792 (−1)	3.733 (−1)
41.96	2.590 (+1)	1.893 (+0)	5.104 (−1)	2.150 (−1)
50.00	2.270 (+1)	1.643 (+0)	4.414 (−1)	1.856 (−1)
75.00	1.662 (+1)	1.179 (+0)	3.143 (−1)	1.317 (−1)
100.00	1.326 (+1)	9.283 (−1)	2.464 (−1)	1.030 (−1)
150.00	9.584 (+0)	6.604 (−1)	1.742 (−1)	7.257 (−2)
250.00	6.313 (+0)	4.275 (−1)	1.120 (−1)	4.650 (−2)
400.00	4.269 (+0)	2.851 (−1)	7.429 (−2)	3.076 (−2)
700.00	2.660 (+0)	1.751 (−1)	4.537 (−2)	1.873 (−2)
1000.00	1.960 (+0)	1.280 (−1)	3.306 (−2)	1.362 (−2)

TABLE IB. Electron Excitation Cross Sections for Excited State–Excited State Transitions in Sodium

See page 157 for Explanation of Tables

E/E_t	Q(4p → 3d)	Q(4p → 4d)	Q(4p → 5d)	Q(4p → 6d)
	$E_t = -0.1361$	$E_t = 0.5304$	$E_t = 0.8389$	$E_t = 1.006$
1.02	2.698 (+3)	6.695 (+1)	9.113 (+0)	3.084 (+0)
1.04	3.718 (+3)	9.765 (+1)	1.323 (+1)	4.459 (+0)
1.08	5.002 (+3)	1.453 (+2)	1.951 (+1)	6.543 (+0)
1.16	6.435 (+3)	2.208 (+2)	2.924 (+1)	9.742 (+0)
1.32	7.674 (+3)	3.360 (+2)	4.356 (+1)	1.439 (+1)
1.64	8.164 (+3)	4.866 (+2)	6.046 (+1)	1.957 (+1)
2.28	7.537 (+3)	6.211 (+2)	7.137 (+1)	2.229 (+1)
3.56	6.037 (+3)	6.601 (+2)	6.871 (+1)	2.061 (+1)
6.12	4.289 (+3)	5.838 (+2)	5.519 (+1)	1.595 (+1)
11.24	2.785 (+3)	4.457 (+2)	3.883 (+1)	1.089 (+1)
21.48	1.702 (+3)	3.062 (+2)	2.503 (+1)	6.860 (+0)
41.96	9.987 (+2)	1.959 (+2)	1.525 (+1)	4.105 (+0)
50.00	8.660 (+2)	1.731 (+2)	1.333 (+1)	3.573 (+0)
75.00	6.203 (+2)	1.287 (+2)	9.702 (+0)	2.579 (+0)
100.00	4.880 (+2)	1.037 (+2)	7.709 (+0)	2.039 (+0)
150.00	3.467 (+2)	7.583 (+1)	5.544 (+0)	1.457 (+0)
250.00	2.242 (+2)	5.057 (+1)	3.632 (+0)	9.478 (−1)
400.00	1.494 (+2)	3.453 (+1)	2.446 (+0)	6.346 (−1)
700.00	9.170 (+1)	2.172 (+1)	1.517 (+0)	3.913 (−1)
1000.00	6.701 (+1)	1.609 (+1)	1.115 (+0)	2.867 (−1)

E/E_t	Q(5p → 3d)	Q(5p → 4d)	Q(5p → 5d)	Q(5p → 6d)
	$E_t = -0.7277$	$E_t = -0.06116$	$E_t = 0.2473$	$E_t = 0.4148$
1.02	1.699 (+1)	2.076 (+4)	1.957 (+2)	2.733 (+1)
1.04	2.305 (+1)	2.864 (+4)	2.739 (+2)	3.690 (+1)
1.08	3.016 (+1)	3.857 (+4)	3.855 (+2)	4.969 (+1)
1.16	3.708 (+1)	4.977 (+4)	5.614 (+2)	7.048 (+1)
1.32	4.133 (+1)	5.976 (+4)	8.783 (+2)	1.101 (+2)
1.64	3.976 (+1)	6.450 (+4)	1.414 (+3)	1.731 (+2)
2.28	3.156 (+1)	6.099 (+4)	2.053 (+3)	2.357 (+2)
3.56	2.100 (+1)	5.017 (+4)	2.445 (+3)	2.542 (+2)
6.12	1.235 (+1)	3.645 (+4)	2.354 (+3)	2.206 (+2)
11.24	6.735 (+0)	2.412 (+4)	1.904 (+3)	1.630 (+2)
21.48	3.526 (+0)	1.495 (+4)	1.361 (+3)	1.086 (+2)
41.96	1.808 (+0)	8.875 (+3)	8.951 (+2)	6.770 (+1)
50.00	1.518 (+0)	7.715 (+3)	7.952 (+2)	5.945 (+1)
75.00	1.013 (+0)	5.555 (+3)	5.982 (+2)	4.369 (+1)
100.00	7.668 (−1)	4.365 (+3)	4.851 (+2)	3.492 (+1)
150.00	5.081 (−1)	3.128 (+3)	3.577 (+2)	2.530 (+1)
250.00	3.055 (−1)	2.032 (+3)	2.406 (+2)	1.670 (+1)
400.00	1.914 (−1)	1.359 (+3)	1.653 (+2)	1.131 (+1)
700.00	1.097 (−1)	8.370 (+2)	1.047 (+2)	7.058 (+0)
1000.00	7.689 (−2)	6.129 (+2)	7.780 (+1)	5.206 (+0)

TABLE IC. Electron Excitation Cross Sections for Excited State–Excited State Transitions in Potassium

See page 157 for Explanation of Tables

E/E_t	Q(4p → 5s)	Q(4p → 6s)	Q(4p → 7s)	Q(4p → 8s)
	$E_t = 0.9922$	$E_t = 1.789$	$E_t = 2.139$	$E_t = 2.324$
1.02	6.601 (+0)	2.737 (−1)	6.473 (−2)	2.602 (−2)
1.04	9.552 (+0)	4.242 (−1)	1.050 (−1)	4.335 (−2)
1.08	1.402 (+1)	6.853 (−1)	1.789 (−1)	7.592 (−2)
1.16	2.077 (+1)	1.125 (+0)	3.068 (−1)	1.328 (−1)
1.32	3.028 (+1)	1.753 (+0)	4.867 (−1)	2.119 (−1)
1.64	4.087 (+1)	2.365 (+0)	6.522 (−1)	2.827 (−1)
2.28	4.761 (+1)	2.610 (+0)	7.080 (−1)	3.047 (−1)
3.56	4.632 (+1)	2.356 (+0)	6.276 (−1)	2.681 (−1)
6.12	3.822 (+1)	1.801 (+0)	4.716 (−1)	2.001 (−1)
11.24	2.774 (+1)	1.222 (+0)	3.155 (−1)	1.331 (−1)
21.48	1.839 (+1)	7.670 (−1)	1.958 (−1)	8.228 (−2)
41.96	1.146 (+1)	4.581 (−1)	1.160 (−1)	4.856 (−2)
50.00	1.007 (+1)	3.987 (−1)	1.007 (−1)	4.215 (−2)
75.00	7.411 (+0)	2.876 (−1)	7.237 (−2)	3.024 (−2)
100.00	5.928 (+0)	2.273 (−1)	5.704 (−2)	2.381 (−2)
150.00	4.300 (+0)	1.623 (−1)	4.061 (−2)	1.693 (−2)
250.00	2.843 (+0)	1.056 (−1)	2.632 (−2)	1.096 (−2)
400.00	1.928 (+0)	7.065 (−2)	1.757 (−2)	7.306 (−3)
700.00	1.205 (+0)	4.355 (−2)	1.080 (−2)	4.486 (−3)
1000.00	8.894 (−1)	3.191 (−2)	7.896 (−3)	3.279 (−3)

