Cross sections for electron capture from atomic helium by fully stripped ions

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Abstract. We give tables of theoretical cross sections for single electron capture from helium by fully stripped projectile ions with nuclear charge (Z) from 1 to 20, in the energy range 80–10000 keV/amu.

1. Introduction

The data produced in the present compilation has been obtained using the Continuum Distorted Wave (CDW) theory where the interaction between the active electron and the target is represented by model potential. We summarize the main concepts of the theory and refer to the literature for full details.

The energy range we are interested in corresponds to the intermediate and high impact energy range for which the first order of perturbative theories (eg. first-Born) is inadequate. At intermediate impact energies the response of the target atom to the projectile field is highly nonlinear while at high projectile velocities the contribution of double scattering cannot be neglected. The usefulness of the CDW theory for describing the electron capture process in the energy range considered has been demonstrated by the comparison with experimental results in a number of previous studies [1, 2].

2. Theory

It is well known that perturbative methods such as the Born series cannot be applied in the case of long range potentials like the Coulomb interaction. The CDW approximation was proposed by Cheshire [3, 4] as a solution to this problem in the case of electron capture. It can be shown that it is the first order of a distorted-wave series and that this series is free of divergences arising from the incorrect treatment of the Coulomb potential [1, 2]. This model belongs to a family of multiple scattering approaches based on the Distorted-Wave Theory and includes contributions from higher order scattering terms in the conventional Born series [2]. Despite a few deficiencies discussed in [5] the CDW model has major advantages: (i) it accounts for the long-range behavior of the Coulomb potential and includes distortions in the entrance and exit channels on equal footing, (ii) the scattering amplitude is given analytically in the case of Coulomb potentials, (iii) the model gives reasonable agreement with experiments for a number of collision systems.

The extension of the CDW model to the case of multi-electronic targets has been done within the framework of the one active electron picture [1]. In this model there is only one active electron which is captured by the impinging projectile while the others remain frozen. Up to now this extension of the model has been limited by the use of Coulomb wave functions with an effective charge to describe the distortion by the residual target. This means that the potential created by the passive electrons is approximated by a Coulomb field. The major problems with this representation is that the target potential is chosen differently in the entrance and exit channels and that in many cases the Coulomb field is not accurate enough, specially at small distances, to represent the field produced by the passive electrons.

In a recent extension of CDW model these problems were solved by the use of spherically symmetric model potentials to represent the potential due to the projectile and target nuclei and the passive electrons bound to them in both the initial and final channels [6]. Therefore the active electron evolves in a two center potential defined by these two model potentials. This allows for a more accurate description of the initial-target and final-projectile bound states and of the distortions in both channels. Here we give the main points in the generalization of the CDW theory and refer to [6, 7] for full details.

Let us consider the transfer of one electron from the target atom B to a projectile ion A. Z_B and Z_A denote the residual-target and projectile charge respectively. The potentials V_A (V_B) describes the interaction between the active electron and the projectile (residual target). In the pure three-body problem the continuum distorted waves are introduced as follows [3, 4]:

$$\begin{aligned}
\xi_i^+ &= \varphi_i(\boldsymbol{x})\; E_{i,-\boldsymbol{v}}(\boldsymbol{r})\; N(\nu_A)\; {}_1F_1(i\nu_A;1;ivs+i\boldsymbol{v}\cdot\boldsymbol{s}) \\
&= \varphi_i(\boldsymbol{x})\; E_{i,-\boldsymbol{v}}(\boldsymbol{r})\; D^+_{-\boldsymbol{v}}(Z_A,\boldsymbol{s}) \\
&= \varphi_i(\boldsymbol{x})\; E_{i,-\boldsymbol{v}}(\boldsymbol{r})\; \exp(i\boldsymbol{v}\cdot\boldsymbol{s})\; \psi^+_{-\boldsymbol{v}}(Z_A,\boldsymbol{s}) \qquad (1)
\end{aligned}$$

$$\begin{aligned}
\xi_f^- &= \varphi_f(\boldsymbol{s})\; E_{f,\boldsymbol{v}}(\boldsymbol{r})\; N(\nu_B)\; {}_1F_1(-i\nu_B;1;-ivx-i\boldsymbol{v}\cdot\boldsymbol{x}) \\
&= \varphi_f(\boldsymbol{s})\; E_{f,\boldsymbol{v}}(\boldsymbol{r})\; D^-_{\boldsymbol{v}}(Z_B,\boldsymbol{x}) \\
&= \varphi_f(\boldsymbol{s})\; E_{f,\boldsymbol{v}}(\boldsymbol{r})\; \exp(-i\boldsymbol{v}\cdot\boldsymbol{x})\; \psi^-_{\boldsymbol{v}}(Z_B,\boldsymbol{x}), \qquad (2)
\end{aligned}$$

with

$$E_{n,\boldsymbol{u}} = \exp\left[i\frac{1}{2}\boldsymbol{u}\cdot\boldsymbol{r} - i\frac{1}{8}u^2t - i\epsilon_n t\right], \qquad (3)$$

where $\boldsymbol{s}$, $\boldsymbol{x}$ and $\boldsymbol{r}$ denote the position vectors of the active electron with respect to a reference frame fixed at the target and projectile nucleus, and to the midpoint of the internuclear separation, $\boldsymbol{v}$ is the collision velocity, ${}_1F_1$ denotes the hypergeometric function and $\epsilon_{i,f}$ are the binding energies of the active electron in the initial and final states. In

the present case, the bound φ and continuum ψ wave functions are obtained from the numerical solutions of the eigen equations:

$$\left(-\frac{1}{2}\nabla_{x,s}^2 + V_X - \epsilon_{i,f}\right)\varphi_{i,f} = 0 \tag{4}$$

$$\left(-\frac{1}{2}\nabla_{x,s}^2 + V_X - v^2\right)\psi_{\boldsymbol{v}}^{\pm} = 0 \tag{5}$$

where V_X is the model potential, $\nu = Z_X/v$ and $N(\nu) = \exp(\nu\pi/2)\Gamma(1 - i\nu)$ (X stands for A and B).

Using the straight line version of the impact parameter approximation, the transition amplitude for capture is given by:

$$T_{if}(\boldsymbol{\eta}) = -N(\nu_A)\, N(\nu_B)\, \boldsymbol{I}_A \cdot \boldsymbol{J}_B, \tag{6}$$

where $\boldsymbol{\eta}$ is the transverse component of the momentum transfer, and $\boldsymbol{I}_A$ and $\boldsymbol{J}_B$ are defined as follows:

$$\boldsymbol{I}_A = \int \mathrm{d}\boldsymbol{s}\, \exp(i\boldsymbol{\rho}_A \cdot \boldsymbol{s})\, \varphi_f^*(\boldsymbol{s})\, \boldsymbol{\nabla}_s D_{\boldsymbol{v}}^+(Z_A, \boldsymbol{s}) \tag{7}$$

$$\boldsymbol{J}_B = \int \mathrm{d}\boldsymbol{x}\, \exp(i\boldsymbol{\rho}_B \cdot \boldsymbol{x})\, D_{-\boldsymbol{v}}^-(Z_B, \boldsymbol{x})\, \boldsymbol{\nabla}_x \varphi_i(\boldsymbol{x}) \tag{8}$$

with

$$\boldsymbol{\rho}_{A,B} = \pm\boldsymbol{\eta} - \left(\frac{v}{2} \pm \frac{\epsilon_i - \epsilon_f}{v}\right)\hat{\boldsymbol{v}} \tag{9}$$

where the $+(-)$ sign corresponds to the label A (B). The integrals $\boldsymbol{I}_A$ and $\boldsymbol{J}_B$ can be evaluated numerically (see ref. [7] for details).

The total cross section is obtained as:

$$\sigma_{if} = (2\pi v)^{-2} \int \mathrm{d}\boldsymbol{\eta}\, |T_{if}(\boldsymbol{\eta})|^2 \tag{10}$$

We have applied this generalized CDW model for the calculation of the total cross sections for single electron capture from helium by bare projectile impact. The charge of the impinging ions range from 1-20 and the collision energies from 80 keV/amu to 10 MeV/amu. The interaction of the active electron with the $He+$ ion was represented by the Hartree-Fock-Slater potential [8]. The cross sections were calculated to selective (characterized by the quantum numbers n, l and m) final bound states and the sum of

them over l and m are presented for a given n manifold in the tables. The sum of the state selective cross sections, calculated using the n^3 rule, are also given in the last line of a given table:

$$\sigma_{all} = \sum_{n=1}^{7} \sigma_n + 4.53\sigma_8, \tag{11}$$

provided that $\sigma_8 < \sigma_7 < \sigma_6$, where σ_n is the sum of the cross section for capture to each final bound state with principal quantum number n. All cross sections are given in cm^2. Dashes indicate entries which have been omitted because they are outside the domain of validity of the CDW model [1] defined by E(keV/amu) $\geq$ 80 sup(| ϵ_i | , | ϵ_f |).

