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Electron Impact Excıtatıon of Sıngle $_{114}$Fl, $_{115}$Uup, $_{116}$Uuh, $_{117}$Uus, $_{118}$Uuo Atoms N and N_i Subshells Ionızatıon Cross Sectıon by usıng Lotz's Equatıons

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Abstract

N shell and seven N subshells ionization cross sections σ_N and σ_{Ni} (i = 1, .,,7) following electron impact on $_{114}$Fl, $_{115}$Uup, $_{116}$Uuh, $_{117}$Uus, $_{118}$Uuo atoms calculated. By using Lotz's equation in Matlab ionization cross section values obtained for 24 electron impact energy values in first ionization energy to five times ionization energy range for each atom. Lotz's parameters and special commands used for each ionization cross sections calculations. Starting all most from ionization threshold values; σ_N and σ_{Ni} are increasing rapidly with electron impact energy E_o. For higher E_o values this increments getting smaller for every N_i subshells. For smaller E_o energy close to threshold all σ_N and σ_{Ni} decrease. For a fixed electron impact energy while Z value increases from 114≤ Z≤ 118; ionization cross sections decrease with Z. Results may help to understand similar findings which obtained from other electron impact excitation of N_i subshells σ_N and σ_{Ni} studies for similar size single atoms.

Keywords: *N_i subshells ionization cross section, $_{114}$Fl, $_{115}$Uup, $_{116}$Uuh, $_{117}$Uus, $_{118}$Uuo calculations, Electron impact on single atoms(114≤Z≤118), Lotz's equations*

1. Introduction

N subshell inner-shell ionization cross section studies σ_N and σ_{Ni} of atoms by electron impact are subjects of ongoing research for many years [1, 2, 5-8]. Inner shell ionization cross section information help us to understand, characterization of used target atoms in the following fields: astrophysics, plasma physics, radiation protection, design of instruments, energy transfer by electron impact on or in tissues study required [5, 6, 7, 8, 9-21]. In this study, N shell and N_i σ_N and σ_{Ni}(i =1,2,.,7) for $_{114}$Fl, $_{115}$Uup, $_{116}$Uuh, $_{117}$Uus, $_{118}$Uuo atoms are calculated. For each of atoms, 24 electron impact energy values E_{oi} are used. E_{oi} values were chosen in the $E_{Ni} < E_{oi} < 7{,}5.E_{Ni}$ range for each atom. E_{Ni} is the binding energy of that N_i(i =1,.,7) subshells. If a neutral atom A bombarded by an electron with sufficiently big E_{oi} under $E_{Ni} < E_{oi}$ conditions, atom A becomes excited ions A^{+*} at ith N_i subshell. In addition to the scattered electron, probably an electron is ejected with specific energy from the proper subshell respectively. Creation of electron holes in N_i subshells depends on how big the E_{oi} compare to E_{Ni}. Lotz put forward a semi-empirical formula at [1,2], for calculation of σ_N and σ_{Ni} for low energetic electron impact excitation of free atoms at inner shells which was based on Born Approximation(BA) [1, 2, 6]. He added a correction factor as a multiplier to the Bethe formula for developing Lotz equation [1, 2]. Calculations for σ_N and σ_{Ni} of Z = 114 to Z = 118 atoms carried out by using Lotz equations in Matlab program [8, 14, 15].

$$\sigma_{Ni} = a_i\, q_i[\ln(E_o/E_i)/E_oE_i][1 - b_i \exp(-c_i (E_o/E_i))] \quad (1)$$

a_i, b_i, c_i constants and q_i of the ith subshell which are taken from Lotz [1, 2]. q_i are the number of equivalent electrons at ith N_i subshell and E_i is the binding energy of the ith subshell. σ_{Ni} are the ionization cross section of ith subshells. By using the Equation.1 and using sum of calculated 7 σ_{Ni} subshells of each atom for 24 values of E_{oi} σ_{Ni} shell σ_{Ntotal} were calculated.

2. Method

N shell σ_{Ntotal} and σ_{Ni} subshells ionization cross sections of $_{114}$Fl, $_{115}$Uup, $_{116}$Uuh, $_{117}$Uus, $_{118}$Uuo atoms are calculated. Calculations done for 24 E_{oi} values which they chosen in energy range of $E_{Ni} \leq E_{oi} \leq 9{,}64E_{Ni}$ for each atom. E_{oi} calculations repeated for σ_N and σ_{Ni} (i =1, 2, .,7) of $_{114}$Fl to $_{118}$Uuo. It means that for $_{114}$Fl Flevorium used over all E_{oi} values fall in 1400eV≤E_o≤13500eV range. E_{oi} chosen according to the electron binding energies of E_{Ni} values of targeted atom which most of them estimated under the guidence of Gwyn, and Porter [3, 4]. Calculations carried out by using written commands for Lotz's Equation.1 in Matlab for each atom [1, 2, 8, 9]. The similar values of a_i, b_i, c_i and q_i are given in the same order for N_i subshells as an example set: for a_i equal to (4e-14 4e-14 4e-14 2e-14 2e-14 1.5e-14 1.35e-14)10^{-14}cm^2(eV)^2; for b_i equal to (0.3 0.5 0.5 0.94 0.94 0.97 0.95); for c_i = 0.3 0.5 0.5 0.15 0.15 0.11 0.10), and for q_i = (2 2 4 4 6 5 3.5) values used [1-2, 8]. By using sum of calculated

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7 σ_{Ni} subshells of atoms for 24 values of E_{oi} and N shell σ_{Ntotal} of each atom calculated. Used estimated electron binding energies of these atoms given in Table.A. [3, 4].

Table A: Used electron binding energies of N_i subshells of $_{114}$Fl, $_{115}$Uup, $_{116}$Uuh, $_{117}$Uus, $_{118}$Uuo atoms given in eV. [3, 4]. Please notice that subshells numbered from inner side to outer side of the atoms. Tablo değerleri kontrol edilecek??

Name of Atom	$N_1 E_{N1}$(eV)	N_2 E_{N2}(eV)	$N_3 E_{N3}$(eV))	N_4 E_{N4}(eV)	N_5 E_{N5}(eV)	N_6 E_{N6}(eV)	N_7 E_{N7}(eV))
$_{114}$Fl Flevorium	1501	1328	1087	816	771	414	403
115Uup	1560	1380	1123	846	798	436	424
116Uuh	1620	1438	1165	880	829	460	445
117Uus	1665	1498	1207	916	862	484	470
118Uuso	1744	1558	1249	955	898	511	495