E/E_t	Q(6p → 5s)	Q(6p → 6s)	Q(6p → 7s)	Q(6p → 8s)
	$E_t = -0.9892$	$E_t = -0.1927$	$E_t = 0.1574$	$E_t = 0.3423$
1.02	5.247 (+0)	5.632 (+2)	7.735 (+1)	2.562 (+0)
1.04	7.489 (+0)	8.219 (+2)	1.501 (+2)	4.643 (+0)
1.08	1.068 (+1)	1.222 (+3)	3.116 (+2)	9.534 (+0)
1.16	1.497 (+1)	1.842 (+3)	6.524 (+2)	2.171 (+1)
1.32	1.966 (+1)	2.732 (+3)	1.277 (+3)	4.885 (+1)
1.64	2.252 (+1)	3.741 (+3)	2.173 (+3)	9.055 (+1)
2.28	2.131 (+1)	4.426 (+3)	3.038 (+3)	1.242 (+2)
3.56	1.660 (+1)	4.376 (+3)	3.387 (+3)	1.264 (+2)
6.12	1.107 (+1)	3.655 (+3)	3.070 (+3)	1.023 (+2)
11.24	6.666 (+0)	2.674 (+3)	2.374 (+3)	7.114 (+1)
21.48	3.779 (+0)	1.783 (+3)	1.643 (+3)	4.507 (+1)
41.96	2.072 (+0)	1.116 (+3)	1.056 (+3)	2.700 (+1)
50.00	1.767 (+0)	9.816 (+2)	9.336 (+2)	2.350 (+1)
75.00	1.221 (+0)	7.235 (+2)	6.957 (+2)	1.636 (+1)
100.00	9.387 (−1)	5.794 (+2)	5.608 (+2)	1.340 (+1)
150.00	6.465 (−1)	4.208 (+2)	4.106 (+2)	9.568 (+0)
250.00	4.037 (−1)	2.786 (+2)	2.742 (+2)	6.218 (+0)
400.00	2.613 (−1)	1.892 (+2)	1.874 (+2)	4.159 (+0)
700.00	1.553 (−1)	1.183 (+2)	1.180 (+2)	2.562 (+0)
1000.00	1.114 (−1)	8.739 (+1)	8.744 (+1)	1.876 (+0)

E/E_t	Q(5p → 5s)	Q(5p → 6s)	Q(5p → 7s)	Q(5p → 8s)
	$E_t = -0.4572$	$E_t = 0.3393$	$E_t = 0.6894$	$E_t = 0.8743$
1.02	1.609 (−2)	3.939 (+1)	6.317 (−1)	1.347 (−1)
1.04	2.265 (+2)	6.220 (+1)	1.496 (+0)	3.512 (−1)
1.08	3.170 (+2)	1.037 (+2)	3.488 (+0)	8.558 (−1)
1.16	4.373 (+2)	1.792 (+2)	7.505 (+0)	1.874 (+0)
1.32	5.824 (+2)	3.026 (+2)	1.401 (+1)	3.535 (+0)
1.64	7.191 (+2)	4.581 (+2)	2.156 (+1)	5.449 (+0)
2.28	7.812 (+2)	5.821 (+2)	2.616 (+1)	6.491 (+0)
3.56	7.240 (+2)	6.057 (+2)	2.490 (+1)	6.013 (+0)
6.12	5.774 (+2)	5.240 (+2)	1.948 (+1)	4.586 (+0)
11.24	4.091 (+2)	3.927 (+2)	1.333 (+1)	3.072 (+0)
21.48	2.667 (+2)	2.661 (+2)	8.385 (+0)	1.901 (+0)
41.96	1.643 (+2)	1.686 (+2)	5.006 (+0)	1.120 (+0)
50.00	1.440 (+2)	1.486 (+2)	4.355 (+0)	9.717 (−1)
75.00	1.054 (+2)	1.100 (+2)	3.139 (+0)	6.962 (−1)
100.00	8.403 (+1)	8.838 (+1)	2.479 (+0)	5.477 (−1)
150.00	6.072 (+1)	6.442 (+1)	1.769 (+0)	3.890 (−1)
250.00	3.998 (+1)	4.281 (+1)	1.149 (+0)	2.514 (−1)
400.00	2.703 (+1)	2.915 (+1)	7.684 (−1)	1.674 (−1)
700.00	1.683 (+1)	1.829 (+1)	4.732 (−1)	1.026 (−1)
1000.00	1.240 (+1)	1.353 (+1)	3.465 (−1)	7.496 (−2)

E/E_t	Q(4p → 3d)	Q(4p → 4d)	Q(4p → 5d)	Q(4p → 6d)
	$E_t = 1.055$	$E_t = 1.782$	$E_t = 2.128$	$E_t = 2.315$
1.02	1.178 (+2)	5.935 (+0)	1.484 (+0)	5.326 (−1)
1.04	1.636 (+2)	8.081 (+0)	2.000 (+0)	7.131 (−1)
1.08	2.233 (+2)	1.063 (+1)	2.583 (+0)	9.095 (−1)
1.16	2.950 (+2)	1.314 (+1)	3.094 (+0)	1.068 (+0)
1.32	3.681 (+2)	1.468 (+1)	3.295 (+0)	1.105 (+0)
1.64	4.193 (+2)	1.420 (+1)	2.990 (+0)	9.707 (−1)
2.28	4.211 (+2)	1.154 (+1)	2.268 (+0)	7.204 (−1)
3.56	3.664 (+2)	7.949 (+0)	1.472 (+0)	4.704 (−1)
6.12	2.790 (+2)	4.820 (+0)	8.586 (−1)	2.856 (−1)
11.24	1.914 (+2)	2.692 (+0)	4.703 (−1)	1.668 (−1)
21.48	1.219 (+2)	1.433 (+0)	2.489 (−1)	9.504 (−2)
41.96	7.388 (+1)	7.440 (−1)	1.294 (−1)	5.323 (−2)
50.00	6.451 (+1)	6.263 (−1)	1.091 (−1)	4.571 (−2)
75.00	4.688 (+1)	4.205 (−1)	7.351 (−2)	3.211 (−2)
100.00	3.722 (+1)	3.169 (−1)	5.556 (−2)	2.497 (−2)
150.00	2.675 (+1)	2.126 (−1)	3.745 (−2)	1.748 (−2)
250.00	1.751 (+1)	1.286 (−1)	2.279 (−2)	1.113 (−2)
400.00	1.178 (+1)	8.093 (−2)	1.443 (−2)	7.325 (−3)
700.00	7.304 (+0)	4.662 (−2)	8.375 (−3)	4.438 (−3)
1000.00	5.368 (+0)	3.281 (−2)	5.920 (−3)	3.220 (−3)

TABLE IC. Electron Excitation Cross Sections for Excited State–Excited State Transitions in Potassium