REFERENCES

[1] Dž. BELKIĆ, R. GAYET, A. SALIN, Phys. Rep. **56**, 249 (1979).
[2] D.P. DEWANGAN, J. EICHLER, Phys. Rep. **247**, 59 (1994).
[3] I.M. CHESHIRE, Proc. Phys. Soc. (London) **84**, 89 (1964).
[4] R. GAYET, J. Phys. B **5**, 483 (1972).
[5] D.S.F. CROTHERS, L. DUBÉ, Adv. At. Mol. Opt. Phys. **30**, 285 (1993).
[6] S. SUZUKI, L. GULYÁS, N. SHIMAKURA, P.D. FAINSTEIN, T. SHIRAI, J. Phys. B **33**, 3307 (2000).
[7] L. GULYÁS, P.D. FAINSTEIN, T. SHIRAI, Phys. Rev. A: submitted for publication (2001).
[8] F. HERMAN, S. SKILLMAN, *Atomic Structure Calculations* (Prentice-Hall, Inc., Englewood Cliffs, N. J., 1963).

Table 1. Cross-sections for the process $B^+ + He(1s^2) \rightarrow B^{0+}(n) + He^+(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^+ is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	80	90	100	125	150	200	300	400
1	5.74^{-17}	4.09^{-17}	2.98^{-17}	1.48^{-17}	8.03^{-18}	2.88^{-18}	5.94^{-19}	1.78^{-19}
2	9.76^{-18}	7.08^{-18}	5.23^{-18}	2.63^{-18}	1.43^{-18}	5.03^{-19}	9.96^{-20}	2.88^{-20}
3	3.17^{-18}	2.30^{-18}	1.70^{-18}	8.53^{-19}	4.62^{-19}	1.62^{-19}	3.17^{-20}	9.10^{-21}
4	1.40^{-18}	1.02^{-18}	7.50^{-19}	3.75^{-19}	2.03^{-19}	7.08^{-20}	1.38^{-20}	3.94^{-21}
5	7.38^{-19}	5.34^{-19}	3.94^{-19}	1.97^{-19}	1.06^{-19}	3.70^{-20}	7.18^{-21}	2.05^{-21}
6	4.33^{-19}	3.13^{-19}	2.31^{-19}	1.12^{-19}	6.09^{-20}	2.13^{-20}	4.14^{-21}	1.18^{-21}
7	2.75^{-19}	1.99^{-19}	1.47^{-19}	7.11^{-20}	3.85^{-20}	1.35^{-20}	2.62^{0}	7.48^{0}
8	1.85^{-19}	1.34^{-19}	9.87^{-20}	4.78^{-20}	2.59^{-20}	9.04^{-21}	1.76^{-21}	5.02^{-22}
σ_{all}	7.40^{-17}	5.29^{-17}	3.87^{-17}	1.92^{-17}	1.04^{-17}	3.72^{-18}	7.61^{-19}	2.26^{-19}

Table 1. Cross-sections for the process $B^+ + He(1s^2) \rightarrow B^{0+}(n) + He^+(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^+ is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	500	600	700	800	900	1000	2000	3000
1	6.68^{-20}	2.92^{-20}	1.43^{-20}	7.58^{-21}	4.30^{-21}	2.57^{-21}	7.61^{-23}	8.84^{-24}
2	1.05^{-20}	4.51^{-21}	2.17^{-21}	1.13^{-21}	6.36^{-22}	3.77^{-22}	1.06^{-23}	1.21^{-24}
3	3.30^{-21}	1.41^{-21}	6.74^{-22}	3.52^{-22}	1.97^{-22}	1.16^{-22}	3.24^{-24}	3.67^{-25}
4	1.43^{-21}	6.08^{-22}	2.90^{-22}	1.51^{-22}	8.46^{-23}	5.00^{-23}	1.39^{-24}	1.57^{-25}
5	7.42^{-22}	3.15^{-22}	1.50^{-22}	7.84^{-23}	4.38^{-23}	2.59^{-23}	7.16^{-25}	8.10^{-26}
6	4.29^{-22}	1.82^{-22}	8.70^{-23}	4.53^{-23}	2.53^{-23}	1.49^{-23}	4.14^{-25}	4.68^{-26}
7	2.71^{-22}	1.15^{-22}	5.49^{-23}	2.86^{-23}	1.60^{-23}	9.43^{-24}	2.61^{-25}	2.95^{-26}
8	1.82^{-22}	7.72^{-23}	3.69^{-23}	1.92^{-23}	1.07^{-23}	6.33^{-24}	1.75^{-25}	1.98^{-26}
σ_{all}	8.43^{-20}	3.67^{-20}	1.79^{-20}	9.46^{-21}	5.35^{-21}	3.19^{-21}	9.35^{-23}	1.08^{-23}

Table 1. Cross-sections for the process $B^{+} + He(1s^2) \rightarrow B^{0+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{+} is a fully stripped ion

Final state	Projectile energy (keV/amu)						
n	4000	5000	6000	7000	8000	9000	10000
1	1.86^{-24}	5.44^{-25}	1.98^{-25}	8.36^{-26}	3.95^{-26}	2.04^{-26}	1.12^{-26}
2	2.51^{-25}	7.31^{-26}	2.65^{-26}	1.12^{-26}	5.28^{-27}	2.72^{-27}	1.50^{-27}
3	7.62^{-26}	2.22^{-26}	8.04^{-27}	3.39^{-27}	1.60^{-27}	8.24^{-28}	4.54^{-28}
4	3.26^{-26}	9.48^{-27}	3.43^{-27}	1.45^{-27}	6.84^{-28}	3.52^{-28}	1.94^{-28}
5	1.68^{-26}	4.89^{-27}	1.77^{-27}	7.73^{-28}	3.53^{-28}	1.82^{-28}	1.00^{-28}
6	9.70^{-27}	2.83^{-27}	1.02^{-27}	4.32^{-28}	2.04^{-28}	1.05^{-28}	5.78^{-29}
7	6.12^{-27}	1.78^{-27}	6.46^{-28}	2.72^{-28}	1.28^{-28}	6.61^{-29}	3.64^{-29}
8	4.10^{-27}	1.20^{-27}	4.33^{-28}	1.82^{-28}	8.61^{-29}	4.43^{-29}	2.44^{-29}
σ_{all}	2.27^{-24}	6.64^{-25}	2.41^{-25}	1.02^{-25}	4.82^{-26}	2.48^{-26}	1.37^{-26}

Table 2. Cross-sections for the process $B^{2+} + He(1s^2) \rightarrow B^{+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{2+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	80	90	100	125	150	200	300	400
1	–	–	–	–	–	2.24^{-17}	5.86^{-18}	2.05^{-18}
2	1.71^{-16}	1.23^{-16}	9.09^{-17}	4.60^{-17}	2.55^{-17}	9.36^{-18}	1.99^{-18}	6.07^{-19}
3	6.70^{-17}	4.86^{-17}	3.59^{-17}	1.82^{-17}	1.00^{-17}	3.60^{-18}	7.39^{-19}	2.19^{-19}
4	3.19^{-17}	2.32^{-17}	1.71^{-17}	8.67^{-18}	4.74^{-18}	1.69^{-18}	3.41^{-19}	9.97^{-20}
5	1.75^{-17}	1.27^{-17}	9.40^{-18}	4.73^{-18}	2.58^{-18}	9.15^{-19}	1.82^{-19}	5.28^{-20}
6	1.05^{-17}	7.61^{-18}	5.63^{-18}	2.83^{-18}	1.54^{-18}	5.23^{-19}	1.05^{-19}	3.07^{-20}
7	6.72^{-18}	4.88^{-18}	3.61^{-18}	1.82^{-18}	9.92^{-19}	3.34^{-19}	6.72^{-19}	1.96^{-20}
8	4.56^{-18}	3.31^{-18}	2.45^{-18}	1.23^{-18}	6.73^{-19}	2.26^{-19}	4.53^{-20}	1.32^{-20}
σ_{all}	–	–	–	–	–	3.99^{-17}	9.49^{-18}	3.14^{-18}

Table 2. Cross-sections for the process $B^{2+} + He(1s^2) \rightarrow B^{+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{2+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	500	600	700	800	900	1000	2000	3000
1	8.63^{-19}	4.11^{-19}	2.14^{-19}	1.20^{-19}	7.13^{-20}	4.43^{-20}	1.59^{-21}	2.00^{-22}
2	2.30^{-19}	1.02^{-19}	4.98^{-20}	2.66^{-20}	1.51^{-20}	9.06^{-21}	2.72^{-22}	3.18^{-23}
3	8.12^{-20}	3.52^{-20}	1.70^{-20}	8.98^{-21}	5.06^{-21}	3.01^{-21}	8.66^{-23}	9.99^{-24}
4	3.66^{-20}	1.57^{-20}	7.58^{-21}	3.98^{-21}	2.24^{-21}	1.33^{-21}	3.77^{-23}	4.33^{-24}
5	1.93^{-20}	8.29^{-21}	3.98^{-21}	2.10^{-21}	1.17^{-21}	6.90^{-22}	1.95^{-23}	2.23^{-24}
6	1.13^{-20}	4.84^{-21}	2.33^{-21}	1.22^{-21}	6.84^{-22}	4.06^{-22}	1.15^{-23}	1.31^{-24}
7	7.17^{-21}	3.07^{-21}	1.48^{-21}	7.74^{-22}	4.34^{-22}	2.57^{-22}	7.25^{-24}	8.27^{-25}
8	4.83^{-21}	2.07^{-21}	9.94^{-22}	5.21^{-22}	2.92^{-22}	1.73^{-22}	4.87^{-24}	5.56^{-25}
σ_{all}	1.27^{-18}	5.89^{-19}	3.01^{-19}	1.66^{-19}	9.73^{-20}	5.98^{-20}	2.05^{-21}	2.54^{-22}

