ARTICLE 19

Excited Electron: Pepliz LAN Empire I: $LAN_{n\to\infty}$ vs. LAN (P50)

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ABSTRACT

This is 19th article of 24 dedicated to atomic model based on Victoria equation (Articles index is at end). LAN allows creation of Serelles Secondary Line from Torrebotana Central Line [1,2]. Different relations have LAN role as common link: Riquelme de Gozy (RG) [2] [3] and [9], Flui Piep de Garberí (FPG) [4] and Silva de Peral y Alameda (SPA) [5,8]. This article works preferably wit RG relation.

First part is dedicated to linearity between $LAN_{n\to\infty}$ and LAN(P050) in RG representation, as well as asymptotic tendency to its corresponding limits as n_s is increased. Second part serves as introduction to Pepliz LAN empire as region of first quadrant in LAN(P65) vs. LAN(P50) representation that is subdivided into zones. Electron jumps are located in one or other zones depending on jump type. External and internal limits of Pepliz LAN empire are postulated.

KEYWORDS

Relation of Riquelme de Gozy, RG relation, Tete-Vic equation, LAN, Pepliz LAN empire, Pepliz LAN empire limits: external and internal, LAN(P50), LAN(P65).

INTRODUCTION

P50, Initial LAN value in jump from ns to ns, is introduced in [2] and implies that initial LAN value is corresponding to initial state and is not first jump. Consequently, initial LAN_R value is result of applying IE instead E_{dR}. Initial LAN value in $n_sS\to ns$ is called LAN(P50) (1) where n_sS is start ns. Abbreviations Table is at end article.

$$(1)\text{ - LAN(P50)} = -LAN_{ns\,\to\,ns} = \frac{(-E_o)^{1/2} z_s}{(-IE)^{1/2} z_o} - n_{initial}$$

This $n_sS\to ns$ exclusive fact allows to know RG (Riquelme de Gozy) slope with only one excited state since other point is provided by non-excited state. On the other hand, rest of jumps requires two excited states to know slope. Alignment of RG relation between LAN(P50) and electron jump other than $n_sS\to ns$ is not correct and there is only certain approximation with some specific electron jump as $n_sS^2\to n_sSns$.

Disparate alignment behaviour between electron jump type and at the same time homogeneous within concrete jump gives map idea where each jump dominates territory located in its limits. First step is to express relation between LAN(P50) and any electron jump by P65.

P65 Linearity between $LAN_{n\to\infty}$ and LAN(P050) in RG.

Relation of Riquelme de Gozy for given isoelectronic series includes Linearity between $LAN_{n\to\infty}$ or LAN(P65) and LAN(P050).

P65 is going to be checked with electron jumps from s or p to s or p. For example, in atomic oxygen (O I) is applied to $2p^4 \to 2p^3ns$ and $2p^3np$ in their different Term and J options.

LANn→∞ is called LAN(P065) and is obtained as Y-intercept in LAN_R vs. E_{dR} representation by first two RG points because $E_{dR}=0$ when n→∞. Likewise, LAN(P65) can be obtained with Ek which is magnitude indicated in reference [11] (2). RG point number, which is equivalent to excited state number in non $n_s s \to ns$ jumps, is indicated in parentheses. $E_k(F)$ is referred to final state that for LAN(P65) is when n→∞ and therefore $E_k(F)=-IE$ (where IE is ionization energy).

$$(2)\mathrm{LAN}(\mathrm{P65}) = \mathrm{LAN}(1) + \frac{\mathrm{LAN}(2)-\mathrm{LAN}(1)}{E_k(2)-E_k(1)}\left(E_k(F)-E_k(1)\right)$$

Relation between LAN(P65) and LAN(P50) is compared with real start LAN. Real start LAN is LAN when $n=n_{START}=n_S$ and $E_k=0$. Consequently, LAN_S is got with Y-intercept in LAN_R vs. E_k representation by first two RG points (3). (2) is transformed into (3) because $E_k(F)=0$ in jump absence.

$$(3)\mathrm{LANs} = \mathrm{LAN}_{\mathrm{START}} = \mathrm{LAN}(1) - \frac{\mathrm{LAN}(2)-\mathrm{LAN}(1)}{E_k(2)-E_k(1)}E_k(1)$$