See page 157 for Explanation of Tables

E/E_t	Q(5p → 3d)	Q(5p → 4d)	Q(5p → 5d)	Q(5p → 6d)
	$E_t=-0.3941$	$E_t=0.3327$	$E_t=0.6784$	$E_t=0.8657$
1.02	1.560 (+2)	7.426 (+2)	3.403 (+1)	8.226 (+0)
1.04	2.188 (+2)	1.047 (+3)	4.808 (+1)	1.167 (+1)
1.08	3.044 (+2)	1.467 (+3)	6.739 (+1)	1.637 (+1)
1.16	4.156 (+2)	2.027 (+3)	9.121 (+1)	2.197 (+1)
1.32	5.456 (+2)	2.698 (+3)	1.140 (+2)	2.656 (+1)
1.64	6.613 (+2)	3.320 (+3)	1.234 (+2)	2.713 (+1)
2.28	7.030 (+2)	3.599 (+3)	1.108 (+2)	2.260 (+1)
3.56	6.370 (+2)	3.343 (+3)	8.194 (+1)	1.551 (+1)
6.12	4.989 (+2)	2.677 (+3)	5.207 (+1)	9.256 (+0)
11.24	3.489 (+2)	1.904 (+3)	3.000 (+1)	5.079 (+0)
21.48	2.254 (+2)	1.245 (+3)	1.635 (+1)	2.663 (+0)
41.96	1.389 (+2)	7.689 (+2)	8.643 (+0)	1.364 (+0)
50.00	1.207 (+2)	6.741 (+2)	7.309 (+0)	1.145 (+0)
75.00	8.813 (+1)	4.946 (+2)	4.954 (+0)	7.631 (−1)
100.00	7.016 (+1)	3.942 (+2)	3.758 (+0)	5.723 (−1)
150.00	5.059 (+1)	2.851 (+2)	2.541 (+0)	3.816 (−1)
250.00	3.324 (+1)	1.879 (+2)	1.555 (+0)	2.289 (−1)
400.00	2.243 (+1)	1.271 (+2)	9.878 (−1)	1.431 (−1)
700.00	1.394 (+1)	7.922 (+1)	5.753 (−1)	8.177 (−2)
1000.00	1.026 (+1)	5.840 (+1)	4.075 (−1)	5.724 (−2)

E/E_t	Q(6p → 3d)	Q(6p → 4d)	Q(6p → 5d)	Q(6p → 6d)
	$E_t=-0.9261$	$E_t=-0.1993$	$E_t=0.1464$	$E_t=0.3337$
1.02	3.540 (+0)	4.387 (+2)	2.957 (+3)	1.022 (+2)
1.04	5.208 (+0)	6.390 (+2)	4.236 (+3)	1.488 (+2)
1.08	7.781 (+0)	9.462 (+2)	6.108 (+3)	2.188 (+2)
1.16	1.154 (+1)	1.414 (+3)	8.809 (+3)	3.198 (+2)
1.32	1.597 (+1)	2.066 (+3)	1.240 (+4)	4.452 (+2)
1.64	1.890 (+1)	2.778 (+3)	1.624 (+4)	5.458 (+2)
2.28	1.829 (+1)	3.251 (+3)	1.873 (+4)	5.412 (+2)
3.56	1.466 (+1)	3.211 (+3)	1.830 (+4)	4.278 (+2)
6.12	1.011 (+1)	2.689 (+3)	1.521 (+4)	2.831 (+2)
11.24	6.300 (+0)	1.975 (+3)	1.111 (+4)	1.673 (+2)
21.48	3.690 (+0)	1.321 (+3)	7.399 (+3)	9.277 (+1)
41.96	2.084 (+0)	8.292 (+2)	4.631 (+3)	4.972 (+1)
50.00	1.790 (+0)	7.295 (+2)	4.072 (+3)	4.217 (+1)
75.00	1.257 (+0)	5.383 (+2)	3.001 (+3)	2.857 (+1)
100.00	9.761 (−1)	4.311 (+2)	2.404 (+3)	2.192 (+1)
150.00	6.819 (−1)	3.136 (+2)	1.746 (+3)	1.492 (+1)
250.00	4.325 (−1)	2.079 (+2)	1.156 (+3)	9.184 (+0)
400.00	2.837 (−1)	1.412 (+2)	7.848 (+2)	5.870 (+0)
700.00	1.712 (−1)	8.840 (+1)	4.909 (+2)	3.442 (+0)
1000.00	1.239 (−1)	6.532 (+1)	3.626 (+2)	2.448 (+0)

TABLE ID. Electron Excitation Cross Sections for Excited State–Excited State Transitions in Rubidium

See page 157 for Explanation of Tables

E/E_t	$Q(5p \rightarrow 6s)$	$Q(5p \rightarrow 7s)$	$Q(5p \rightarrow 8s)$	$Q(5p \rightarrow 9s)$
	$E_t = 0.9170$	$E_t = 1.683$	$E_t = 2.022$	$E_t = 2.202$
1.02	8.589 (+0)	3.390 (−1)	7.943 (−2)	3.191 (−2)
1.04	1.240 (+1)	5.244 (−1)	1.287 (−1)	5.309 (−2)
1.08	1.813 (+1)	8.445 (−1)	2.187 (−1)	9.276 (−2)
1.16	2.672 (+1)	1.381 (+0)	3.739 (−1)	1.617 (−1)
1.32	3.870 (+1)	2.142 (+0)	5.908 (−1)	2.571 (−1)
1.64	5.193 (+1)	2.878 (+0)	7.894 (−1)	3.423 (−1)
2.28	6.023 (+1)	3.167 (+0)	8.556 (−1)	3.686 (−1)
3.56	5.814 (+1)	2.852 (+0)	7.572 (−1)	3.240 (−1)
6.12	4.813 (+1)	2.174 (+0)	5.678 (−1)	2.414 (−1)
11.24	3.488 (+1)	1.471 (+0)	3.791 (−1)	1.604 (−1)
21.48	2.310 (+1)	9.216 (−1)	2.349 (−1)	9.898 (−2)
41.96	1.440 (+1)	5.495 (−1)	1.389 (−1)	5.835 (−2)
50.00	1.265 (+1)	4.781 (−1)	1.206 (−1)	5.063 (−2)
75.00	9.302 (+0)	3.446 (−1)	8.660 (−2)	3.630 (−2)
100.00	7.440 (+0)	2.721 (−1)	6.823 (−2)	2.858 (−2)
150.00	5.395 (+0)	1.943 (−1)	4.855 (−2)	2.031 (−2)
250.00	3.567 (+0)	1.262 (−1)	3.144 (−2)	1.314 (−2)
400.00	2.419 (+0)	8.444 (−2)	2.098 (−2)	8.756 (−3)
700.00	1.511 (+0)	5.202 (−2)	1.289 (−2)	5.374 (−3)
1000.00	1.115 (+0)	3.810 (−2)	9.422 (−3)	3.927 (−3)