Table 2. Cross-sections for the process $B^{2+} + He(1s^2) \rightarrow B^{+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{2+} is a fully stripped ion

Final state	Projectile energy (keV/amu)						
n	4000	5000	6000	7000	8000	9000	10000
1	4.40^{-23}	1.33^{-23}	4.94^{-24}	2.12^{-24}	1.02^{-24}	5.28^{-25}	2.93^{-25}
2	6.72^{-24}	1.98^{-24}	7.23^{-25}	3.07^{-25}	1.46^{-25}	7.53^{-26}	4.16^{-26}
3	2.09^{-24}	6.14^{-25}	2.24^{-25}	9.45^{-26}	4.46^{-26}	2.31^{-26}	1.27^{-26}
4	9.04^{-25}	2.63^{-25}	9.61^{-26}	4.07^{-26}	1.91^{-26}	9.88^{-27}	5.45^{-27}
5	4.67^{-25}	1.36^{-25}	4.99^{-26}	2.08^{-26}	9.81^{-27}	5.09^{-27}	2.81^{-27}
6	2.73^{-25}	8.00^{-26}	2.91^{-26}	1.23^{-26}	5.83^{-27}	3.01^{-27}	1.66^{-27}
7	1.73^{-25}	5.05^{-26}	1.84^{-26}	7.78^{-27}	3.68^{-27}	1.90^{-27}	1.05^{-27}
8	1.16^{-25}	3.39^{-26}	1.23^{-26}	5.22^{-27}	2.47^{-27}	1.28^{-27}	7.05^{-28}
σ_{all}	5.52^{-23}	1.66^{-23}	6.13^{-24}	2.63^{-24}	1.25^{-24}	6.52^{-25}	3.62^{-25}

Table 3. Cross-sections for the process $B^{3+} + He(1s^2) \rightarrow B^{2+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{3+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	80	90	100	125	150	200	300	400
1	–	–	–	–	–	–	–	3.98^{-18}
2	–	–	3.16^{-16}	1.65^{-16}	9.46^{-17}	3.73^{-17}	8.76^{-18}	2.86^{-18}
3	3.37^{-16}	2.44^{-16}	1.81^{-16}	9.21^{-17}	5.12^{-17}	1.90^{-17}	4.09^{-18}	1.26^{-18}
4	1.81^{-16}	1.31^{-16}	9.71^{-17}	4.93^{-17}	2.73^{-17}	9.91^{-18}	2.06^{-18}	6.18^{-19}
5	1.04^{-16}	7.58^{-17}	5.62^{-17}	2.85^{-17}	1.57^{-17}	5.65^{-18}	1.16^{-18}	3.43^{-19}
6	6.39^{-17}	4.66^{-17}	3.46^{-17}	1.75^{-17}	9.66^{-18}	3.15^{-18}	6.59^{-19}	1.97^{-19}
7	4.17^{-17}	3.03^{-17}	2.25^{-17}	1.15^{-17}	6.30^{-18}	2.03^{-18}	4.24^{-19}	1.26^{-19}
8	2.85^{-17}	2.08^{-17}	1.54^{-17}	7.86^{-18}	4.32^{-18}	1.38^{-18}	2.88^{-19}	8.56^{-20}
σ_{all}	–	–	–	–	–	–	–	9.77^{-18}

Table 3. Cross-sections for the process $B^{3+} + He(1s^2) \rightarrow B^{2+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{3+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	500	600	700	800	900	1000	2000	3000
1	1.97^{-18}	1.06^{-18}	6.11^{-19}	3.69^{-19}	2.33^{-19}	1.53^{-19}	7.25^{-21}	1.02^{-21}
2	1.14^{-18}	5.24^{-19}	2.65^{-19}	1.45^{-19}	8.39^{-20}	5.11^{-20}	1.66^{-21}	2.01^{-22}
3	4.78^{-19}	2.11^{-19}	1.04^{-19}	5.55^{-20}	3.16^{-20}	1.89^{-20}	5.69^{-22}	6.66^{-23}
4	2.31^{-19}	1.01^{-19}	4.90^{-20}	2.60^{-20}	1.47^{-20}	8.74^{-21}	2.54^{-22}	2.95^{-23}
5	1.27^{-19}	5.48^{-20}	2.66^{-20}	1.40^{-20}	7.86^{-21}	4.67^{-21}	1.33^{-22}	1.54^{-23}
6	7.32^{-20}	3.18^{-20}	1.54^{-20}	8.11^{-21}	4.57^{-21}	2.72^{-21}	7.79^{-23}	8.95^{-24}
7	4.69^{-20}	2.03^{-20}	9.83^{-21}	5.18^{-21}	2.91^{-21}	1.73^{-21}	4.94^{-23}	5.67^{-24}
8	3.18^{-20}	1.38^{-20}	6.65^{-21}	3.50^{-21}	1.97^{-21}	1.17^{-21}	3.33^{-23}	3.81^{-24}
σ_{all}	4.22^{-18}	2.07^{-18}	1.11^{-18}	6.39^{-19}	3.88^{-19}	2.46^{-19}	1.01^{-20}	1.36^{-21}

Table 3. Cross-sections for the process $B^{3+} + He(1s^2) \rightarrow B^{2+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{3+} is a fully stripped ion

Final state	Projectile energy (keV/amu)						
n	4000	5000	6000	7000	8000	9000	10000
1	2.39^{-22}	7.50^{-23}	2.86^{-23}	1.26^{-23}	6.11^{-24}	3.22^{-24}	1.81^{-24}
2	4.32^{-23}	1.29^{-23}	4.75^{-24}	2.03^{-24}	9.69^{-25}	5.03^{-25}	2.79^{-25}
3	1.41^{-23}	4.15^{-24}	1.52^{-24}	6.45^{-25}	3.06^{-25}	1.58^{-25}	8.77^{-26}
4	6.18^{-24}	1.81^{-24}	6.64^{-25}	2.80^{-25}	1.33^{-25}	6.89^{-26}	3.79^{-26}
5	3.22^{-24}	9.43^{-25}	3.45^{-25}	1.45^{-25}	6.87^{-26}	3.57^{-26}	1.96^{-26}
6	1.87^{-24}	5.50^{-25}	2.00^{-25}	8.50^{-26}	4.03^{-26}	2.08^{-26}	1.15^{-26}
7	1.19^{-24}	3.48^{-25}	1.27^{-25}	5.37^{-26}	2.55^{-26}	1.32^{-26}	7.29^{-27}
8	7.97^{-25}	2.34^{-25}	8.51^{-26}	3.61^{-26}	1.71^{-26}	8.84^{-27}	4.94^{-27}
σ_{all}	3.12^{-22}	9.67^{-23}	3.66^{-23}	1.60^{-23}	7.73^{-24}	4.06^{-24}	2.28^{-24}

Table 4. Cross-sections for the process $B^{4+} + He(1s^2) \rightarrow B^{3+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{4+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	80	90	100	125	150	200	300	400
1	–	–	–	–	–	–	–	–
2	–	–	–	–	–	7.09^{-17}	1.92^{-17}	6.90^{-18}
3	8.61^{-16}	6.31^{-16}	4.72^{-16}	2.44^{-16}	1.38^{-16}	5.34^{-17}	1.22^{-17}	3.91^{-18}
4	5.57^{-16}	4.04^{-16}	3.01^{-16}	1.54^{-16}	8.58^{-17}	3.20^{-17}	6.90^{-18}	2.12^{-18}
5	3.50^{-16}	2.54^{-16}	1.88^{-16}	9.59^{-17}	5.31^{-17}	1.95^{-17}	4.10^{-18}	1.24^{-18}
6	2.21^{-16}	1.61^{-16}	1.20^{-16}	6.12^{-17}	3.39^{-17}	1.02^{-17}	2.24^{-18}	6.92^{-19}
7	1.47^{-16}	1.07^{-16}	7.99^{-17}	4.08^{-17}	2.26^{-17}	6.66^{-18}	1.46^{-18}	4.50^{-19}
8	1.01^{-16}	7.42^{-17}	5.53^{-17}	2.83^{-17}	1.57^{-17}	4.57^{-18}	1.00^{-18}	3.07^{-19}
σ_{all}	–	–	–	–	–	–	–	–