3. Results

Nonrelativistic calculations for $\sigma^{nrel}{}_{N}$ and $\sigma^{nrel}{}_{Ni}$ of $_{114}$Fl, $_{115}$Uup, $_{116}$Uuh, $_{117}$Uus, $_{118}$Uuo and for 24 E_{0i} are given in Table 1 to 5 under the name of each atom. These are nonrelativistic data similar to our earlier study which were carried out for E_{0i} electron impact energy close to N subshell ionization threshold energy values of $_{114}$Fl, $_{115}$Uup, $_{116}$Uuh, $_{117}$Uus, $_{118}$Uuo [3, 14]. Each table includes nonrelativistic results for each atom. For the same atomic results also given as colored graphs in a figure which named as same as that atomic table data. These graphs helps to compare how each subshells $\sigma^{nrel}{}_{Ni}$ depends at any value of E_{0i} energy at any atom nonrelativistic N shell $\sigma^{nrel}{}_{Ntotal}$ and N_i subshells $\sigma^{nrel}{}_{Ni}$ calculations for each atom: $\sigma^{nrel}{}_{Ni}$ values are given in Tables 1-5 and in Figures.1-5. There are some common charcteristics of $\sigma^{nrel}{}_{Ni}$ for each atom very close to threshold region: 1) Seven $\sigma^{nrel}{}_{Ni}$ for 1keV to about 4 keV electron impact of $_{114}$Fl as seeing at Figs.1a, and 1b: σ^{nrel} N_3 crosses the other cross sections in the following order(1, 2, 4, 5, 6,7): For instance; $\sigma^{nrel}{}_{N1}$ $\sigma^{nrel}{}_{N2}$ $\sigma^{nrel}{}_{N4}$ and $\sigma^{nrel}{}_{N5}$ and the $\sigma^{nrel}{}_{N6}$ and $\sigma^{nrel}{}_{N7;}$ As seeing at Figs.2a and 2b for $_{115}$Uup atom: $\sigma^{nrel}{}_{N3}$; $\sigma^{nrel}{}_{N1}$, $\sigma^{nrel}{}_{N2}$, $\sigma^{nrel}{}_{N4,}$ and the $\sigma^{nrel}{}_{N6}$ and $\sigma^{nrel}{}_{N7}$ crossed. For $_{116}$Uuh, $\sigma^{nrel}{}_{N3}$ as seeing in Fig 3b. crosses $\sigma^{nrel}{}_{N1}$, $\sigma^{nrel}{}_{N2}$, $\sigma^{nrel}{}_{N4}$, $\sigma^{nrel}{}_{N6}$ and $\sigma^{nrel}{}_{N7}$. Also, in Figure 4b and Figure.5b for $_{117}$Uus and 118$_{Uuo}$ atoms; $\sigma^{nrel}{}_{N3}$ crosses all subshell cross section graphs in the same order as in this order: $\sigma^{nrel}{}_{N1}$ $\sigma^{nrel}{}_{N2}$ $\sigma^{nrel}{}_{N4}$, $\sigma^{nrel}{}_{N5}$,$\sigma^{nrel}{}_{N6}$ and $\sigma^{nrel}{}_{N7}$ respectively. $\sigma^{nrel}{}_{N3}$ crosses the other cross sections in the following impact energy intervals: 2,2-4keV for Z=114, 2,4 to 4,4keV for Z=115; 2,4 to 4,70keV; Z=116; 2,65 to 4,87keV; Z=117; 3 to 4,8keV; Z=117; 3,3 to 5,4keV; as seeing at Figs.1a to 5a. $\sigma^{nrel}{}_{N3}$ crosses all other $\sigma^{nrel}{}_{Ni}$ and $\sigma^{nrel}{}_{N3}$ and crosses only $\sigma^{nrel}{}_{N3}$ at higher energies namely through end region of graphs.. Each $\sigma^{nrel}{}_{Ni}$ increases differently with electron impact energy. Z dependency of ionization cross sections for about fixed E_{0i} = 4,8 keV impact given in Table.6 and Figs.6, 6b. All each $\sigma^{nrel}{}_{Ni}$ decrease with atomic number 114≤ Z ≤118.

Table 1: $_{114}$Fl Flevorium N_1 to N_7 subshell ionization cross sections by electron impact in 10^4 b.

E_0(keV)	$\sigma_{N1x}10^4$ b	$\sigma_{N2x}10^4$ b	$\sigma_{N3x}10^4$ b	$\sigma_{N4x}10^4$ b	$\sigma_{N5x}10^4$ b	$\sigma_{N6x}10^4$ b	$\sigma_{N7x}10^4$ b	$\sigma_{Ntotal}10^4$ b
1,4	-0,01352	-0,0875	-0,01729	-0,00181	-0,00255	-0,00104	0,00024	-0,12347
1,8	-0,7637	-0,4721	-0,8975	-0,0945	-0,0993	0,0011	0,1207	-2,2053
2,2	-0,4364	-0,2397	-0,4193	-0,0378	0,0044	0,0754	0,1896	-0,8638
2,6	-0,2363	-0,0924	-0,1166	0,0031	0,0798	0,1321	0,2422	0,0119
2,9	-0,1337	0,0143	0,0434	0,0273	0,1246	0,1667	0,2743	0,5169
3,2	-0,0573	0,0456	0,1658	0,0475	0,1623	0,1964	0,3018	0,8621
3,4	-0,0169	0,0781	0,2321	0,0593	0,1843	0,2141	0,3181	1,0691
3,6	0,0171	0,1058	0,2886	0,0701	0,2042	0,2302	0,3327	1,2487
3,8	0,0459	0,1298	0,3372	0,0798	0,2224	0,2451	0,3462	1,4064
4	0,0703	0,1505	0,3793	0,0887	0,2391	0,2587	0,3586	1,5452
4,4	0,1092	0,1844	0,4477	0,1045	0,2684	0,2832	0,3805	1,7779
4,8	0,1381	0,2105	0,5001	0,1181	0,2936	0,3044	0,3991	1,9639
5,2	0,1598	0,2309	0,5404	0,1299	0,3154	0,3229	0,4151	2,1144
5,7	0,1797	0,2502	0,5784	0,1426	0,3388	0,3429	0,4321	2,2647
6,6	0,2022	0,2734	0,6228	0,1612	0,3724	0,372	0,4556	2,4596
7,5	0,2142	0,2867	0,6472	0,1757	0,3981	0,3943	0,4725	2,5887
8,4	0,2202	0,2939	0,659	0,1871	0,4178	0,4116	0,4844	2,674
9	0,2221	0,2964	0,6622	0,1934	0,4284	0,4208	0,4903	2,7136
9,7	0,2226	0,2976	0,6625	0,1997	0,4386	0,4298	0,4953	2,7461
10,5	0,222	0,2973	0,6597	0,2057	0,4481	0,4381	0,4991	2,772
11,2	0,2207	0,2961	0,6551	0,2101	0,4545	0,4436	0,5011	2,7812
12	0,2186	0,2936	0,6481	0,2142	0,4603	0,4486	0,5019	2,7853
12,5	0,2171	0,2917	0,6431	0,2163	0,4632	0,4511	0,5018	2,7843
13,5	0,2136	0,2874	0,632	0,2199	0,4674	0,4546	0,5006	2,7755