E/E_t	$Q(7p \rightarrow 6s)$	$Q(7p \rightarrow 7s)$	$Q(7p \rightarrow 8s)$	$Q(7p \rightarrow 9s)$
	$E_t = -0.9578$	$E_t = -0.1918$	$E_t = 0.1473$	$E_t = 0.3274$
1.02	4.964 (+0)	4.876 (+2)	1.142 (+2)	2.515 (+0)
1.04	7.178 (+0)	7.194 (+2)	2.108 (+2)	4.945 (+0)
1.08	1.046 (+1)	1.088 (+3)	4.182 (+2)	1.087 (+1)
1.16	1.506 (+1)	1.679 (+3)	8.464 (+2)	2.561 (+1)
1.32	2.037 (+1)	2.552 (+3)	1.617 (+3)	5.775 (+1)
1.64	2.400 (+1)	3.573 (+3)	2.704 (+3)	1.058 (+2)
2.28	2.329 (+1)	4.304 (+3)	3.729 (+3)	1.432 (+2)
3.56	1.854 (+1)	4.312 (+3)	4.117 (+3)	1.441 (+2)
6.12	1.259 (+1)	3.635 (+3)	3.707 (+3)	1.154 (+2)
11.24	7.703 (+0)	2.677 (+3)	2.854 (+3)	7.960 (+1)
21.48	4.427 (+0)	1.793 (+3)	1.970 (+3)	5.010 (+1)
41.96	2.455 (+0)	1.126 (+3)	1.263 (+3)	2.986 (+1)
50.00	2.100 (+0)	9.909 (+2)	1.116 (+3)	2.596 (+1)
75.00	1.461 (+0)	7.313 (+2)	8.311 (+2)	1.869 (+1)
100.00	1.127 (+0)	5.861 (+2)	6.697 (+2)	1.474 (+1)
150.00	7.897 (−1)	4.262 (+2)	4.900 (+2)	1.050 (+1)
250.00	4.904 (−1)	2.825 (+2)	3.270 (+2)	6.812 (+0)
400.00	3.190 (−1)	1.919 (+2)	2.234 (+2)	4.549 (+0)
700.00	1.908 (−1)	1.202 (+2)	1.405 (+2)	2.797 (+0)
1000.00	1.374 (−1)	8.879 (+1)	1.042 (+2)	2.046 (+0)

E/E_t	$Q(6p \rightarrow 6s)$	$Q(6p \rightarrow 7s)$	$Q(6p \rightarrow 8s)$	$Q(6p \rightarrow 9s)$
	$E_t = -0.4505$	$E_t = 0.3155$	$E_t = 0.6546$	$E_t = 0.8347$
1.02	1.501 (+2)	5.383 (+1)	8.135 (−1)	1.586 (−1)
1.04	2.123 (+2)	8.378 (+1)	1.861 (+0)	4.134 (−1)
1.08	2.994 (+2)	1.370 (+2)	4.248 (+0)	1.007 (+0)
1.16	4.180 (+2)	2.319 (+2)	9.028 (+0)	2.206 (+0)
1.32	5.657 (+2)	3.848 (+2)	1.672 (+1)	4.157 (+0)
1.64	7.105 (+2)	5.753 (+2)	2.553 (+1)	6.378 (+0)
2.28	7.831 (+2)	7.243 (+2)	3.072 (+1)	7.540 (+0)
3.56	7.340 (+2)	7.486 (+2)	2.900 (+1)	6.929 (+0)
6.12	5.901 (+2)	6.446 (+2)	2.252 (+1)	5.246 (+0)
11.24	4.206 (+2)	4.816 (+2)	1.532 (+1)	3.494 (+0)
21.48	2.753 (+2)	3.257 (+2)	9.585 (+0)	2.151 (+0)
41.96	1.701 (+2)	2.059 (+2)	5.699 (+0)	1.263 (+0)
50.00	1.491 (+2)	1.815 (+2)	4.954 (+0)	1.094 (+0)
75.00	1.093 (+2)	1.343 (+2)	3.564 (+0)	7.825 (−1)
100.00	8.723 (+1)	1.078 (+2)	2.811 (+0)	6.149 (−1)
150.00	6.309 (+1)	7.857 (+1)	2.003 (+0)	4.361 (−1)
250.00	4.159 (+1)	5.219 (+1)	1.299 (+0)	2.813 (−1)
400.00	2.814 (+1)	3.553 (+1)	8.675 (−1)	1.871 (−1)
700.00	1.754 (+1)	2.228 (+1)	5.335 (−1)	1.145 (−1)
1000.00	1.293 (+1)	1.648 (+1)	3.903 (−1)	8.358 (−2)

E/E_t	$Q(5p \rightarrow 4d)$	$Q(5p \rightarrow 5d)$	$Q(5p \rightarrow 6d)$	$Q(5p \rightarrow 7d)$
	$E_t = 0.8205$	$E_t = 1.607$	$E_t = 1.978$	$E_t = 2.175$
1.02	2.402 (+2)	4.869 (+0)	1.040 (+0)	4.009 (−1)
1.04	3.322 (+2)	6.541 (+0)	1.383 (+0)	5.305 (−1)
1.08	4.501 (+2)	8.384 (+0)	1.740 (+0)	6.630 (−1)
1.16	5.869 (+2)	9.908 (+0)	1.999 (+0)	7.563 (−1)
1.32	7.171 (+2)	1.031 (+1)	2.026 (+0)	7.694 (−1)
1.64	7.934 (+2)	9.104 (+0)	1.810 (+0)	7.161 (−1)
2.28	7.712 (+2)	6.839 (+0)	1.507 (+0)	6.484 (−1)
3.56	6.508 (+2)	4.619 (+0)	1.231 (+0)	5.762 (−1)
6.12	4.836 (+2)	2.992 (+0)	9.695 (−1)	4.768 (−1)
11.24	3.255 (+2)	1.899 (+0)	7.109 (−1)	3.570 (−1)
21.48	2.045 (+2)	1.176 (+0)	4.832 (−1)	2.444 (−1)
41.96	1.226 (+2)	7.088 (−1)	3.088 (−1)	1.565 (−1)
50.00	1.068 (+2)	6.191 (−1)	2.729 (−1)	1.383 (−1)
75.00	7.728 (+1)	4.508 (−1)	2.032 (−1)	1.030 (−1)
100.00	6.118 (+1)	3.586 (−1)	1.638 (−1)	8.303 (−2)
150.00	4.380 (+1)	2.586 (−1)	1.200 (−1)	6.079 (−2)
250.00	2.856 (+1)	1.700 (−1)	8.017 (−2)	4.060 (−2)
400.00	1.916 (+1)	1.148 (−1)	5.481 (−2)	2.775 (−2)
700.00	1.184 (+1)	7.148 (−2)	3.453 (−2)	1.747 (−2)
1000.00	8.686 (+0)	5.266 (−2)	2.561 (−2)	1.295 (−2)

TABLE ID. Electron Excitation Cross Sections for Excited State–Excited State Transitions in Rubidium