Table 4. Cross-sections for the process $B^{4+} + He(1s^2) \rightarrow B^{3+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{4+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	500	600	700	800	900	1000	2000	3000
1	–	–	7.97^{-19}	5.27^{-19}	3.60^{-19}	2.51^{-19}	1.67^{-20}	2.71^{-21}
2	2.94^{-18}	1.41^{-18}	7.43^{-19}	4.18^{-19}	2.48^{-19}	1.55^{-19}	5.61^{-21}	7.06^{-22}
3	1.54^{-18}	6.95^{-19}	3.49^{-19}	1.89^{-19}	1.09^{-19}	6.60^{-20}	2.08^{-21}	2.49^{-22}
4	8.10^{-19}	3.58^{-19}	1.76^{-19}	9.42^{-20}	5.37^{-20}	3.22^{-20}	9.62^{-22}	1.13^{-22}
5	4.65^{-19}	2.03^{-19}	9.91^{-20}	5.24^{-20}	2.97^{-20}	1.77^{-20}	5.17^{-22}	5.98^{-23}
6	2.64^{-19}	1.16^{-19}	5.69^{-20}	3.02^{-20}	1.71^{-20}	1.02^{-20}	3.00^{-22}	3.46^{-23}
7	1.71^{-19}	7.50^{-20}	3.67^{-20}	1.95^{-20}	1.10^{-20}	6.58^{-21}	1.91^{-22}	2.20^{-23}
8	1.16^{-19}	5.10^{-20}	2.49^{-20}	1.32^{-20}	7.48^{-21}	4.46^{-21}	1.29^{-22}	1.48^{-23}
σ_{all}	–	–	2.37^{-18}	1.39^{-18}	8.63^{-19}	5.59^{-19}	2.70^{-20}	3.96^{-21}

Table 4. Cross-sections for the process $B^{4+} + He(1s^2) \rightarrow B^{3+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{4+} is a fully stripped ion

Final state	Projectile energy (keV/amu)						
n	4000	5000	6000	7000	8000	9000	10000
1	6.85^{-22}	2.26^{-22}	8.97^{-23}	4.04^{-23}	2.01^{-23}	1.08^{-23}	6.13^{-24}
2	1.55^{-22}	4.69^{-23}	1.75^{-23}	7.51^{-24}	3.60^{-24}	1.88^{-24}	1.05^{-24}
3	5.29^{-23}	1.57^{-23}	5.78^{-24}	2.47^{-24}	1.17^{-24}	6.09^{-25}	3.38^{-25}
4	2.38^{-23}	7.01^{-24}	2.57^{-24}	1.09^{-24}	5.18^{-25}	2.68^{-25}	1.48^{-25}
5	1.26^{-23}	3.69^{-24}	1.34^{-24}	5.70^{-25}	2.70^{-25}	1.40^{-25}	7.70^{-26}
6	7.25^{-24}	2.13^{-24}	7.78^{-25}	3.30^{-25}	1.57^{-25}	8.11^{-26}	4.49^{-26}
7	4.60^{-24}	1.35^{-24}	4.93^{-25}	2.09^{-25}	9.93^{-26}	5.13^{-26}	2.84^{-26}
8	3.10^{-24}	9.09^{-25}	3.31^{-25}	1.41^{-25}	6.67^{-26}	3.49^{-26}	1.91^{-26}
σ_{all}	9.55^{-22}	3.07^{-22}	1.20^{-22}	5.32^{-23}	2.62^{-23}	1.39^{-23}	7.90^{-24}

Table 5. Cross-sections for the process $B^{5+} + He(1s^2) \rightarrow B^{4+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{5+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	125	150	200	300	400	500	600	700
1	–	–	–	–	–	–	–	–
2	–	–	–	2.75^{-17}	1.10^{-17}	5.09^{-18}	2.59^{-18}	1.42^{-18}
3	4.24^{-16}	2.50^{-16}	1.02^{-16}	2.51^{-17}	8.51^{-18}	3.48^{-18}	1.62^{-18}	8.30^{-19}
4	3.35^{-16}	1.90^{-16}	7.25^{-17}	1.64^{-17}	5.20^{-18}	2.03^{-18}	9.15^{-19}	4.57^{-19}
5	2.32^{-16}	1.29^{-16}	4.81^{-17}	1.04^{-17}	3.21^{-18}	1.23^{-18}	5.43^{-19}	2.67^{-19}
6	1.54^{-16}	8.57^{-17}	3.18^{-17}	6.76^{-18}	2.05^{-18}	7.76^{-19}	3.03^{-19}	1.51^{-19}
7	1.05^{-16}	5.87^{-17}	2.16^{-17}	4.56^{-18}	1.37^{-18}	5.16^{-19}	1.97^{-19}	9.80^{-19}
8	7.40^{-17}	4.13^{-17}	1.52^{-17}	3.19^{-18}	9.56^{-19}	3.58^{-19}	1.35^{-19}	6.71^{-20}
σ_{all}	–	–	–	–	–	–	–	–

Table 5. Cross-sections for the process $B^{5+} + He(1s^2) \rightarrow B^{4+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{5+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	800	900	1000	2000	3000	4000	5000	6000
1	–	–	–	2.58^{-20}	4.91^{-21}	1.36^{-21}	4.78^{-22}	1.97^{-22}
2	8.33^{-19}	5.10^{-19}	3.26^{-19}	1.34^{-20}	1.78^{-21}	4.02^{-22}	1.24^{-22}	4.65^{-23}
3	4.58^{-19}	2.68^{-19}	1.65^{-19}	5.53^{-21}	6.75^{-22}	1.46^{-22}	4.35^{-23}	1.61^{-23}
4	2.47^{-19}	1.42^{-19}	8.57^{-20}	2.66^{-21}	3.15^{-22}	6.69^{-23}	1.98^{-23}	7.26^{-24}
5	1.43^{-19}	8.14^{-20}	4.88^{-20}	1.46^{-21}	1.70^{-22}	3.58^{-23}	1.05^{-23}	3.85^{-24}
6	8.11^{-20}	4.64^{-20}	2.79^{-20}	8.42^{-22}	9.79^{-23}	2.06^{-23}	6.07^{-24}	2.21^{-24}
7	5.26^{-20}	3.01^{-20}	1.81^{-20}	5.39^{-22}	6.25^{-23}	1.31^{-23}	3.85^{-24}	1.41^{-24}
8	3.60^{-20}	2.05^{-20}	1.23^{-20}	3.65^{-22}	4.22^{-23}	8.85^{-24}	2.60^{-24}	9.47^{-25}
σ_{all}	–	–	–	5.19^{-20}	8.20^{-21}	2.09^{-21}	6.97^{-22}	2.79^{-22}

Table 5. Cross-sections for the process $B^{5+} + He(1s^2) \rightarrow B^{4+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{5+} is a fully stripped ion

Final state	Projectile energy (keV/amu)			
n	7000	8000	9000	10000
1	9.17^{-23}	4.67^{-23}	2.55^{-23}	1.48^{-23}
2	2.02^{-23}	9.75^{-24}	5.11^{-24}	2.86^{-24}
3	6.88^{-24}	3.29^{-24}	1.71^{-24}	9.50^{-25}
4	3.09^{-24}	1.47^{-24}	7.63^{-25}	4.23^{-25}
5	1.64^{-24}	7.76^{-25}	4.00^{-25}	2.21^{-25}
6	9.41^{-25}	4.47^{-25}	2.31^{-25}	1.28^{-25}
7	5.97^{-25}	2.83^{-25}	1.47^{-25}	8.11^{-26}
8	4.02^{-25}	1.91^{-25}	9.85^{-26}	5.45^{-26}
σ_{all}	1.27^{-22}	6.36^{-23}	3.43^{-23}	1.97^{-23}

Table 6. Cross-sections for the process $B^{6+} + He(1s^2) \rightarrow B^{5+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{6+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	200	300	400	500	600	700	800	900
1	–	–	–	–	–	–	–	–
2	–	–	1.33^{-17}	6.69^{-18}	3.65^{-18}	2.11^{-18}	1.29^{-18}	8.15^{-19}
3	1.49^{-16}	4.04^{-17}	1.45^{-17}	6.20^{-18}	2.98^{-18}	1.57^{-18}	8.86^{-19}	5.28^{-19}
4	1.30^{-16}	3.10^{-17}	1.02^{-17}	4.09^{-18}	1.88^{-18}	9.53^{-19}	5.21^{-19}	3.03^{-19}
5	9.52^{-17}	2.14^{-17}	6.73^{-18}	2.62^{-18}	1.18^{-18}	5.86^{-19}	3.15^{-19}	1.81^{-19}
6	6.54^{-17}	1.44^{-17}	4.46^{-18}	1.71^{-18}	6.24^{-19}	3.18^{-19}	1.74^{-19}	1.01^{-19}
7	4.57^{-17}	9.93^{-18}	3.04^{-18}	1.16^{-18}	4.12^{-19}	2.09^{-19}	1.14^{-19}	6.60^{-20}
8	3.27^{-17}	7.05^{-18}	2.15^{-18}	8.13^{-19}	2.84^{-19}	1.44^{-19}	7.84^{-20}	4.53^{-20}
σ_{all}	–	–	–	–	–	–	–	–