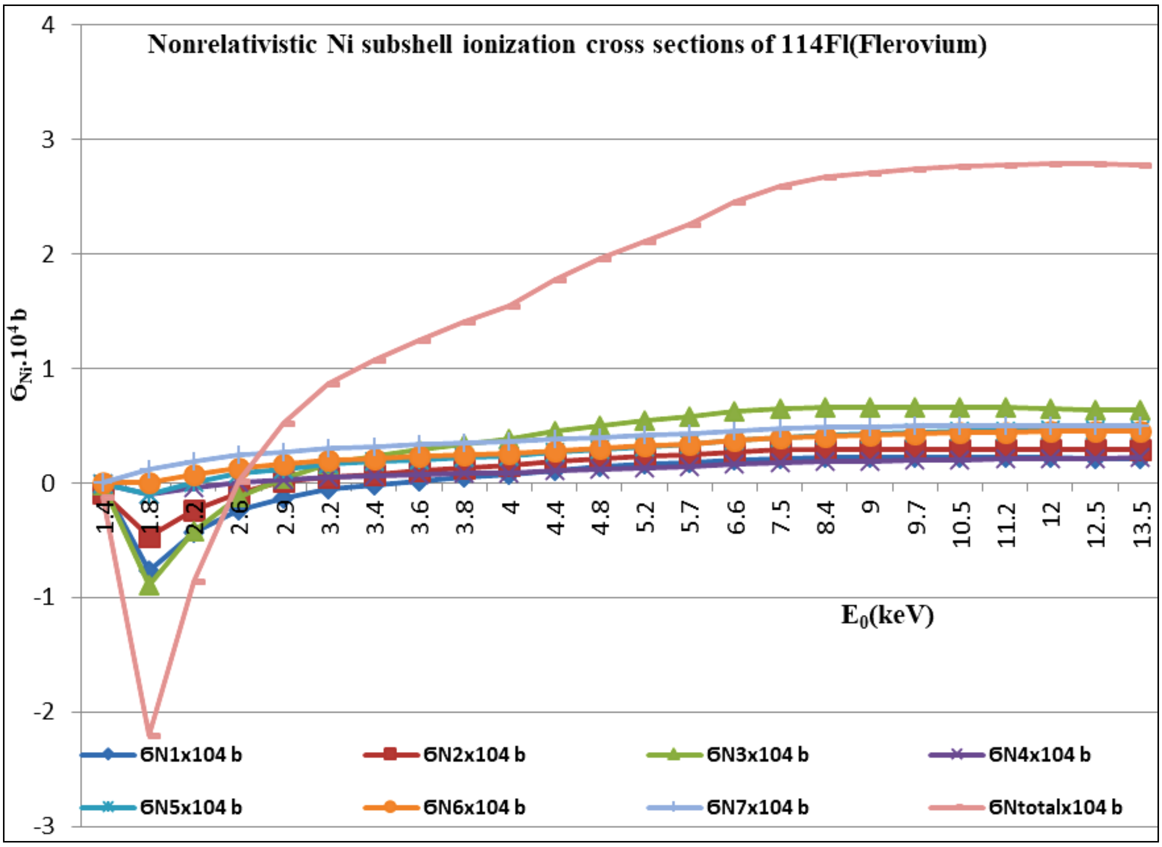


Fig 1a: $_{114}$Fl Flevorium N_1 to N_7 subshell ionization cross sections by electron impact in 10^4 b.

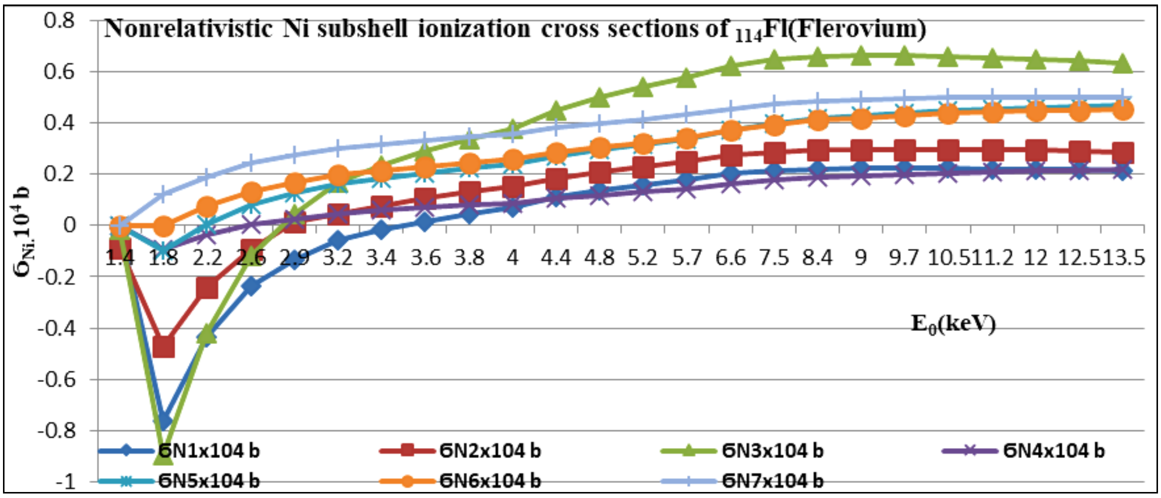
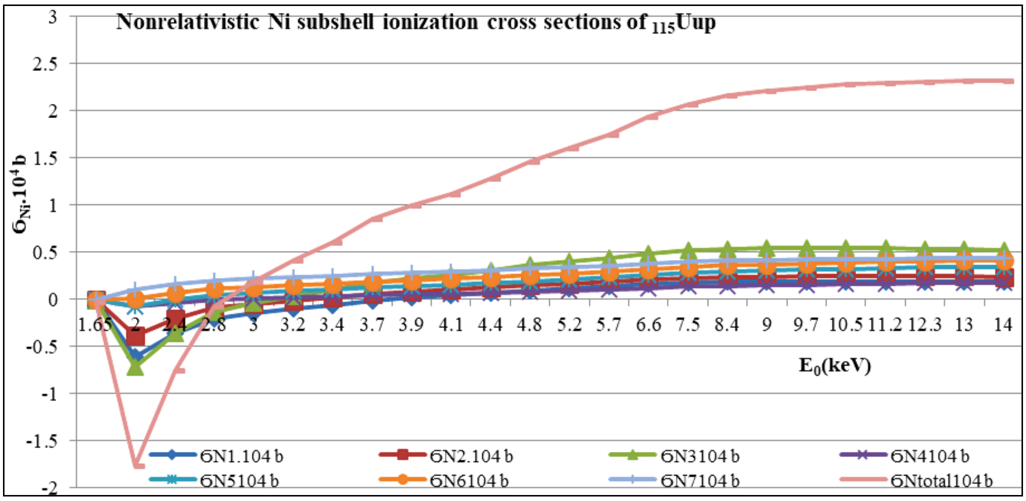


Fig 1b: $_{114}$Fl Flevorium N_1 to N_7 subshell ionization cross sections by electron impact in 10^5 b.

Table 2: For $_{115}$Uup nonrelativistic N_1 to N_7 subshell ionization cross sections by electron impact in 10^4 b

E₀(keV)	σN1.10⁴ b	σN2.10⁴ b	σN3 10⁴ b	σN4 10⁴ b	σN5 10⁴ b	σN6 10⁴ b	σN7 10⁴ b	σNtotal 10⁴ b
1,65	-0,00962	-0,0062	-0,01218	-0,00128	-0,00169	-0,00069	0,00041	-0,03125
2	-0,6099	-0,3804	-0,7227	-0,0763	-0,0811	0,0027	0,1036	-1,7641
2,4	-0,3632	-0,2067	-0,3651	-0,0342	-0,0097	0,0642	0,1579	-0,7568
2,8	-0,206	-0,0921	-0,1297	-0,003	0,0436	0,1121	0,2004	-0,0747
3	-0,1482	-0,0488	-0,0409	0,0098	0,0657	0,1324	0,2184	0,1884
3,2	-0,1003	-0,0123	0,034	0,0213	0,0854	0,1508	0,2347	0,4136
3,4	-0,0602	0,0189	0,0978	0,0316	0,1031	0,1676	0,2495	0,6083
3,7	-0,0114	0,0577	0,1769	0,0453	0,1267	0,1903	0,2694	0,8549
3,9	0,0152	0,0792	0,2208	0,0534	0,1407	0,2039	0,2813	0,9945
4,1	0,0379	0,0981	0,2591	0,0608	0,1536	0,2165	0,2923	1,1183
4,4	0,0663	0,1221	0,3077	0,071	0,171	0,2338	0,3073	1,2792
4,8	0,0958	0,1478	0,3597	0,0828	0,1914	0,2542	0,3247	1,4564
5,2	0,1182	0,1681	0,4004	0,0931	0,2091	0,2721	0,3398	1,6008
5,7	0,1391	0,1877	0,4395	0,1042	0,2282	0,2916	0,3561	1,7464
6,6	0,1635	0,212	0,487	0,1206	0,256	0,3202	0,379	1,9383
7,5	0,1773	0,2269	0,5154	0,1334	0,2775	0,3425	0,3961	2,0691
8,4	0,1849	0,2359	0,5316	0,1436	0,2944	0,3601	0,4088	2,1593
9	0,1877	0,2397	0,5378	0,1494	0,3037	0,3698	0,4153	2,2034
9,7	0,1895	0,2423	0,5417	0,1551	0,3129	0,3793	0,4213	2,2421
10,5	0,1901	0,2438	0,5428	0,1607	0,3216	0,3883	0,4264	2,2737
11,2	0,1898	0,2439	0,5416	0,1649	0,3278	0,3947	0,4295	2,2922
12,3	0,1882	0,2427	0,5369	0,1702	0,3356	0,4026	0,4325	2,3087
13	0,1867	0,2413	0,5326	0,173	0,3394	0,4064	0,4334	2,3128
14	0,1841	0,2385	0,5252	0,1762	0,3437	0,4104	0,4335	2,3116