See page 157 for Explanation of Tables

E/E_t	$Q(6p \rightarrow 4d)$ $E_t = -0.5470$	$Q(6p \rightarrow 5d)$ $E_t = 0.2400$	$Q(6p \rightarrow 6d)$ $E_t = 0.6102$	$Q(6p \rightarrow 7d)$ $E_t = 0.8077$
1.02	2.572 (+1)	1.960 (+3)	4.245 (+1)	8.308 (+0)
1.04	3.777 (+1)	2.727 (+3)	5.848 (+1)	1.147 (+1)
1.08	5.670 (+1)	3.735 (+3)	7.840 (+1)	1.538 (+1)
1.16	8.643 (+1)	4.967 (+3)	9.942 (+1)	1.929 (+1)
1.32	1.290 (+2)	6.265 (+3)	1.131 (+2)	2.112 (+1)
1.64	1.755 (+2)	7.237 (+3)	1.079 (+2)	1.898 (+1)
2.28	2.033 (+2)	7.368 (+3)	8.385 (+1)	1.423 (+1)
3.56	1.968 (+2)	6.483 (+3)	5.489 (+1)	9.685 (+0)
6.12	1.621 (+2)	4.980 (+3)	3.247 (+1)	6.465 (+0)
11.24	1.177 (+2)	3.436 (+3)	1.846 (+1)	4.272 (+0)
21.48	7.814 (+1)	2.198 (+3)	1.035 (+1)	2.744 (+0)
41.96	4.880 (+1)	1.336 (+3)	5.758 (+0)	1.701 (+0)
50.00	4.288 (+1)	1.167 (+3)	4.942 (+0)	1.495 (+0)
75.00	3.158 (+1)	8.432 (+2)	3.469 (+0)	1.102 (+0)
100.00	2.527 (+1)	6.747 (+2)	2.698 (+0)	8.839 (−1)
150.00	1.834 (+1)	4.853 (+2)	1.891 (+0)	6.430 (−1)
250.00	1.214 (+1)	3.180 (+2)	1.205 (+0)	4.269 (−1)
400.00	8.236 (+0)	2.142 (+2)	7.947 (−1)	2.906 (−1)
700.00	5.149 (+0)	1.329 (+2)	4.825 (−1)	1.823 (−1)
1000.00	3.802 (+0)	9.771 (+1)	3.504 (−1)	1.348 (−1)

E/E_t	$Q(7p \rightarrow 4d)$ $E_t = -1.054$	$Q(7p \rightarrow 5d)$ $E_t = -0.2673$	$Q(7p \rightarrow 6d)$ $E_t = 0.1029$	$Q(7p \rightarrow 7d)$ $E_t = 0.3001$
1.02	1.571 (+0)	1.092 (+2)	9.610 (+3)	1.417 (+2)
1.04	2.374 (+0)	1.575 (+2)	1.348 (+4)	2.053 (+2)
1.08	3.671 (+0)	2.294 (+2)	1.875 (+4)	2.976 (+2)
1.16	5.628 (+0)	3.359 (+2)	2.556 (+4)	4.153 (+2)
1.32	7.964 (+0)	4.866 (+2)	3.340 (+4)	5.267 (+2)
1.64	9.641 (+0)	6.776 (+2)	4.020 (+4)	5.633 (+2)
2.28	9.723 (+0)	8.570 (+2)	4.260 (+4)	4.783 (+2)
3.56	8.219 (+0)	9.177 (+2)	3.880 (+4)	3.236 (+2)
6.12	5.987 (+0)	8.214 (+2)	3.059 (+4)	1.917 (+2)
11.24	3.925 (+0)	6.334 (+2)	2.151 (+4)	1.051 (+2)
21.48	2.401 (+0)	4.585 (+2)	1.395 (+4)	5.653 (+1)
41.96	1.400 (+0)	2.871 (+2)	8.565 (+3)	3.066 (+1)
50.00	1.219 (+0)	2.491 (+2)	7.560 (+3)	2.551 (+1)
75.00	8.713 (−1)	1.860 (+2)	5.481 (+3)	1.718 (+1)
100.00	6.846 (−1)	1.500 (+2)	4.367 (+3)	1.327 (+1)
150.00	4.853 (−1)	1.059 (+2)	3.152 (+3)	9.413 (+0)
250.00	3.133 (−1)	7.341 (+1)	2.073 (+3)	5.795 (+0)
400.00	2.084 (−1)	5.019 (+1)	1.400 (+3)	3.684 (+0)
700.00	1.276 (−1)	3.161 (+1)	8.711 (+2)	2.187 (+0)
1000.00	9.315 (−2)	2.314 (+1)	6.415 (+2)	1.567 (+0)

TABLE IE. Electron Excitation Cross Sections for Excited State–Excited State Transitions in Cesium

See page 157 for Explanation of Tables

E/E$_t$	Q(6p → 7s)	Q(6p → 8s)	Q(6p → 9s)	Q(6p → 10s)
	E$_t$=0.8664	E$_t$=1.583	E$_t$=1.905	E$_t$=2.077
1.02	2.891 (−2)	8.462 (+0)	3.153 (−1)	7.230 (−2)
1.04	5.102 (−2)	1.234 (+1)	5.050 (−1)	1.232 (−1)
1.08	9.467 (−2)	1.832 (+1)	8.499 (−1)	2.215 (−1)
1.16	1.732 (−1)	2.762 (+1)	1.453 (+0)	3.973 (−1)
1.32	2.849 (−1)	4.101 (+1)	2.332 (+0)	6.498 (−1)
1.64	3.895 (−1)	5.621 (+1)	3.212 (+0)	8.909 (−1)
2.28	4.294 (−1)	6.623 (+1)	3.608 (+0)	9.875 (−1)
3.56	3.843 (−1)	6.503 (+1)	3.303 (+0)	8.894 (−1)
6.12	2.902 (−1)	5.402 (+1)	2.548 (+0)	6.755 (−1)
11.24	1.946 (−1)	3.939 (+1)	1.739 (+0)	4.552 (−1)
21.48	1.210 (−1)	2.619 (+1)	1.096 (+0)	2.841 (−1)
41.96	7.175 (−2)	1.637 (+1)	6.569 (−1)	1.689 (−1)
50.00	6.234 (−2)	1.439 (+1)	5.721 (−1)	1.468 (−1)
75.00	4.482 (−2)	1.060 (+1)	4.133 (−1)	1.057 (−1)
100.00	3.533 (−2)	8.463 (+0)	3.268 (−1)	8.338 (−2)
150.00	2.517 (−2)	6.158 (+0)	2.337 (−1)	5.945 (−2)
250.00	1.632 (−2)	4.074 (+0)	1.521 (−1)	3.858 (−2)
400.00	1.089 (−2)	2.765 (+0)	1.019 (−1)	2.578 (−2)
700.00	6.699 (−3)	1.729 (+0)	6.289 (−2)	1.587 (−2)
1000.00	4.901 (−3)	1.276 (+0)	4.610 (−2)	1.161 (−2)

E/E$_t$	Q(8p → 7s)	Q(8p → 8s)	Q(8p → 9s)	Q(8p → 10s)
	E$_t$=−0.8963	E$_t$=−0.1794	E$_t$=0.1421	E$_t$=0.3144
1.02	3.061 (+0)	5.302 (+0)	5.528 (+2)	9.973 (+1)
1.04	5.391 (+0)	7.732 (+0)	8.170 (+2)	1.929 (+2)
1.08	1.097 (+1)	1.141 (+1)	1.239 (+3)	3.994 (+2)
1.16	2.549 (+1)	1.668 (+1)	1.918 (+3)	8.352 (+2)
1.32	5.902 (+1)	2.289 (+1)	2.926 (+3)	1.635 (+3)
1.64	1.112 (+2)	2.724 (+1)	4.108 (+3)	2.789 (+3)
2.28	1.536 (+2)	2.661 (+1)	4.959 (+3)	3.907 (+3)
3.56	1.567 (+2)	2.124 (+1)	4.977 (+3)	4.361 (+3)
6.12	1.267 (+2)	1.445 (+1)	4.200 (+3)	3.957 (+3)
11.24	8.793 (+1)	8.838 (+0)	3.096 (+3)	3.061 (+3)
21.48	5.569 (+1)	5.077 (+0)	2.074 (+3)	2.120 (+3)
41.96	3.325 (+1)	2.814 (+0)	1.303 (+3)	1.363 (+3)
50.00	2.893 (+1)	2.407 (+0)	1.147 (+3)	1.205 (+3)
75.00	2.065 (+1)	1.673 (+0)	8.466 (+2)	8.978 (+2)
100.00	1.647 (+1)	1.291 (+0)	6.786 (+2)	7.238 (+2)
150.00	1.175 (+1)	8.940 (−1)	4.935 (+2)	5.300 (+2)
250.00	7.629 (+0)	5.614 (−1)	3.271 (+2)	3.539 (+2)
400.00	5.100 (+0)	3.651 (−1)	2.223 (+2)	2.419 (+2)
700.00	3.140 (+0)	2.183 (−1)	1.392 (+2)	1.523 (+2)
1000.00	2.298 (+0)	1.571 (−1)	1.029 (+2)	1.129 (+2)