Table 6. Cross-sections for the process $B^{6+} + He(1s^2) \rightarrow B^{5+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{6+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	1000	2000	3000	4000	5000	6000	7000	8000
1	–	3.03^{-20}	6.88^{-21}	2.11^{-21}	7.93^{-22}	3.43^{-22}	1.65^{-22}	8.65^{-23}
2	5.36^{-19}	2.57^{-20}	3.62^{-21}	8.43^{-22}	2.65^{-22}	1.01^{-22}	4.42^{-23}	2.15^{-23}
3	3.29^{-19}	1.19^{-20}	1.49^{-21}	3.27^{-22}	9.87^{-23}	3.66^{-23}	1.57^{-23}	7.54^{-24}
4	1.85^{-19}	6.00^{-21}	7.20^{-22}	1.54^{-22}	4.58^{-23}	1.69^{-23}	7.20^{-24}	3.43^{-24}
5	1.09^{-19}	3.36^{-21}	3.95^{-22}	8.36^{-23}	2.47^{-23}	9.04^{-24}	3.85^{-24}	1.83^{-24}
6	6.15^{-20}	1.94^{-21}	2.28^{-22}	4.81^{-23}	1.42^{-23}	5.19^{-24}	2.20^{-24}	1.05^{-24}
7	4.01^{-20}	1.25^{-21}	1.46^{-22}	3.07^{-23}	9.04^{-24}	3.30^{-24}	1.40^{-24}	6.65^{-25}
8	2.75^{-20}	8.48^{-22}	9.87^{-23}	2.08^{-23}	6.10^{-24}	2.23^{-24}	9.44^{-25}	4.48^{-25}
σ_{all}	–	8.43^{-20}	1.39^{-20}	3.69^{-21}	1.28^{-21}	5.25^{-22}	2.44^{-22}	1.25^{-22}

Table 6. Cross-sections for the process $B^{6+} + He(1s^2) \rightarrow B^{5+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{6+} is a fully stripped ion

Final state	Projectile energy (keV/amu)	
n	9000	10000
1	4.84^{-23}	2.85^{-23}
2	1.13^{-23}	6.38^{-24}
3	3.93^{-24}	2.19^{-24}
4	1.78^{-24}	9.90^{-25}
5	9.46^{-25}	5.26^{-25}
6	5.42^{-25}	3.00^{-25}
7	3.44^{-25}	1.90^{-25}
8	2.32^{-25}	1.28^{-25}
σ_{all}	6.83^{-23}	3.97^{-23}

Table 7. Cross-sections for the process $B^{7+} + He(1s^2) \rightarrow B^{6+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{7+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	400	500	600	700	800	900	1000	2000
1	–	–	–	–	–	–	–	2.95^{-20}
2	–	7.26^{-18}	4.22^{-18}	2.59^{-18}	1.65^{-18}	1.09^{-18}	7.38^{-19}	4.18^{-20}
3	2.08^{-17}	9.33^{-18}	4.66^{-18}	2.52^{-18}	1.46^{-18}	8.84^{-19}	5.60^{-19}	2.21^{-20}
4	1.70^{-17}	7.03^{-18}	3.30^{-18}	1.71^{-18}	9.46^{-19}	5.56^{-19}	3.43^{-19}	1.17^{-20}
5	1.21^{-17}	4.82^{-18}	2.19^{-18}	1.11^{-18}	6.02^{-19}	3.48^{-19}	2.12^{-19}	6.74^{-21}
6	8.33^{-18}	3.25^{-18}	1.08^{-18}	5.64^{-19}	3.16^{-19}	1.87^{-19}	1.15^{-19}	3.85^{-21}
7	5.81^{-18}	2.25^{-18}	7.17^{-18}	3.75^{-19}	2.09^{-19}	1.23^{-19}	7.58^{-20}	2.50^{-21}
8	4.16^{-18}	1.59^{-18}	4.99^{-19}	2.60^{-19}	1.45^{-19}	8.50^{-20}	5.23^{-20}	1.70^{-21}
σ_{all}	–	–	–	–	–	–	–	1.26^{-19}

Table 7. Cross-sections for the process $B^{7+} + He(1s^2) \rightarrow B^{6+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{7+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	3000	4000	5000	6000	7000	8000	9000	10000
1	8.03^{-21}	2.74^{-21}	1.11^{-21}	5.04^{-22}	2.53^{-22}	1.36^{-22}	7.81^{-23}	4.70^{-23}
2	6.29^{-21}	1.52^{-21}	4.89^{-22}	1.89^{-22}	8.40^{-23}	4.12^{-23}	2.19^{-23}	1.24^{-23}
3	2.86^{-21}	6.38^{-22}	1.94^{-22}	7.27^{-23}	3.14^{-23}	1.51^{-23}	7.88^{-24}	4.40^{-24}
4	1.43^{-21}	3.09^{-22}	9.24^{-23}	3.42^{-23}	1.46^{-23}	6.98^{-24}	3.63^{-24}	2.01^{-24}
5	8.02^{-22}	1.71^{-22}	5.05^{-23}	1.85^{-23}	7.89^{-24}	3.76^{-24}	1.95^{-24}	1.08^{-24}
6	4.61^{-22}	9.80^{-23}	2.90^{-23}	1.06^{-23}	4.51^{-24}	2.15^{-24}	1.11^{-24}	6.16^{-25}
7	2.96^{-22}	6.28^{-23}	1.85^{-23}	6.77^{-24}	2.88^{-24}	1.37^{-24}	7.07^{-25}	3.91^{-25}
8	2.01^{-22}	4.25^{-23}	1.25^{-23}	4.57^{-24}	1.94^{-24}	9.21^{-25}	4.76^{-25}	2.64^{-25}
σ_{all}	2.11^{-20}	5.73^{-21}	2.04^{-21}	8.57^{-22}	4.07^{-22}	2.11^{-22}	1.17^{-22}	6.90^{-23}

Table 8. Cross-sections for the process $B^{8+} + He(1s^2) \rightarrow B^{7+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{8+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	400	500	600	700	800	900	1000	2000
1	–	–	–	–	–	–	–	–
2	–	–	–	2.74^{-18}	1.84^{-18}	1.26^{-18}	8.82^{-19}	5.99^{-20}
3	2.56^{-17}	1.22^{-17}	6.37^{-18}	3.56^{-18}	2.11^{-18}	1.31^{-18}	8.44^{-19}	3.66^{-20}
4	2.50^{-17}	1.07^{-17}	5.15^{-18}	2.72^{-18}	1.53^{-18}	9.12^{-19}	5.68^{-19}	2.06^{-20}
5	1.95^{-17}	7.89^{-18}	3.66^{-18}	1.87^{-18}	1.03^{-18}	6.00^{-19}	3.68^{-19}	1.22^{-20}
6	1.38^{-17}	5.51^{-18}	1.60^{-18}	8.70^{-19}	5.01^{-19}	3.03^{-19}	1.90^{-19}	6.87^{-21}
7	9.84^{-18}	3.88^{-18}	1.08^{-18}	5.85^{-19}	3.35^{-19}	2.02^{-19}	1.26^{-19}	4.48^{-21}
8	7.13^{-18}	2.79^{-18}	7.56^{-19}	4.09^{-19}	2.33^{-19}	1.40^{-19}	8.76^{-20}	3.07^{-21}
σ_{all}	–	–	–	–	–	–	–	–

Table 8. Cross-sections for the process $B^{8+} + He(1s^2) \rightarrow B^{7+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{8+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	3000	4000	5000	6000	7000	8000	9000	10000
1	8.15^{-21}	3.11^{-21}	1.35^{-21}	6.51^{-22}	3.40^{-22}	1.90^{-22}	1.11^{-22}	6.85^{-23}
2	9.72^{-21}	2.45^{-21}	8.08^{-22}	3.19^{-22}	1.43^{-22}	7.10^{-23}	3.80^{-23}	2.16^{-23}
3	4.92^{-21}	1.12^{-21}	3.45^{-22}	1.30^{-22}	5.65^{-23}	2.73^{-23}	1.43^{-23}	8.00^{-24}
4	2.57^{-21}	5.61^{-22}	1.68^{-22}	6.25^{-23}	2.68^{-23}	1.29^{-23}	6.69^{-24}	3.72^{-24}
5	1.47^{-21}	3.14^{-22}	9.35^{-23}	3.44^{-23}	1.47^{-23}	6.99^{-24}	3.62^{-24}	2.01^{-24}
6	8.39^{-22}	1.80^{-22}	5.35^{-23}	1.97^{-23}	8.38^{-24}	3.98^{-24}	2.06^{-24}	1.14^{-24}
7	5.43^{-22}	1.16^{-22}	3.43^{-23}	1.26^{-23}	5.35^{-24}	2.54^{-24}	1.32^{-24}	7.28^{-25}
8	3.70^{-22}	7.88^{-23}	2.33^{-23}	8.52^{-24}	3.62^{-24}	1.72^{-24}	8.88^{-25}	4.91^{-25}
σ_{all}	2.99^{-20}	8.21^{-21}	2.96^{-21}	1.27^{-21}	6.11^{-22}	3.22^{-22}	1.81^{-22}	1.08^{-22}