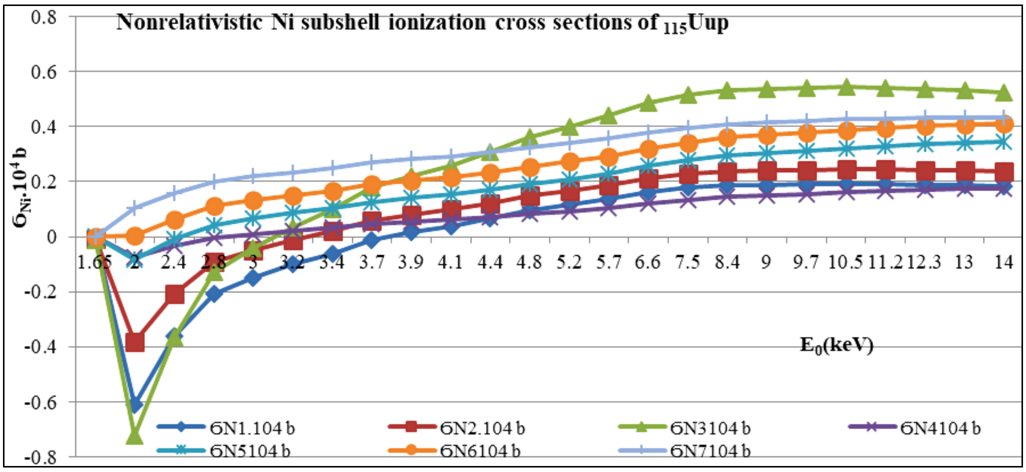


Fig 2a: $_{115}$Uup N_1 to N_7 subshell ionization cross sections by electron impact in 10^4 b.

Table 3: For $_{116}$Lv nonrelativistic N_1 to N_7 subshell ionization cross sections by electron impact in 10^4 b.

E_0(keV)	$σ_{N1}.10^4$ b	$σ_{N2}.10^4$ b	$σ_{N3}10^4$ b	$σ_{N4}10^4$ b	$σ_{N5}10^4$ b	$σ_{N6}10^4$ b	$σ_{N7}10^4$ b	$σ_{Ntotal}10^4$ b
1,75	-0,0086	-0,00557	-0,01098	-0,00115	-0,00156	-0,00072	0,00016	-0,02842
2	-0,6369	-0,4054	-0,7862	-0,0838	-0,1045	-0,0299	0,0524	-1,9943
2,3	-0,4484	-0,2752	-0,5183	-0,0546	-0,056	0,0106	0,0877	-1,2542
2,6	-0,3147	-0,1807	-0,3242	-0,0316	-0,0177	0,0438	0,1167	-0,7084
2,9	-0,2167	-0,1098	-0,1785	-0,0129	0,0136	0,0717	0,1412	-0,2914
3,2	-0,1428	-0,0551	-0,0662	0,0027	0,0397	0,0957	0,1622	0,0362
3,4	-0,1033	-0,0251	-0,0051	0,0117	0,055	0,1099	0,1747	0,2178
3,6	-0,0699	0,0006	0,0475	0,0199	0,0688	0,1231	0,1861	0,3761
3,8	-0,0413	0,0229	0,0931	0,0273	0,0814	0,135	0,1965	0,5149
4,1	-0,0059	0,0512	0,1507	0,0373	0,0983	0,1513	0,2108	0,6937
4,4	0,0226	0,0745	0,1981	0,0462	0,1133	0,166	0,2235	0,8442
4,8	0,0525	0,0996	0,2491	0,0565	0,1309	0,1834	0,2384	1,0104
5,2	0,0755	0,1196	0,2895	0,0655	0,1461	0,1987	0,2514	1,1463
5,7	0,0974	0,1392	0,3288	0,0753	0,1626	0,2154	0,2654	1,2841
6,6	0,1233	0,1639	0,3778	0,0897	0,1868	0,2402	0,2858	1,4675
7,5	0,1388	0,1797	0,4086	0,101	0,2057	0,2598	0,3013	1,5949
8,4	0,148	0,1899	0,4278	0,1102	0,2208	0,2756	0,3133	1,6856
9	0,1519	0,1945	0,4361	0,1153	0,2292	0,2843	0,3197	1,731
9,7	0,1548	0,1982	0,4425	0,1206	0,2376	0,2932	0,3258	1,7727
10,5	0,1566	0,2008	0,4465	0,1257	0,2457	0,3016	0,3313	1,8082
11,2	0,1573	0,2021	0,4479	0,1295	0,2517	0,3079	0,3351	1,8315
12,3	0,1571	0,2024	0,447	0,1346	0,2594	0,3158	0,3393	1,8556
13	0,1564	0,202	0,4451	0,1373	0,2634	0,3198	0,3411	1,8651
14	0,1551	0,2007	0,4411	0,1405	0,2681	0,3244	0,3427	1,8726

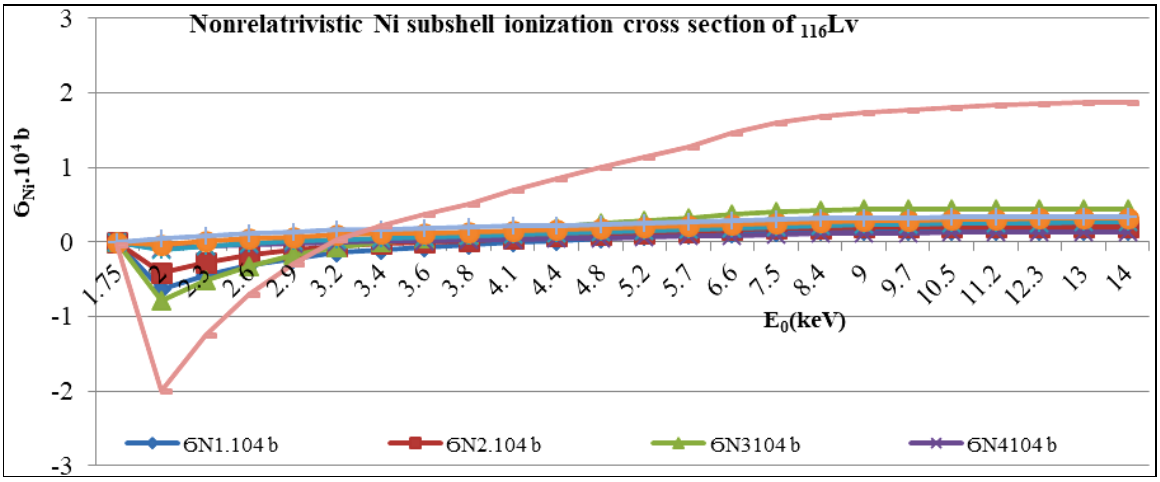


Fig 3a: For $_{116}$Lv nonrelativistic N_1 to N_7 subshell ionization cross sections by electron impact in 10^4 b