LAN_S and LAN(P65) are obtained by reference values extrapolation that are affected by relativistic excess [8] and [9]. First two points have been selected because are the least affected by E_o relativistic excess (ER_o) but is significant as Z increases. On the other hand, although E_{dR} relativistic excess (ER_{dR}) is more important in first jumps its role is less prominent because its IE is low in examples studied. Example where E_{dR} relativistic excess is not overlooked is in [8]: $1s^2 \to 1sns$ (Term=^{1}S and J=0)

Figure 1 is LAN_R vs. E_{dR} representation for Al I $[Ne]3s^23p \to [Ne]3s^2ns$ with n=[4,15]. [9] is verified with gradual curvature as n increases as consequence of not being considered ER_o. In view of Figure 1, extrapolation from first two points is optimal because are less affected by ER_o. **Figure 2** shows LAN(P65) and LAN_S by first two points extrapolation: Al 3p→4s and 5s.

Figure 1 - RG with LAN=f(E_k or E_{dR}) Al I 3p→ns (n=[4-15]).

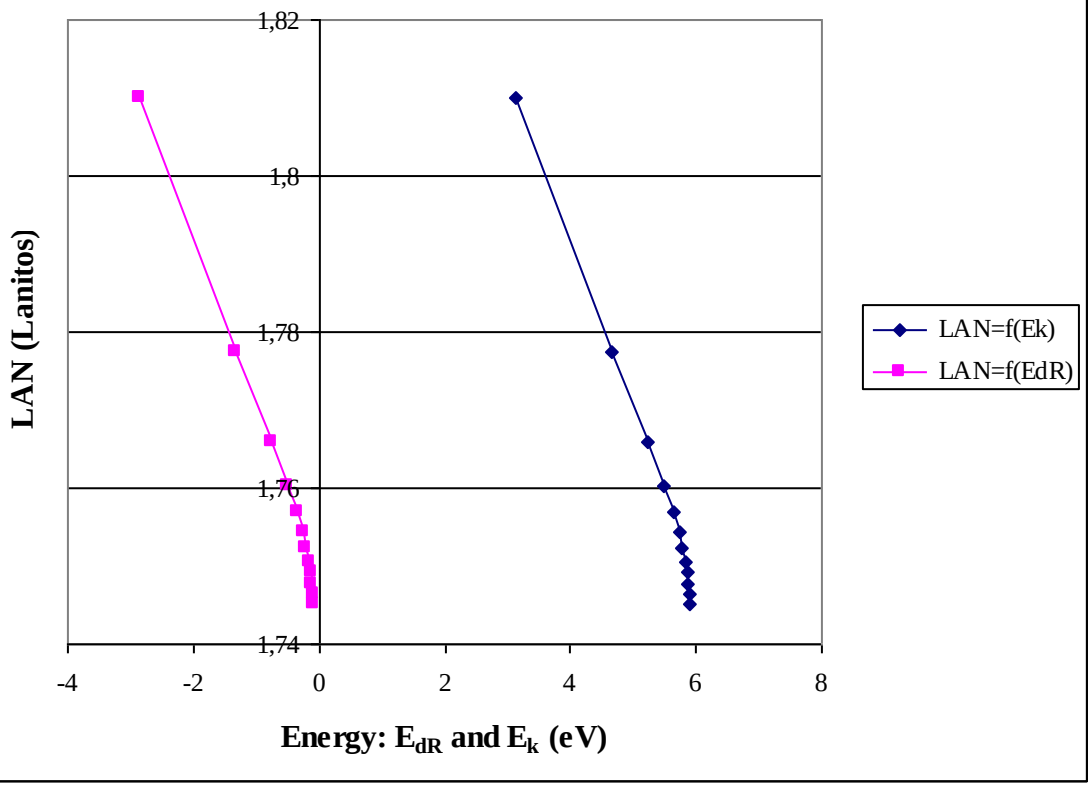
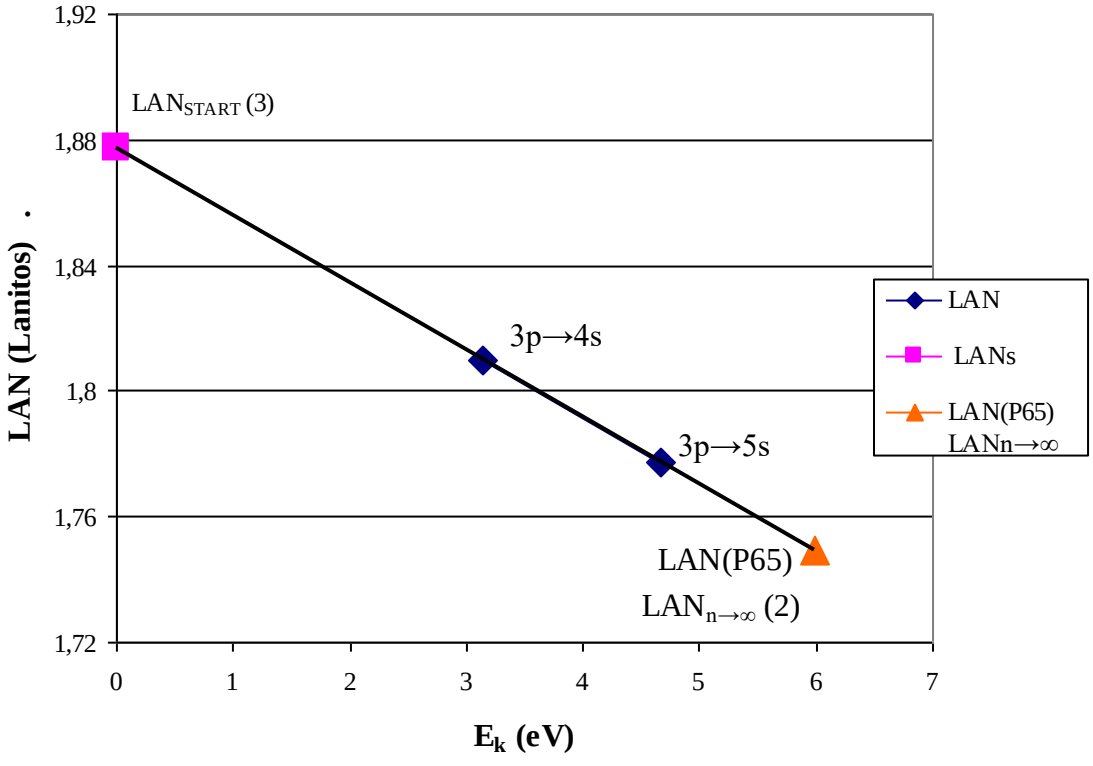