E/E$_t$	Q(7p → 7s)	Q(7p → 8s)	Q(7p → 9s)	Q(7p → 10s)
	E$_t$=−0.4155	E$_t$=0.3014	E$_t$=0.6229	E$_t$=0.7952
1.02	1.615 (−1)	1.739 (+2)	5.045 (+1)	7.257 (−1)
1.04	4.171 (−1)	2.461 (+2)	8.016 (+1)	1.780 (+0)
1.08	1.019 (+0)	3.479 (+2)	1.347 (+2)	4.240 (+0)
1.16	2.267 (+0)	4.875 (+2)	2.348 (+2)	9.273 (+0)
1.32	4.394 (+0)	6.629 (+2)	3.992 (+2)	1.761 (+1)
1.64	6.938 (+0)	8.365 (+2)	6.082 (+2)	2.759 (+1)
2.28	8.375 (+0)	9.256 (+2)	7.771 (+2)	3.386 (+1)
3.56	7.809 (+0)	8.701 (+2)	8.121 (+2)	3.241 (+1)
6.12	5.973 (+0)	7.010 (+2)	7.046 (+2)	2.542 (+1)
11.24	4.007 (+0)	5.003 (+2)	5.291 (+2)	1.741 (+1)
21.48	2.480 (+0)	3.278 (+2)	3.590 (+2)	1.095 (+1)
41.96	1.462 (+0)	2.027 (+2)	2.276 (+2)	6.534 (+0)
50.00	1.268 (+0)	1.778 (+2)	2.007 (+2)	5.684 (+0)
75.00	9.085 (−1)	1.303 (+2)	1.487 (+2)	4.096 (+0)
100.00	7.147 (−1)	1.040 (+2)	1.194 (+2)	3.234 (+0)
150.00	5.076 (−1)	7.525 (+1)	8.709 (+1)	2.308 (+0)
250.00	3.280 (−1)	4.962 (+1)	5.790 (+1)	1.499 (+0)
400.00	2.184 (−1)	3.358 (+1)	3.943 (+1)	1.002 (+0)
700.00	1.339 (−1)	2.094 (+1)	2.474 (+1)	6.170 (−1)
1000.00	9.780 (−2)	1.543 (+1)	1.831 (+1)	4.51 (−1)

E/E$_t$	Q(6p → 5s)	Q(6p → 6d)	Q(6p → 7d)	Q(6p → 8d)
	E$_t$=0.5772	E$_t$=1.372	E$_t$=1.799	E$_t$=2.017
1.02	1.017 (−3)	2.784 (+0)	7.083 (−1)	2.963 (−1)
1.04	1.402 (−3)	3.910 (+0)	9.981 (−1)	4.175 (−1)
1.08	1.888 (−3)	5.470 (+0)	1.405 (+0)	5.874 (−1)
1.16	2.432 (−3)	7.642 (+0)	1.980 (+0)	8.276 (−1)
1.32	2.904 (−3)	1.073 (+1)	2.805 (+0)	1.169 (+0)
1.64	3.053 (−3)	1.503 (+1)	3.893 (+0)	1.606 (+0)
2.28	2.845 (−3)	1.968 (+1)	4.888 (+0)	1.973 (+0)
3.56	2.262 (−3)	2.207 (+1)	5.146 (+0)	2.022 (+0)
6.12	1.589 (−3)	2.056 (+1)	4.505 (+0)	1.726 (+0)
11.24	1.022 (−3)	1.633 (+1)	3.403 (+0)	1.278 (+0)
21.48	6.201 (−4)	1.155 (+1)	2.317 (+0)	8.576 (−1)
41.96	3.619 (−4)	7.542 (+0)	1.471 (+0)	5.388 (−1)
50.00	3.134 (−4)	6.690 (+0)	1.297 (+0)	4.740 (−1)
75.00	2.239 (−4)	5.019 (+0)	9.619 (−1)	3.498 (−1)
100.00	1.759 (−4)	4.063 (+0)	7.731 (−1)	2.803 (−1)
150.00	1.247 (−4)	2.990 (+0)	5.639 (−1)	2.037 (−1)
250.00	8.044 (−5)	2.007 (+0)	3.750 (−1)	1.350 (−1)
400.00	5.351 (−5)	1.377 (+0)	2.555 (−1)	9.170 (−2)
700.00	3.278 (−5)	8.707 (−1)	1.604 (−1)	5.739 (−2)
1000.00	2.392 (−5)	6.468 (−1)	1.187 (−1)	4.240 (−2)

TABLE IE. Electron Excitation Cross Sections for Excited State–Excited State Transitions in Cesium

See page 157 for Explanation of Tables

E/E_t	Q(7p → 5d)	Q(7p → 6d)	Q(7p → 7d)	Q(7p → 8d)
	$E_t = -0.9086$	$E_t = 0.09030$	$E_t = 0.5175$	$E_t = 0.7355$
1.02	1.432 (+1)	1.124 (+4)	3.918 (+1)	7.610 (+0)
1.04	1.957 (+1)	1.549 (+4)	5.179 (+1)	9.965 (+0)
1.08	2.587 (+1)	2.084 (+4)	6.479 (+1)	1.233 (+1)
1.16	3.215 (+1)	2.682 (+4)	7.477 (+1)	1.423 (+1)
1.32	3.590 (+1)	3.200 (+4)	7.965 (+1)	1.569 (+1)
1.64	3.451 (+1)	3.407 (+4)	8.371 (+1)	1.792 (+1)
2.28	2.853 (+1)	3.149 (+4)	9.544 (+1)	2.206 (+1)
3.56	2.123 (+1)	2.524 (+4)	1.109 (+2)	2.525 (+1)
6.12	1.476 (+1)	1.793 (+4)	1.127 (+2)	2.411 (+1)
11.24	9.723 (+0)	1.165 (+4)	9.659 (+1)	1.941 (+1)
21.48	6.111 (+0)	7.122 (+3)	7.220 (+1)	1.381 (+1)
41.96	3.694 (+0)	4.182 (+3)	4.902 (+1)	9.041 (+0)
50.00	3.226 (+0)	3.627 (+3)	4.384 (+1)	8.023 (+0)
75.00	2.347 (+0)	2.598 (+3)	3.343 (+1)	6.024 (+0)
100.00	1.865 (+0)	2.045 (+3)	2.732 (+1)	4.878 (+0)
150.00	1.343 (+0)	1.453 (+3)	2.034 (+1)	3.591 (+0)
250.00	8.809 (−1)	9.398 (+2)	1.382 (+1)	2.421 (+0)
400.00	5.939 (−1)	6.264 (+2)	9.568 (+0)	1.655 (+0)
700.00	3.690 (−1)	3.845 (+2)	6.102 (+0)	1.046 (+0)
1000.00	2.715 (−1)	2.810 (+2)	4.555 (+0)	7.771 (−1)