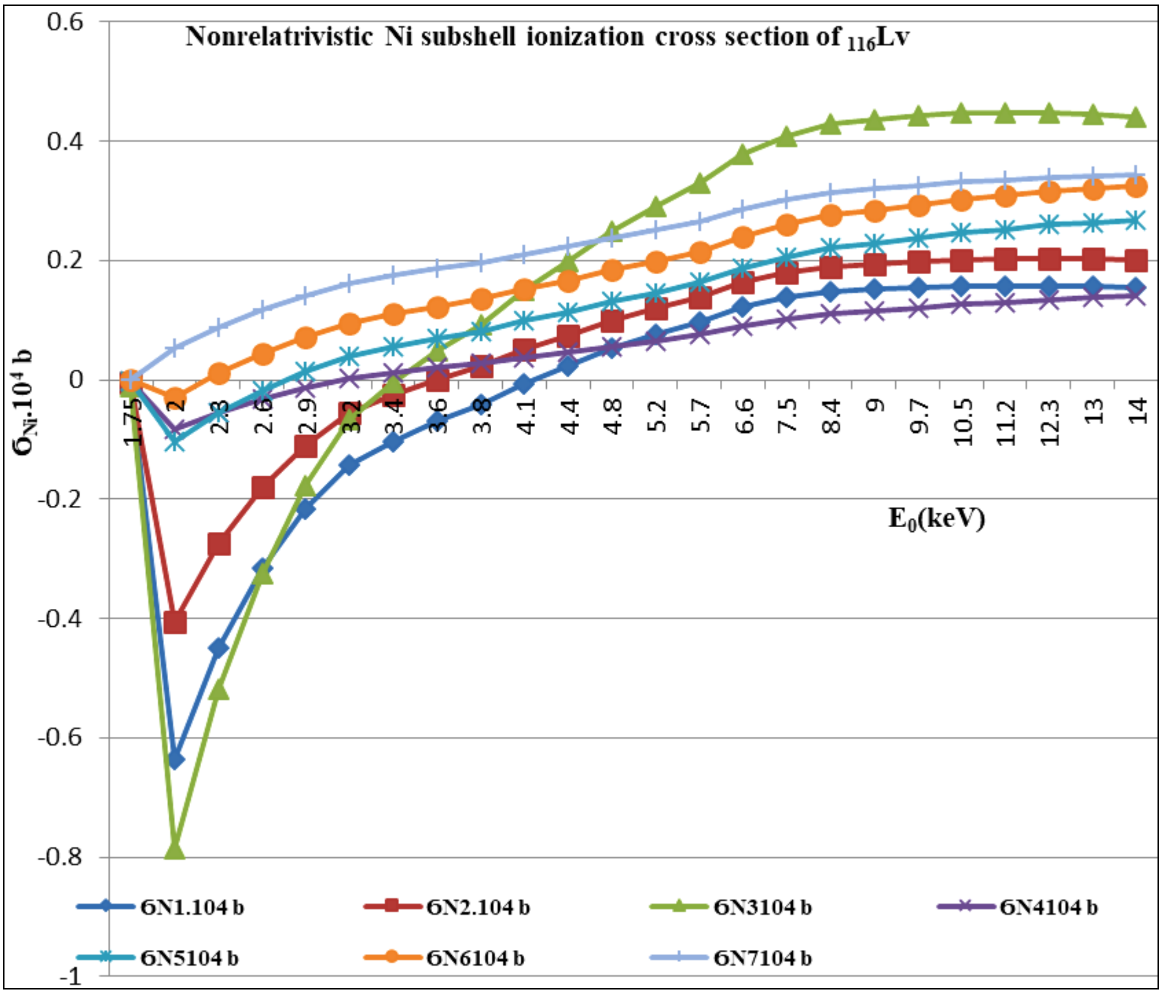


Fig 3b: For $_{116}$Lv nonrel N_1 to N_7 subshell ionization cross sections by electron impact in 10^4 b.

Table.4. $_{117}$Us N_1 to N_7 subshell ionization cross sections by electron impact in 10^4 b.

E(keV)	$б_{N1}.10^4$ b	$б_{N2}.10^4$ b	$б_{N3}10^4$ b	$б_{N4}10^4$ b	$б_{N5}10^4$ b	$б_{N6}10^4$ b	$б_{N7}10^4$ b	$б_{Ntot}.10^4$ b
2	-0,6468	-0,4191	-0,8251	-0,088	-0,1217	-0,044	0,0151	-2,1296
2,3	-0,4619	-0,2942	-0,5698	-0,0625	-0,0757	-0,0123	0,0426	-1,4338
2,6	-0,3306	-0,2036	-0,3845	-0,0425	-0,0395	0,0137	0,0653	-0,9217
2,9	-0,234	-0,1354	-0,2452	-0,0264	-0,0099	0,0355	0,0843	-0,5311
3,2	-0,161	-0,0826	-0,1376	-0,0131	0,0147	0,0541	0,1007	-0,2248
3,4	-0,122	-0,0538	-0,0788	-0,0052	0,0291	0,0652	0,1104	-0,0551
3,6	-0,0888	-0,0289	-0,0074	0,0282	0,0018	0,0753	0,1193	0,0995
3,8	-0,0605	-0,0074	0,0158	0,0082	0,0538	0,0847	0,1275	0,2221
4,1	-0,0252	0,0201	0,0715	0,0167	0,0697	0,0974	0,1386	0,3888
4,4	0,0034	0,0427	0,1175	0,0243	0,0837	0,1089	0,1486	0,5291
4,8	0,0333	0,0673	0,1673	0,0331	0,1002	0,1225	0,1604	0,6841
5,2	0,0565	0,0869	0,2071	0,0408	0,1144	0,1344	0,1707	0,8108
5,7	0,0785	0,1063	0,2461	0,0491	0,1299	0,1476	0,1819	0,9394
6,6	0,1052	0,131	0,2955	0,0614	0,1527	0,1671	0,1984	1,1113
7,5	0,1214	0,1472	0,3276	0,0712	0,1706	0,1828	0,2113	1,2321
8,4	0,1313	0,1581	0,3485	0,0791	0,1851	0,1955	0,2214	1,319
9	0,1356	0,1631	0,3581	0,0835	0,1931	0,2027	0,227	1,3631
9,7	0,1391	0,1674	0,3662	0,0881	0,2013	0,2099	0,2324	1,4044
10,5	0,1414	0,1707	0,3721	0,0926	0,2093	0,217	0,2376	1,4407
11,2	0,1425	0,1726	0,3752	0,0961	0,2153	0,2223	0,2412	1,4652
12,3	0,1429	0,1741	0,3771	0,1007	0,2231	0,2292	0,2457	1,4928
13	0,1426	0,1743	0,3769	0,1032	0,2271	0,2328	0,2478	1,5047
14	0,1417	0,1739	0,3752	0,1062	0,232	0,2371	0,2501	1,5162
15	0,1403	0,1728	0,3723	0,1088	0,236	0,2405	0,2516	1,5223