Figure 2. LAN_S and LAN(P65) in RG: Al I 3p →ns with n=[4,5]

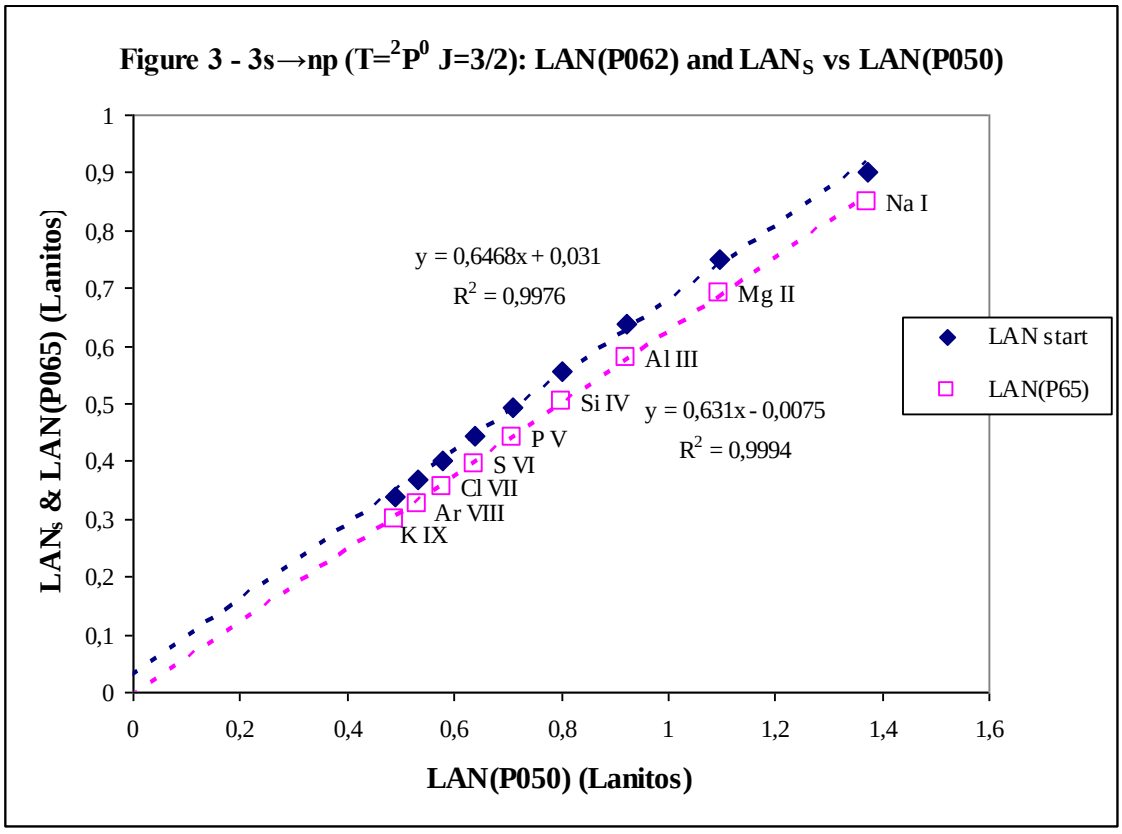


LAN(P50) equals 1.49079 with start n or n_s=3 (1) and, as previously indicated, is different from LAN_{START} because is not $n_s s \rightarrow ns$. Next point within P65 is first linearity example between LAN(P50) and LAN(P65) or $LAN_{n\rightarrow\infty}$. At the same time, relation between LAN(P50) and LAN_S is proven to have worse R^2.

ns→np (Term=$^2P^0$ J=3/2)

[Ne]3s →[Ne]3p (Term=$^2P^0$ J=3/2) is chosen as linearity example between LAN(P65) and LAN(P50). X axis is LAN(P50) and Y axis is LAN_S and LAN(P65) in **Figure 3**. X axis selection is not random and its reason is to recognize that excited state location (LAN_S and LAN(P65) use excited states) in map idea is directed by non-excited state since LAN(P50) is based on IE (ionization energy) (1). Atoms used are from Na I to K IX both included. Two resulting linear regressions are (4) and (5) with better linearity for LAN(P65) vs. LAN(P50): Y-intercept≈0 and R^2=0.9994

(4) LAN(P65) = 0.6310 LAN(P50) – 0.0075 R^2 = 0,9994
(5) LAN_S = 0.6468 LAN(P50) + 0.031 R^2 = 0,9976



P66 is explained to continue with 4s→np

P66 nd^x adaptation for LAN(P65) vs. LAN(P50) linearity

As seen in RG relation [3] and SPA relation [6], nd^x also requires first energetic step (6) in order to comply with LAN(P65) vs. LAN(P50) linearity. New ionization energy from which is calculated LAN(P50) and RG relation includes this first energetic step:

$$(6)\quad n_s d^x \rightarrow nd^{x-1}(n+1)s \text{ or } nd^{x-1}(n+1)p$$