E/E_t	Q(8p → 5d)	Q(8p → 6d)	Q(8p → 7d)	Q(8p → 8d)
	$E_t = -1.389$	$E_t = -0.3905$	$E_t = 0.03673$	$E_t = 0.2547$
1.02	3.585 (+0)	8.230 (+1)	7.803 (+4)	1.742 (+2)
1.04	4.840 (+0)	1.091 (+2)	1.076 (+5)	2.409 (+2)
1.08	6.256 (+0)	1.366 (+2)	1.447 (+5)	3.237 (+2)
1.16	7.473 (+0)	1.558 (+2)	1.864 (+5)	4.076 (+2)
1.32	7.867 (+0)	1.568 (+2)	2.228 (+5)	4.490 (+2)
1.64	7.028 (+0)	1.413 (+2)	2.384 (+5)	4.192 (+2)
2.28	5.325 (+0)	1.212 (+2)	2.224 (+5)	3.791 (+2)
3.56	3.519 (+0)	1.048 (+2)	1.804 (+5)	3.819 (+2)
6.12	2.115 (+0)	8.818 (+1)	1.295 (+5)	3.856 (+2)
11.24	1.198 (+0)	6.817 (+1)	8.491 (+4)	3.431 (+2)
21.48	6.553 (−1)	4.813 (+1)	5.227 (+4)	2.660 (+2)
41.96	3.509 (−1)	3.159 (+1)	3.086 (+4)	1.857 (+2)
50.00	2.979 (−1)	2.807 (+1)	2.680 (+4)	1.670 (+2)
75.00	2.039 (−1)	2.113 (+1)	1.924 (+4)	1.289 (+2)
100.00	1.558 (−1)	1.715 (+1)	1.517 (+4)	1.061 (+2)
150.00	1.065 (−1)	1.266 (+1)	1.080 (+4)	7.963 (+1)
250.00	6.596 (−2)	8.528 (+0)	6.999 (+3)	5.457 (+1)
400.00	4.240 (−2)	5.868 (+0)	4.673 (+3)	3.803 (+1)
700.00	2.503 (−2)	3.720 (+0)	2.874 (+3)	2.441 (+1)
1000.00	1.788 (−2)	2.768 (+0)	2.102 (+3)	1.828 (+1)

TABLE II. Absorption Oscillator Strengths for Excited State–Excited State Transitions in Alkali Atoms

See page 157 for Explanation of Tables

LITHIUM

Trans.	Anal. C. A.	Num. C. A.	Model Pot.	Experim.
2p−3s	1.148 (−1)	1.089 (−1)	1.096 (−1)	1.15 (−1)
2p−4s	1.325 (−2)	1.264 (−2)	1.271 (−2)	1.25 (−2)
2p−5s	4.450 (−3)	4.248 (−3)	4.274 (−3)	4.20 (−3)
2p−6s	2.099 (−3)	2.055 (−3)	2.014 (−3)	1.98 (−3)
3p−3s	1.215 (+0)	1.210 (+0)	1.213 (+0)	1.23 (+0)
3p−4s	2.232 (−1)	2.224 (−1)	2.228 (−1)	2.23 (−1)
3p−5s	2.595 (−2)	2.584 (−2)	2.588 (−2)	2.54 (−2)
3p−6s	8.884 (−3)	8.844 (−3)	8.841 (−3)	8.74 (−3)
4p−3s	3.629 (−5)	3.526 (−5)	4.147 (−5)	1.93 (−4)
4p−4s	1.640 (+0)	1.638 (+0)	1.639 (+0)	1.63 (+0)
4p−5s	3.359 (−1)	3.351 (−1)	3.355 (−1)	3.35 (−1)
4p−6s	3.869 (−2)	3.837 (−2)	3.859 (−2)	3.72 (−2)
2p−3d	6.728 (−1)	6.354 (−1)	6.356 (−1)	6.67 (−1)
2p−4d	1.293 (−1)	1.227 (−1)	1.222 (−1)	1.22 (−1)
2p−5d	4.871 (−2)	4.625 (−2)	4.601 (−2)	4.53 (−2)
2p−6d	2.414 (−2)	2.296 (−2)	2.2e0 (−2)	
3p−3d	7.467 (−2)	7.409 (−2)	7.426 (−2)	7.43 (−2)
3p−4d	5.228 (−1)	5.209 (−1)	5.211 (−1)	5.27 (−1)
3p−5d	1.302 (−1)	1.297 (−1)	1.297 (−1)	1.28 (−1)
3p−6d	5.442 (−2)	5.437 (−2)	5.426 (−2)	5.34 (−2)
4p−3d	1.817 (−2)	1.812 (−2)	1.813 (−2)	1.84 (−2)
4p−4d	1.360 (−1)	1.354 (−1)	1.357 (−1)	1.35 (−1)
4p−5d	4.903 (−1)	4.898 (−1)	4.897 (−1)	4.94 (−1)
4p−6d	1.323 (−1)	1.320 (−1)	1.321 (−1)	1.30 (−1)

SODIUM

Trans.	Anal. C. A.	Num. C. A.	Model Pot.	Experim.
3p−4s	1.649 (−1)	1.644 (−1)	1.721 (−1)	1.63 (−1)
3p−5s	1.387 (−2)	1.353 (−2)	1.417 (−2)	1.37 (−2)
3p−6s	4.458 (−3)	4.299 (−3)	4.503 (−3)	4.37 (−3)
3p−7s	2.072 (−3)	1.991 (−3)	2.079 (−3)	2.01 (−3)
4p−4s	1.426 (+0)	1.432 (+0)	1.447 (+0)	1.35 (+0)
4p−5s	3.105 (−1)	3.106 (−1)	3.139 (−1)	
4p−6s	2.318 (−2)	2.313 (−2)	2.333 (−2)	2.32 (−2)
4p−7s	7.305 (−3)	7.312 (−3)	7.337 (−3)	7.3 (−3)
5p−4s	3.776 (−2)	3.849 (−2)	3.782 (−2)	3.85 (−2)
5p−5s	1.873 (+0)	1.875 (+0)	1.884 (+0)	
5p−6s	4.515 (−1)	4.519 (−1)	4.536 (−1)	
5p−7s	3.170 (−2)	3.162 (−2)	3.180 (−2)	
3p−3d	8.520 (−1)	8.439 (−1)	8.618 (−1)	8.3 (−1)
3p−4d	9.775 (−2)	9.837 (−2)	9.754 (−2)	1.06 (−1)
3p−5d	3.045 (−2)	3.071 (−2)	2.992 (−2)	3.11 (−2)
3p−6d	1.370 (−2)	1.386 (−2)	1.335 (−2)	1.40 (−2)
4p−3d	1.185 (−1)	1.167 (−1)	1.185 (−1)	1.17 (−1)
4p−4d	9.454 (−1)	9.451 (−1)	9.523 (−1)	9.1 (−1)
4p−5d	1.416 (−1)	1.418 (−1)	1.421 (−1)	1.42 (−1)
4p−6d	4.899 (−2)	4.923 (−2)	4.896 (−2)	4.93 (−2)
5p−3d	1.653 (−4)	1.631 (−4)	1.583 (−4)	
5p−4d	2.293 (−1)	2.290 (−1)	2.299 (−1)	
5p−5d	1.054 (+0)	1.055 (+0)	1.058 (+0)	
5p−6d	1.724 (−1)	1.726 (−1)	1.728 (−1)	