Table 9. Cross-sections for the process $B^{9+} + He(1s^2) \rightarrow B^{8+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{9+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	400	500	600	700	800	900	1000	2000
1	–	–	–	–	–	–	–	–
2	–	–	–	–	–	1.30^{-18}	9.47^{-19}	7.78^{-20}
3	2.85^{-17}	1.43^{-17}	7.83^{-18}	4.53^{-18}	2.77^{-18}	1.75^{-18}	1.15^{-18}	5.55^{-20}
4	3.32^{-17}	1.47^{-17}	7.30^{-18}	3.93^{-18}	2.26^{-18}	1.37^{-18}	8.60^{-19}	3.32^{-20}
5	2.84^{-17}	1.18^{-17}	5.59^{-18}	2.89^{-18}	1.61^{-18}	9.49^{-19}	5.86^{-19}	2.02^{-20}
6	2.08^{-17}	8.51^{-18}	3.96^{-18}	2.02^{-18}	1.11^{-18}	6.47^{-19}	3.95^{-19}	1.29^{-20}
7	1.51^{-17}	6.11^{-18}	2.81^{-18}	1.42^{-18}	7.77^{-18}	4.49^{-19}	2.73^{-19}	8.61^{-21}
8	1.10^{-17}	4.45^{-18}	2.04^{-18}	1.03^{-18}	5.56^{-19}	3.21^{-19}	1.94^{-19}	5.98^{-21}
σ_{all}	–	–	–	–	–	–	–	–

Table 9. Cross-sections for the process $B^{9+} + He(1s^2) \rightarrow B^{8+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{9+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	3000	4000	5000	6000	7000	8000	9000	10000
1	–	3.18^{-21}	1.49^{-21}	7.59^{-22}	4.14^{-22}	2.39^{-22}	1.44^{-22}	9.09^{-23}
2	1.37^{-20}	3.60^{-21}	1.22^{-21}	4.92^{-22}	2.25^{-22}	1.12^{-22}	6.07^{-23}	3.48^{-23}
3	7.77^{-21}	1.81^{-21}	5.65^{-22}	2.15^{-22}	9.40^{-23}	4.56^{-23}	2.40^{-23}	1.35^{-23}
4	4.25^{-21}	9.41^{-22}	2.85^{-22}	1.06^{-22}	4.56^{-23}	2.18^{-23}	1.14^{-23}	6.37^{-24}
5	2.48^{-21}	5.36^{-22}	1.60^{-22}	5.91^{-23}	2.52^{-23}	1.21^{-23}	6.25^{-24}	3.47^{-24}
6	1.41^{-21}	3.06^{-22}	9.16^{-23}	3.37^{-23}	1.44^{-23}	6.87^{-24}	3.56^{-24}	1.97^{-24}
7	9.16^{-22}	1.98^{-22}	5.90^{-23}	2.17^{-23}	9.23^{-24}	4.39^{-24}	2.27^{-24}	1.26^{-24}
8	6.27^{-22}	1.35^{-22}	4.01^{-23}	1.47^{-23}	6.25^{-24}	2.97^{-24}	1.54^{-24}	8.50^{-25}
σ_{all}	–	1.12^{-20}	4.05^{-21}	1.75^{-21}	8.55^{-22}	4.56^{-22}	2.60^{-22}	1.56^{-22}

Table 10. Cross-sections for the process $B^{10+} + He(1s^2) \rightarrow B^{9+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{10+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	500	600	700	800	900	1000	2000	3000
1	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	9.30^{-20}	1.78^{-20}
3	1.54^{-17}	8.80^{-18}	5.31^{-18}	3.33^{-18}	2.17^{-18}	1.46^{-18}	7.81^{-20}	1.14^{-20}
4	1.88^{-17}	9.59^{-18}	5.29^{-18}	3.09^{-18}	1.90^{-18}	1.21^{-18}	4.99^{-20}	6.58^{-21}
5	1.64^{-17}	7.91^{-18}	4.17^{-18}	2.35^{-18}	1.40^{-18}	8.73^{-19}	3.16^{-20}	3.94^{-21}
6	1.21^{-17}	5.77^{-18}	3.00^{-18}	1.67^{-18}	9.80^{-19}	6.05^{-19}	2.05^{-20}	2.21^{-21}
7	8.86^{-18}	4.18^{-18}	2.15^{-18}	1.19^{-18}	6.93^{-19}	4.24^{-19}	1.38^{-20}	1.45^{-21}
8	6.51^{-18}	3.06^{-18}	1.57^{-18}	8.60^{-19}	5.00^{-19}	3.05^{-19}	9.67^{-21}	9.93^{-22}
σ_{all}	–	–	–	–	–	–	–	–

Table 10. Cross-sections for the process $B^{10+} + He(1s^2) \rightarrow B^{9+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{10+} is a fully stripped ion

Final state	Projectile energy (keV/amu)						
n	4000	5000	6000	7000	8000	9000	10000
1	–	1.51^{-21}	8.17^{-22}	4.65^{-22}	2.78^{-22}	1.73^{-22}	1.12^{-22}
2	4.92^{-21}	1.72^{-21}	7.10^{-22}	3.29^{-22}	1.67^{-22}	9.10^{-23}	5.25^{-23}
3	2.73^{-21}	8.66^{-22}	3.33^{-22}	1.47^{-22}	7.16^{-23}	3.79^{-23}	2.13^{-23}
4	1.48^{-21}	4.52^{-22}	1.69^{-22}	7.30^{-23}	3.51^{-23}	1.83^{-23}	1.02^{-23}
5	8.59^{-22}	2.57^{-22}	9.54^{-23}	4.09^{-23}	1.95^{-23}	1.02^{-23}	5.65^{-24}
6	4.88^{-22}	1.47^{-22}	5.45^{-23}	2.33^{-23}	1.11^{-23}	5.78^{-24}	3.21^{-24}
7	3.17^{-22}	9.51^{-23}	3.51^{-23}	1.50^{-23}	7.14^{-24}	3.70^{-24}	2.05^{-24}
8	2.17^{-22}	6.48^{-23}	2.39^{-23}	1.02^{-23}	4.84^{-24}	2.51^{-24}	1.39^{-24}
σ_{all}	–	5.35^{-21}	2.32^{-21}	1.14^{-21}	6.12^{-22}	3.51^{-22}	2.13^{-22}

Table 11. Cross-sections for the process $B^{11+} + He(1s^2) \rightarrow B^{10+}(n) + He^+(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{11+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	600	700	800	900	1000	2000	3000	4000
1	–	–	–	–	–	–	–	–
2	–	–	–	–	–	1.04^{-19}	2.17^{-20}	6.32^{-21}
3	9.25^{-18}	5.78^{-18}	3.74^{-18}	2.51^{-18}	1.72^{-18}	1.03^{-19}	1.59^{-20}	3.89^{-21}
4	1.18^{-17}	6.65^{-18}	3.97^{-18}	2.47^{-18}	1.61^{-18}	7.12^{-20}	9.66^{-21}	2.20^{-21}
5	1.06^{-17}	5.66^{-18}	3.24^{-18}	1.95^{-18}	1.23^{-18}	4.66^{-20}	5.93^{-21}	1.31^{-21}
6	7.89^{-18}	4.17^{-18}	2.36^{-18}	1.40^{-18}	8.72^{-19}	3.08^{-20}	3.80^{-21}	8.23^{-22}
7	5.78^{-18}	3.04^{-18}	1.70^{-18}	1.01^{-18}	6.22^{-19}	2.10^{-20}	2.54^{-21}	5.43^{-22}
8	4.27^{-18}	2.23^{-18}	1.25^{-18}	7.34^{-19}	4.51^{-19}	1.48^{-20}	1.77^{-21}	3.75^{-22}
σ_{all}	–	–	–	–	–	–	–	–

Table 11. Cross-sections for the process $B^{11+} + He(1s^2) \rightarrow B^{10+}(n) + He^+(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{11+} is a fully stripped ion

Final state	Projectile energy (keV/amu)					
n	5000	6000	7000	8000	9000	10000
1	1.44^{-21}	8.22^{-22}	4.89^{-22}	3.03^{-22}	1.94^{-22}	1.29^{-22}
2	2.29^{-21}	9.65^{-22}	4.55^{-22}	2.34^{-22}	1.29^{-22}	7.51^{-23}
3	1.26^{-21}	4.89^{-22}	2.17^{-22}	1.07^{-22}	5.67^{-23}	3.21^{-23}
4	6.80^{-22}	2.56^{-22}	1.11^{-22}	5.37^{-23}	2.81^{-23}	1.57^{-23}
5	3.95^{-22}	1.46^{-22}	6.30^{-23}	3.02^{-23}	1.57^{-23}	8.75^{-24}
6	2.46^{-22}	9.06^{-23}	3.59^{-23}	1.72^{-23}	8.93^{-24}	4.96^{-24}
7	1.61^{-22}	5.91^{-23}	2.32^{-23}	1.11^{-23}	5.74^{-24}	3.18^{-24}
8	1.11^{-22}	4.05^{-23}	1.58^{-23}	7.51^{-24}	3.89^{-24}	2.16^{-24}
σ_{all}	6.97^{-21}	3.01^{-21}	1.47^{-21}	7.90^{-22}	4.56^{-22}	2.78^{-22}