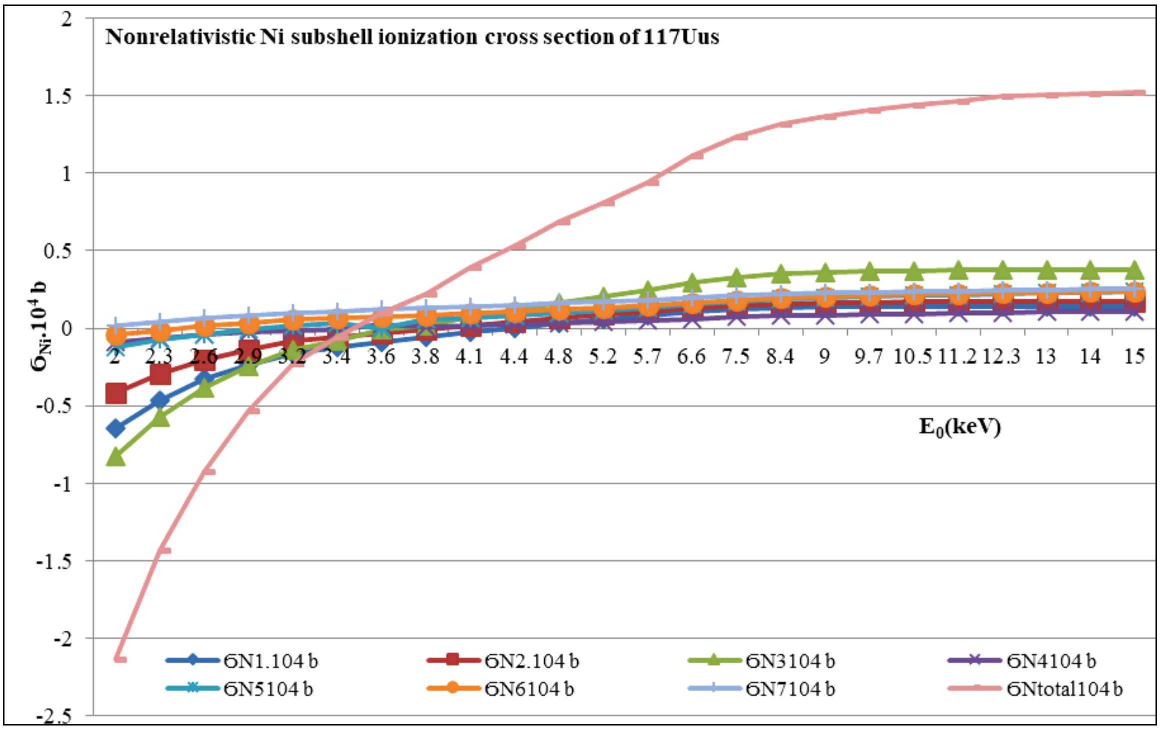


Fig 4a: **$_{117}$Uus** N_1 to N_7 subshell ionization cross sections by electron impact in 10^4 b.

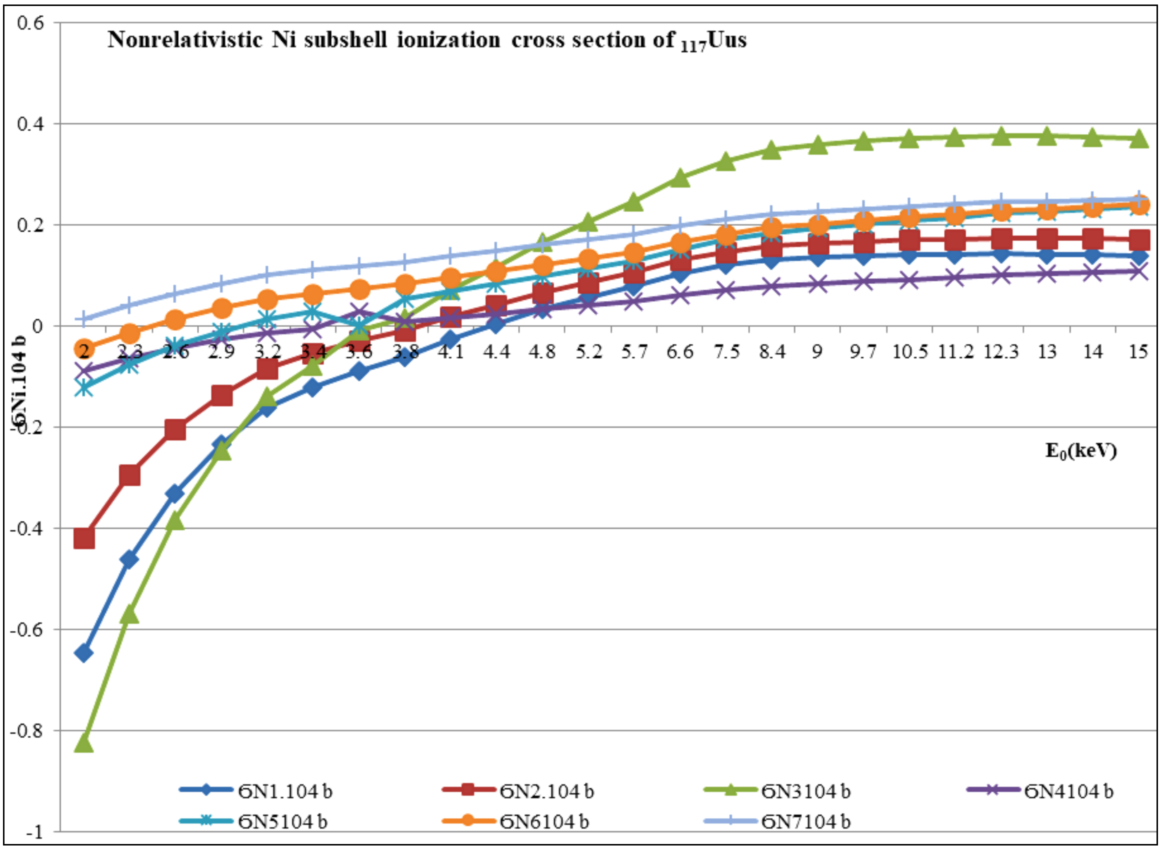


Fig 4b: $_{117}$**Uus** N_1 to N_7 subshell ionization cross sections by electron impact in 10^5 b.

Table 5: $_{118}$**Uus** N_1 to N_7 subshell ionization cross sections by electron impact in 10^4 b.