POTASSIUM

Trans.	Anal. C. A.	Num. C. A.	Model Pot.	Experim.
4p−5s	1.713 (−1)	1.690 (−1)	1.675 (−1)	1.83 (−1)
4p−6s	1.716 (−2)	1.605 (−2)	1.607 (−2)	1.96 (−2)
4p−7s	5.857 (−3)	5.264 (−3)	5.289 (−3)	6.2 (−3)
4p−8s	2.830 (−3)	2.475 (−3)	2.487 (−3)	2.69 (−3)
5p−5s	1.471 (+0)	1.484 (+0)	1.497 (+0)	1.5 (+0)
5p−6s	3.171 (−1)	3.162 (−1)	3.194 (−1)	3.2 (−1)
5p−7s	2.733 (−2)	2.669 (−2)	2.699 (−2)	2.7 (−2)
5p−8s	8.994 (−3)	8.673 (−3)	8.729 (−3)	8.7 (−3)
6p−5s	2.976 (−2)	3.202 (−2)	3.008 (−2)	3.2 (−2)
6p−6s	1.925 (+0)	1.931 (+0)	1.943 (+0)	
6p−7s	4.562 (−1)	4.564 (−1)	4.579 (−1)	
6p−8s	3.659 (−2)	3.624 (−2)	3.640 (−2)	
4p−3d	1.074 (+0)	8.322 (−1)	7.563 (−1)	9.0 (−1)
4p−4d	2.004 (−3)	9.796 (−4)	1.617 (−3)	3.7 (−4)
4p−5d	9.947 (−4)	1.860 (−3)	1.242 (−3)	2.8 (−3)
4p−6d	2.300 (−3)	2.485 (−3)	1.887 (−3)	3.3 (−3)
5p−3d	1.775 (−1)	1.425 (−1)	1.280 (−1)	1.4 (−1)
5p−4d	1.232 (+0)	1.198 (+0)	1.155 (+0)	1.2 (+0)
5p−5d	8.298 (−3)	7.362 (−3)	7.332 (−3)	7.8 (−3)
5p−6d	1.689 (−6)	2.973 (−5)	2.816 (−5)	1.5 (−5)
6p−3d	7.864 (−3)	6.808 (−3)	5.882 (−3)	6.6 (−3)
6p−4d	3.101 (−1)	3.041 (−1)	2.931 (−1)	3.0 (−1)
6p−5d	1.536 (+0)	1.522 (+0)	1.494 (+0)	
6p−6d	1.620 (−2)	1.533 (−2)	1.559 (−2)	

TABLE II. Absorption Oscillator Strengths for Excited State–Excited State Transitions in Alkali Atoms

See page 157 for Explanation of Tables

RUBIDIUM

Trans.	Anal. C. A.	Num. C. A.	Model Pot.
5p−6s	1.831 (−1)	1.814 (−1)	1.892 (−1)
5p−7s	1.801 (−2)	1.649 (−2)	1.751 (−2)
5p−8s	6.207 (−3)	5.390 (−3)	5.750 (−3)
5p−9s	3.028 (−3)	2.534 (−3)	2.705 (−3)
6p−6s	1.501 (+0)	1.519 (+0)	1.530 (+0)
6p−7s	3.326 (−1)	3.329 (−1)	3.360 (−1)
6p−8s	2.727 (−2)	2.618 (−2)	2.691 (−2)
6p−9s	8.965 (−3)	8.431 (−3)	8.654 (−3)
7p−6s	3.923 (−2)	4.426 (−2)	4.017 (−2)
7p−7s	1.954 (+0)	1.962 (+0)	1.973 (+0)
7p−8s	4.741 (−1)	4.761 (−1)	4.762 (−1)
7p−9s	3.568 (−2)	3.489 (−2)	3.542 (−2)
5p−4d	1.033 (+0)	6.875 (−1)	6.090 (−1)
5p−5d	2.574 (−2)	3.442 (−2)	3.345 (−2)
5p−6d	2.126 (−2)	2.525 (−2)	2.634 (−2)
5p−7d	1.296 (−2)	1.488 (−2)	1.583 (−2)
6p−4d	1.342 (−1)	1.007 (−1)	9.350 (−2)
6p−5d	1.021 (+0)	1.005 (+0)	9.585 (−1)
6p−6d	1.804 (−2)	2.156 (−2)	2.046 (−2)
6p−7d	1.797 (−2)	1.869 (−2)	1.850 (−2)
7p−4d	9.610 (−3)	8.544 (−3)	8.027 (−3)
7p−5d	2.126 (−1)	2.144 (−1)	2.059 (−1)
7p−6d	1.272 (+0)	1.259 (+0)	1.242 (+0)
7p−7d	1.269 (−2)	1.504 (−2)	1.353 (−2)

CESIUM

Trans.	Anal. C. A.	Num. C. A.	Model Pot.
6p−7s	1.886 (−1)	1.883 (−1)	2.127 (−1)
6p−8s	1.965 (−2)	1.748 (−2)	2.100 (−2)
6p−9s	6.943 (−3)	5.760 (−3)	7.060 (−3)
6p−10s	3.444 (−3)	2.720 (−3)	3.364 (−3)
7p−7s	1.527 (+0)	1.553 (+0)	1.590 (+0)
7p−8s	3.393 (−1)	3.424 (−1)	3.503 (−1)
7p−9s	2.902 (−2)	2.714 (−2)	2.908 (−2)
7p−10s	9.702 (−3)	8.773 (−3)	9.461 (−3)
8p−7s	3.898 (−2)	4.831 (−2)	3.868 (−2)
8p−8s	1.982 (+0)	1.996 (+0)	2.021 (+0)
8p−9s	4.807 (−1)	4.867 (−1)	4.867 (−1)
8p−10s	3.748 (−2)	3.585 (−2)	3.734(−2)
6p−5d	5.170 (−1)	2.742 (−1)	2.466 (−1)
6p−6d	2.663 (−1)	2.996 (−1)	3.488 (−1)
6p−7d	7.559 (−2)	8.866 (−2)	1.053 (−1)
6p−8d	3.428 (−2)	3.891 (−2)	4.651 (−2)
7p−5d	2.480 (−2)	2.146 (−2)	2.915 (−2)
7p−6d	3.654 (−1)	3.443 (−1)	3.684 (−1)
7p−7d	2.881 (−1)	3.069 (−1)	3.119 (−1)
7p−8d	9.197 (−2)	9.674 (−2)	1.004 (−1)
8p−5d	1.565 (−3)	2.722 (−3)	4.719 (−3)
8p−6d	5.683 (−2)	5.562 (−2)	6.369 (−2)
8p−7d	4.625 (−1)	4.349 (−1)	4.668 (−1)
8p−8d	2.947 (−1)	3.124 (−1)	3.034 (−1)