Table 12. Cross-sections for the process $B^{12+} + He(1s^2) \rightarrow B^{11+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{12+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	700	800	900	1000	2000	3000	4000	5000
1	–	–	–	–	–	–	–	–
2	–	–	–	–	1.10^{-19}	2.51^{-20}	7.71^{-21}	2.89^{-21}
3	5.93^{-18}	3.98^{-18}	2.73^{-18}	1.91^{-18}	1.30^{-19}	2.11^{-20}	5.31^{-21}	1.75^{-21}
4	7.90^{-18}	4.83^{-18}	3.07^{-18}	2.01^{-18}	9.66^{-20}	1.35^{-20}	3.14^{-21}	9.80^{-22}
5	7.29^{-18}	4.23^{-18}	2.58^{-18}	1.64^{-18}	6.58^{-20}	8.56^{-21}	1.91^{-21}	5.80^{-22}
6	5.50^{-18}	3.16^{-18}	1.91^{-18}	1.20^{-18}	4.43^{-20}	5.56^{-21}	1.21^{-21}	3.65^{-22}
7	4.05^{-18}	2.31^{-18}	1.39^{-18}	8.66^{-19}	3.06^{-20}	3.75^{-21}	8.08^{-22}	2.40^{-22}
8	3.00^{-18}	1.71^{-18}	1.02^{-18}	6.34^{-19}	2.18^{-20}	2.63^{-21}	5.60^{-22}	1.66^{-22}
σ_{all}	–	–	–	–	–	–	–	–

Table 12. Cross-sections for the process $B^{12+} + He(1s^2) \rightarrow B^{11+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{12+} is a fully stripped ion

Final state	Projectile energy (keV/amu)				
n	6000	7000	8000	9000	10000
1	7.83^{-22}	4.88^{-22}	3.13^{-22}	2.07^{-22}	1.41^{-22}
2	1.25^{-21}	6.00^{-22}	3.13^{-22}	1.74^{-22}	1.03^{-22}
3	6.88^{-22}	3.08^{-22}	1.52^{-22}	8.14^{-23}	4.62^{-23}
4	3.72^{-22}	1.62^{-22}	7.87^{-23}	4.13^{-23}	2.31^{-23}
5	2.16^{-22}	9.31^{-23}	4.47^{-23}	2.33^{-23}	1.30^{-23}
6	1.35^{-22}	5.30^{-23}	2.54^{-23}	1.33^{-23}	7.38^{-24}
7	8.84^{-23}	3.43^{-23}	1.64^{-23}	8.54^{-24}	4.75^{-24}
8	6.08^{-23}	2.34^{-23}	1.12^{-23}	5.81^{-24}	3.22^{-24}
σ_{all}	3.81^{-21}	1.84^{-21}	9.95^{-22}	5.76^{-22}	3.52^{-22}

Table 13. Cross-sections for the process $B^{13+} + He(1s^2) \rightarrow B^{12+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{13+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	800	900	1000	2000	3000	4000	5000	6000
1	–	–	–	–	–	–	–	–
2	–	–	–	1.11^{-19}	2.78^{-20}	8.99^{-21}	3.49^{-21}	1.55^{-21}
3	4.01^{-18}	2.82^{-18}	2.03^{-18}	1.57^{-19}	2.68^{-20}	6.95^{-21}	2.33^{-21}	9.29^{-22}
4	5.60^{-18}	3.62^{-18}	2.42^{-18}	1.26^{-19}	1.83^{-20}	4.31^{-21}	1.36^{-21}	5.21^{-22}
5	5.30^{-18}	3.28^{-18}	2.11^{-18}	8.94^{-20}	1.19^{-20}	2.68^{-21}	8.22^{-22}	3.08^{-22}
6	4.03^{-18}	2.47^{-18}	1.57^{-18}	6.15^{-20}	7.85^{-21}	1.73^{-21}	5.22^{-22}	1.94^{-22}
7	2.98^{-18}	1.82^{-18}	1.15^{-18}	4.30^{-20}	5.34^{-21}	1.16^{-21}	3.46^{-22}	1.28^{-22}
8	2.22^{-18}	1.35^{-18}	8.51^{-19}	3.08^{-20}	3.77^{-21}	8.09^{-22}	2.40^{-22}	8.81^{-23}
σ_{all}	–	–	–	–	–	–	–	–

Table 13. Cross-sections for the process $B^{13+} + He(1s^2) \rightarrow B^{12+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{13+} is a fully stripped ion

Final state	Projectile energy (keV/amu)			
n	7000	8000	9000	10000
1	4.65^{-22}	3.09^{-22}	2.11^{-22}	1.47^{-22}
2	7.58^{-22}	4.02^{-22}	2.27^{-22}	1.35^{-22}
3	4.21^{-22}	2.10^{-22}	1.13^{-22}	6.43^{-23}
4	2.29^{-22}	1.11^{-22}	5.86^{-23}	3.29^{-23}
5	1.33^{-22}	6.40^{-23}	3.35^{-23}	1.87^{-23}
6	8.31^{-23}	3.98^{-23}	2.07^{-23}	1.15^{-23}
7	5.45^{-23}	2.60^{-23}	1.35^{-23}	7.48^{-24}
8	3.75^{-23}	1.78^{-23}	9.23^{-24}	5.11^{-24}
σ_{all}	2.31^{-21}	1.24^{-21}	7.18^{-22}	4.39^{-22}

Table 14. Cross-sections for the process $B^{14+} + He(1s^2) \rightarrow B^{13+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{14+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	900	1000	2000	3000	4000	5000	6000	7000
1	–	–	–	–	–	–	–	–
2	–	–	1.07^{-19}	2.94^{-20}	1.01^{-20}	4.07^{-21}	1.85^{-21}	9.25^{-22}
3	2.81^{-18}	2.07^{-18}	1.82^{-19}	3.29^{-20}	8.79^{-21}	3.01^{-21}	1.22^{-21}	5.56^{-22}
4	4.11^{-18}	2.79^{-18}	1.59^{-19}	2.38^{-20}	5.73^{-21}	1.83^{-21}	7.06^{-22}	3.12^{-22}
5	4.02^{-18}	2.60^{-18}	1.18^{-19}	1.60^{-20}	3.66^{-21}	1.13^{-21}	4.26^{-22}	1.85^{-22}
6	3.07^{-18}	1.98^{-18}	8.24^{-20}	1.07^{-20}	2.39^{-21}	7.24^{-22}	2.70^{-22}	1.16^{-22}
7	2.28^{-18}	1.47^{-18}	5.84^{-20}	7.38^{-21}	1.61^{-21}	4.85^{-22}	1.79^{-22}	7.66^{-23}
8	1.70^{-18}	1.09^{-18}	4.22^{-20}	5.23^{-21}	1.13^{-21}	3.37^{-22}	1.24^{-22}	5.29^{-23}
σ_{all}	–	–	–	–	–	–	–	–

Table 14. Cross-sections for the process $B^{14+} + He(1s^2) \rightarrow B^{13+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{14+} is a fully stripped ion

Final state	Projectile energy (keV/amu)		
n	8000	9000	10000
1	2.94^{-22}	2.06^{-22}	1.47^{-22}
2	4.98^{-22}	2.84^{-22}	1.71^{-22}
3	2.79^{-22}	1.51^{-22}	8.67^{-23}
4	1.53^{-22}	8.07^{-23}	4.55^{-23}
5	8.92^{-23}	4.66^{-23}	2.61^{-23}
6	5.57^{-23}	2.90^{-23}	1.62^{-23}
7	3.66^{-23}	1.90^{-23}	1.05^{-23}
8	2.52^{-23}	1.30^{-23}	7.22^{-24}
σ_{all}	1.52^{-21}	8.76^{-22}	5.36^{-22}

Table 15. Cross-sections for the process $B^{15+} + He(1s^2) \rightarrow B^{14+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{15+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	1000	2000	3000	4000	5000	6000	7000	8000
1	–	–	–	–	–	–	–	–
2	–	–	3.01^{-20}	1.09^{-20}	4.58^{-21}	2.14^{-21}	1.09^{-21}	5.98^{-22}
3	–	2.04^{-19}	3.90^{-20}	1.08^{-20}	3.76^{-21}	1.55^{-21}	7.15^{-22}	3.62^{-22}
4	3.11^{-18}	1.93^{-19}	3.01^{-20}	7.40^{-21}	2.40^{-21}	9.33^{-22}	4.15^{-22}	2.04^{-22}
5	3.12^{-18}	1.50^{-19}	2.09^{-20}	4.85^{-21}	1.51^{-21}	5.72^{-22}	2.50^{-22}	1.21^{-22}
6	2.40^{-18}	1.07^{-19}	1.43^{-20}	3.21^{-21}	9.80^{-22}	3.67^{-22}	1.58^{-22}	7.61^{-23}
7	1.79^{-18}	7.69^{-20}	9.91^{-21}	2.19^{-21}	6.60^{-22}	2.45^{-22}	1.05^{-22}	5.01^{-23}
8	1.34^{-18}	5.60^{-20}	7.08^{-21}	1.54^{-21}	4.62^{-22}	1.70^{-22}	7.27^{-23}	3.46^{-23}
σ_{all}	–	–	–	–	–	–	–	–