E_0(keV)	$Ϭ_{N1}.10^4$ b	$Ϭ_{N2}.10^4$ b	$Ϭ_{N3}10^4$ b	$Ϭ_{N4}10^4$ b	$Ϭ_{N5}10^4$ b	$Ϭ_{N6}10^4$ b	$Ϭ_{N7}10^4$ b	$Ϭ_{Ntot}10^4$ b
2,2	-0,5303	-0,3477	-0,67682	-0,0725	-0,0953	-0,043	0,0195	-1,74612
2,6	-0,3495	-0,2276	-0,4263	-0,0471	-0,0524	-0,0093	0,0497	-1,0625
2,9	-0,2551	-0,1632	-0,2926	-0,0323	-0,0274	0,0111	0,0681	-0,6914
3,2	-0,1836	-0,1134	-0,1892	-0,0202	-0,0065	0,0285	0,0841	-0,4003
3,4	-0,1452	-0,0861	-0,1326	-0,0131	0,0056	0,0388	0,0934	-0,2392
3,6	-0,1125	-0,0625	-0,0838	-0,0067	0,0165	0,0483	0,1021	-0,0986
3,8	-0,0845	-0,042	-0,0414	-0,0011	0,0265	0,0571	0,1099	0,0245
4,1	-0,0495	-0,0159	0,0125	0,0067	0,0398	0,0689	0,1207	0,1832
44	-0,0213	0,0058	0,0572	0,0136	0,0516	0,0796	0,1304	0,3169
4,8	0,0088	0,0294	0,1057	0,0215	0,0654	0,0923	0,1418	0,4649
5,2	0,0321	0,0484	0,1445	0,0284	0,0774	0,1035	0,1519	0,5862
5,7	0,0545	0,0672	0,1829	0,0359	0,0905	0,1158	0,1628	0,7096
6,6	0,0819	0,0917	0,2323	0,0471	0,1096	0,1342	0,1791	0,8759
7,5	0,0989	0,1081	0,2649	0,0557	0,1248	0,1491	0,1918	0,9933
8,4	0,1096	0,1193	0,2868	0,0629	0,1371	0,1613	0,2021	1,0791
9	0,1145	0,1248	0,2973	0,067	0,1441	0,1683	0,2076	1,1236
9,7	0,1185	0,1297	0,3065	0,0711	0,1511	0,1754	0,2132	1,1655
10,5	0,1215	0,1338	0,3138	0,0753	0,1581	0,1825	0,2186	1,2036
11,2	0,1232	0,1364	0,318	0,0785	0,1634	0,1878	0,2225	1,2298
12,3	0,1244	0,1391	0,3219	0,0828	0,1703	0,1949	0,2273	1,2607
15	0,1235	0,1405	0,3216	0,0905	0,1823	0,2073	0,2344	1,3001
16	0,1224	0,1401	0,3194	0,0926	0,1854	0,2103	0,2357	1,3059

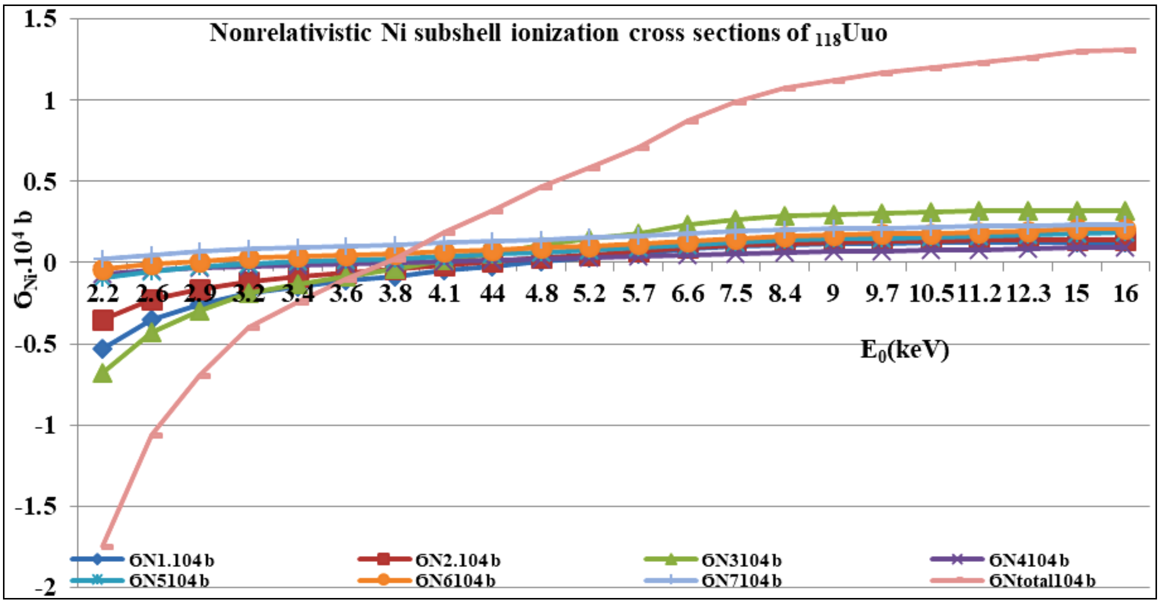


Fig 5a: $_{118}$**Uus** N_1 to N_7 subshell ionization cross sections by electron impact in 10^4 b.

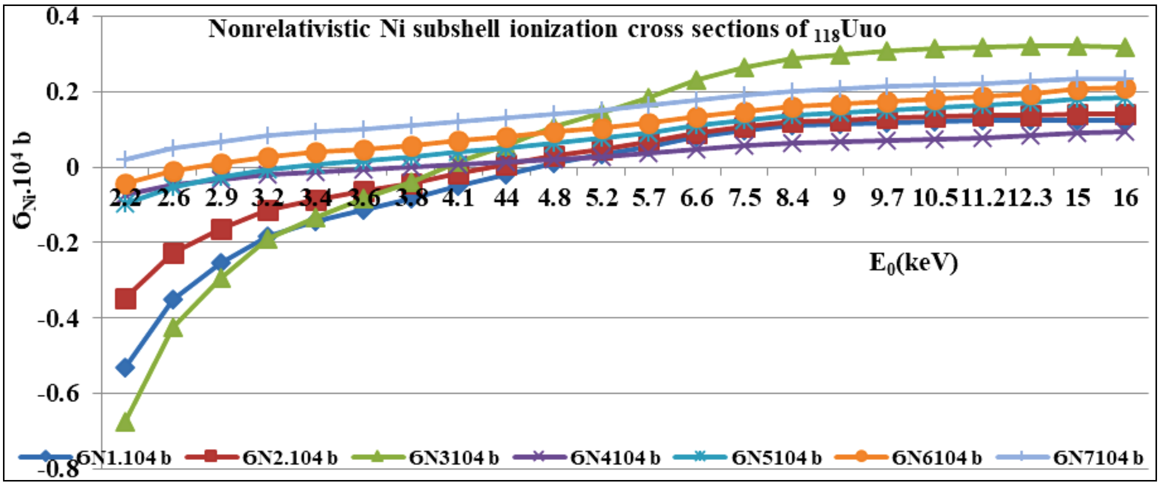


Fig 5b: $_{118}$**Uus** N_1 to N_7 subshell ionization cross sections by electron impact in 10^4 b.

Table 6: Z dependency of σ_{Ni} subshell ionization cross section of Z=114 to 118 Atoms by 4,8 keV electron impact in 10^4 b.