Table 15. Cross-sections for the process $B^{15+} + He(1s^2) \rightarrow B^{14+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{15+} is a fully stripped ion

Final state	Projectile energy (keV/amu)	
n	9000	10000
1	–	1.43^{-22}
2	3.46^{-22}	2.10^{-22}
3	1.97^{-22}	1.14^{-22}
4	1.08^{-22}	6.12^{-23}
5	6.35^{-23}	3.55^{-23}
6	3.97^{-23}	2.21^{-23}
7	2.61^{-23}	1.45^{-23}
8	1.79^{-23}	9.95^{-24}
σ_{all}	–	6.45^{-22}

Table 16. Cross-sections for the process $B^{16+} + He(1s^2) \rightarrow B^{15+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{16+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	3000	4000	5000	6000	7000	8000	9000	10000
1	–	–	–	–	–	–	–	–
2	2.99^{-20}	1.15^{-20}	5.00^{-21}	2.41^{-21}	1.26^{-21}	6.99^{-22}	4.10^{-22}	2.52^{-22}
3	4.49^{-20}	1.28^{-20}	4.59^{-21}	1.91^{-21}	8.96^{-22}	4.57^{-22}	2.51^{-22}	1.45^{-22}
4	3.70^{-20}	9.31^{-21}	3.06^{-21}	1.20^{-21}	5.38^{-22}	2.66^{-22}	1.42^{-22}	8.04^{-23}
5	2.67^{-20}	6.28^{-21}	1.97^{-21}	7.52^{-22}	3.30^{-22}	1.60^{-22}	8.44^{-23}	4.73^{-23}
6	1.85^{-20}	4.21^{-21}	1.30^{-21}	4.87^{-22}	2.11^{-22}	1.02^{-22}	5.31^{-23}	2.96^{-23}
7	1.30^{-20}	2.90^{-21}	8.80^{-22}	3.27^{-22}	1.41^{-22}	6.74^{-23}	3.50^{-23}	1.95^{-23}
8	9.35^{-21}	2.05^{-21}	6.18^{-22}	2.28^{-22}	9.77^{-23}	4.66^{-23}	2.42^{-23}	1.34^{-23}
σ_{all}	–	–	–	–	–	–	–	–

Table 17. Cross-sections for the process $B^{17+} + He(1s^2) \rightarrow B^{16+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{17+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	3000	4000	5000	6000	7000	8000	9000	10000
1	–	–	–	–	–	–	–	–
2	2.90^{-20}	1.18^{-20}	5.32^{-21}	2.64^{-21}	1.41^{-21}	7.96^{-22}	4.74^{-22}	2.94^{-22}
3	5.04^{-20}	1.49^{-20}	5.46^{-21}	2.32^{-21}	1.10^{-21}	5.65^{-22}	3.12^{-22}	1.82^{-22}
4	4.45^{-20}	1.14^{-20}	3.81^{-21}	1.52^{-21}	6.84^{-22}	3.39^{-22}	1.82^{-22}	1.03^{-22}
5	3.33^{-20}	7.94^{-21}	2.52^{-21}	9.69^{-22}	4.26^{-22}	2.08^{-22}	1.10^{-22}	6.18^{-23}
6	2.35^{-20}	5.41^{-21}	1.68^{-21}	6.34^{-22}	2.75^{-22}	1.33^{-22}	6.97^{-23}	3.89^{-23}
7	1.67^{-20}	3.76^{-21}	1.15^{-21}	4.29^{-22}	1.85^{-22}	8.87^{-23}	4.62^{-23}	2.57^{-23}
8	1.21^{-20}	2.68^{-21}	8.11^{-22}	3.01^{-22}	1.29^{-22}	6.16^{-23}	3.20^{-23}	1.78^{-23}
σ_{all}	–	–	–	–	–	–	–	–

Table 18. Cross-sections for the process $B^{18+} + He(1s^2) \rightarrow B^{17+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{18+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	3000	4000	5000	6000	7000	8000	9000	10000
1	–	–	–	–	–	–	–	–
2	–	1.18^{-20}	5.54^{-21}	2.83^{-21}	1.54^{-21}	8.88^{-22}	5.36^{-22}	3.37^{-22}
3	5.54^{-20}	1.70^{-20}	6.35^{-21}	2.74^{-21}	1.32^{-21}	6.85^{-22}	3.81^{-22}	2.24^{-22}
4	5.25^{-20}	1.38^{-20}	4.67^{-21}	1.87^{-21}	8.52^{-22}	4.25^{-22}	2.29^{-22}	1.31^{-22}
5	4.07^{-20}	9.86^{-21}	3.17^{-21}	1.23^{-21}	5.42^{-22}	2.65^{-22}	1.40^{-22}	7.90^{-23}
6	2.92^{-20}	6.83^{-21}	2.13^{-21}	8.10^{-22}	3.53^{-22}	1.71^{-22}	8.98^{-23}	5.03^{-23}
7	2.10^{-20}	4.78^{-21}	1.47^{-21}	5.52^{-22}	2.39^{-22}	1.15^{-22}	5.99^{-23}	3.34^{-23}
8	1.53^{-20}	3.43^{-21}	1.04^{-21}	3.89^{-22}	1.67^{-22}	8.00^{-23}	4.16^{-23}	2.31^{-23}
σ_{all}	–	–	–	–	–	–	–	–

Table 19. Cross-sections for the process $B^{19+} + He(1s^2) \rightarrow B^{18+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{19+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	3000	4000	5000	6000	7000	8000	9000	10000
1	–	–	–	–	–	–	–	–
2	–	1.16^{-20}	5.65^{-21}	2.97^{-21}	1.65^{-21}	9.70^{-22}	5.94^{-22}	3.78^{-22}
3	5.95^{-20}	1.89^{-20}	7.26^{-21}	3.19^{-21}	1.55^{-21}	8.15^{-22}	4.57^{-22}	2.70^{-22}
4	6.06^{-20}	1.63^{-20}	5.61^{-21}	2.28^{-21}	1.04^{-21}	5.24^{-22}	2.83^{-22}	1.63^{-22}
5	4.88^{-20}	1.20^{-20}	3.90^{-21}	1.52^{-21}	6.77^{-22}	3.32^{-22}	1.76^{-22}	9.97^{-23}
6	3.57^{-20}	8.45^{-21}	2.66^{-21}	1.02^{-21}	4.46^{-22}	2.17^{-22}	1.14^{-22}	6.39^{-23}
7	2.58^{-20}	5.98^{-21}	1.85^{-21}	6.99^{-22}	3.03^{-22}	1.46^{-22}	7.64^{-23}	4.26^{-23}
8	1.89^{-20}	4.32^{-21}	1.32^{-21}	4.95^{-22}	2.13^{-22}	1.02^{-22}	5.33^{-23}	2.96^{-23}
σ_{all}	–	–	–	–	–	–	–	–

Table 20. Cross-sections for the process $B^{20+} + He(1s^2) \rightarrow B^{19+}(n) + He^{+}(1s)$ (in cm^2) from CDW calculations using Hartree-Fock-Slater model potential for the electron target interaction, where B^{20+} is a fully stripped ion

Final state	Projectile energy (keV/amu)							
n	3000	4000	5000	6000	7000	8000	9000	10000
1	–	–	–	–	–	–	–	–
2	–	–	5.66^{-21}	3.05^{-21}	1.74^{-21}	1.04^{-21}	6.47^{-22}	4.17^{-22}
3	6.28^{-20}	2.07^{-20}	8.15^{-21}	3.64^{-21}	1.79^{-21}	9.53^{-22}	5.39^{-22}	3.21^{-22}
4	6.88^{-20}	1.90^{-20}	6.63^{-21}	2.72^{-21}	1.26^{-21}	6.36^{-22}	3.45^{-22}	1.99^{-22}
5	5.76^{-20}	1.45^{-20}	4.74^{-21}	1.86^{-21}	8.33^{-22}	4.11^{-22}	2.19^{-22}	1.24^{-22}
6	4.28^{-20}	1.03^{-20}	3.28^{-21}	1.26^{-21}	5.55^{-22}	2.70^{-22}	1.42^{-22}	8.00^{-23}
7	3.13^{-20}	7.36^{-21}	2.30^{-21}	8.72^{-22}	3.80^{-22}	1.83^{-22}	9.60^{-23}	5.37^{-23}
8	2.31^{-20}	5.35^{-21}	1.65^{-21}	6.21^{-22}	2.68^{-22}	1.29^{-22}	6.72^{-23}	3.74^{-23}
σ_{all}	–	–	–	–	–	–	–	–