Z Atom no	$\sigma_{N1}.10^4$ b	$\sigma_{N2}.10^4$ b	$\sigma_{N3}10^4$ b	$\sigma_{N4}10^4$ b	$\sigma_{N5}10^4$ b	$\sigma_{N6}10^4$ b	$\sigma_{N7}10^4$ b	$\sigma_{Ntotal}10^4$ b
114	0,1381	0,2105	0,5024	0,1181	0,2936	0,3044	0,3991	1,9662
115	0,0958	0,1478	0,3597	0,0828	0,1914	0,2542	0,3247	1,4564
116	0,0525	0,0996	0,2491	0,0565	0,1309	0,1834	0,2384	1,0104
117	0,0333	0,0673	0,1673	0,0331	0,1002	0,1225	0,1604	0,6841
118	0,0088	0,0294	0,1057	0,0215	0,0654	0,0923	0,1418	0,4649

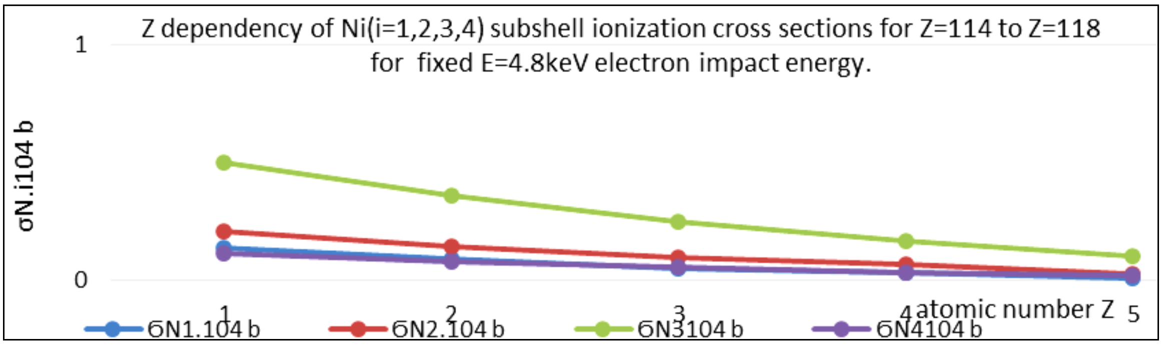


Fig 6a: Z dependency of Ni subshell ionization cross section of Z=114 to 118 Atoms by 4,8 keV electron impact in 10^4 b.

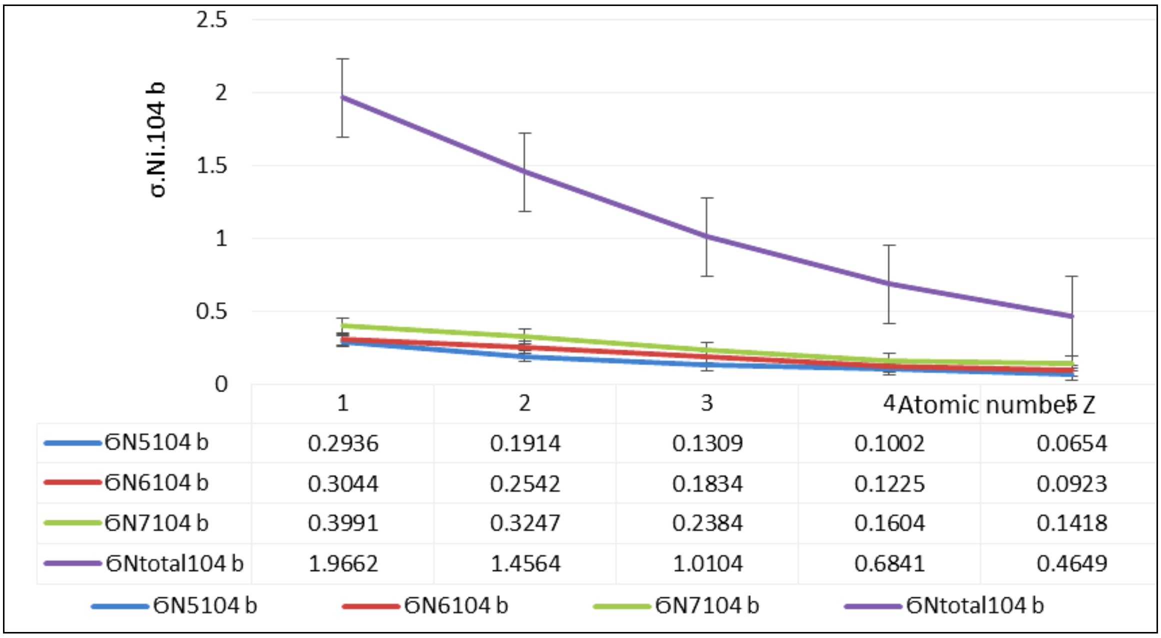


Fig 6b. Z dependency of Ni subshell σ^{nrel}_{Ntotal} and N_i subshells σ^{nrel}_{Ni} of Z=114 to 118 Atoms by 4,8 keV electron impact in 10^4 b.

4. Conclusions

Nonrelativistic N shell σ^{nrel}_{Ntotal} and N_i subshells σ^{nrel}_{Ni} for $_{114}$Fl, $_{115}$Uup, $_{116}$Uuh, $_{117}$Uus, $_{118}$Uuo atoms results given in tables and figures under the name of each atom separately. Following each table, for the same atomic results also given as colored graphs in a figure. These graphs helps to compare how each subshells $\sigma^{nrel}_{Ntotall}$ and N_i subshells σ^{nrel}_{Ni} depends at any value of E_{0i} electron impact energy. σ^{nrel}_{N} values are given in (b) in Tables 1-5 and in Figs.1-5. There are some common charcteristics of σ^{nrel}_{Ni} : For each atom very close to threshold region; 1)Seven σ^{nrel}_{Ni} For 1keV to about 4 keV electron impact of $_{114}$Fl as seeing at Figs.1a, and 1b: σ^{nrel} N_3 crosses the other cross sections in the following order(1,2,4,5,6,7): For instance; σ^{nrel}_{N1} σ^{nrel}_{N2} σ^{nrel}_{N4} and σ^{nrel}_{N5} and the σ^{nrel}_{N6} and $\sigma^{nrel}_{N7;}$ As seeing at Figs.2a and 2b for $_{115}$Uup atom: σ^{nrel}_{N3}; $\sigma^{nrel}_{N1,}$ $\sigma^{nrel}_{N2,}$ $\sigma^{nrel}_{N4,}$ and the σ^{nrel}_{N6} and σ^{nrel}_{N7} crossed. For $_{116}$Uuh, σ^{nrel}_{N3} as seeing in Fig 3b. crosses σ^{nrel}_{N1}, σ^{nrel}_{N2},σ^{nrel}_{N4}, σ^{nrel}_{N6} and σ^{nrel}_{N7}. Also, in Figure 4b and Figure.5b for $_{117}$Uus and 118_{Uuo} atoms; σ^{nrel}_{N3} crosses all subshell cross section graphs in the same order as in this order: σ^{nrel}_{N1} σ^{nrel}_{N2} σ^{nrel}_{N4}, σ^{nrel}_{N5},σ^{nrel}_{N6} and σ^{nrel}_{N7} respectively. σ^{nrel}_{N3} crosses the other cross sections in the following impact energy intervals: 2,2-4keV for Z=114, 2,4 to 4,4keV for Z=115; 2,4 to 4,70keV; Z=116; 2,65 to 4,87keV; Z=117; 3 to 4,8keV; Z=117; 3,3 to 5,4keV; as seeing at Figs.1a to 5a. For electron impact energy range of 8-16 keV higher energies namely at the end region of graphs. each σ^{nrel}_{Ni} increases differently by E_0 impact energy. But it seems to subshell electrons responding impact electron in an accord. How much Auger and Coster-Cronig transitions effects to these σ^{nrel}_{Ni} cross sections? For a fixed E_{oi}=4,8keV, and while Z value changes from $_{114}$Fl≤ Z ≤$_{118}$Uuo σ^{nrel}_{Ni} decrease with atomic number Z. It will be better if the presented results compared with single electron impact on single free atom experimental cross section measurements and with other calculations such as Distorted wave Born approximation (DWBA) and Modified Relativistic Bethe Born Approximations (MRBEB) [5-16,17-21].

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