Isoelectronic series with K I and Cu I present 4s→np (Term=$^2P^0$ J=3/2). Isoelectronic series with K I has transition metals that require first step $3p^6 3d$ a $3p^6 4s$ for /Ed_R/ and LAN calculation [3]. From K I to V V have been selected for K isoelectronic series and atoms with reference [11] make up Cu isoelectronic series with Cu I exception that presents certain disparity in their firs jumps and consequently, extrapolation is erroneous. Specifically, Ga III, Kr VIII, Rb IX and Sr X. are Cu isoelectronic series.

LAN(P65) vs. LAN(P50) and and LAN_S vs. LAN(P50) are done up to start n or n_s=6 and their linear regressions with corresponding R^2 coefficients are compiled in **Table 1** for LAN(P65) vs. LAN(P50) and **Table 2** for LAN_S vs. LAN(P50).

There are less atoms with data [11] as n_s is higher and consequently LAN(P65) vs. LAN(P50) and LAN_S vs. LAN(P50) have less points for linear regressions (Table 1 and 2). In fact, Cs I isoelectronic series only has two points: Cs I and Ba II. In addition, these points present more error because extrapolations are subject to greater error due to increasing ER_o effect (E_o relativistic excess) [8] and [9]

Table 1 - $n_s s \rightarrow$ np (Term=$^2P^0$ y J=3/2): LAN(P65) vs. LAN(P50) linear regression

n	Series	Atoms	Y-intercept (Lanitos)	Slope	R^2
3	Na I	[Na I, K IX]	-0,0075	0,6310	0,9994
4	K I	[K I, V V]	-0,0229	0,7749	0,9998
4	Cu I	Ga III, Kr VIII, Rb IX and Sr X	-0,1119	0,8430	0,9997
5	Rb I	Rb I , Sr II, Zr IV and Mo VI	-0,0753	0,8423	0,9995
5	Ag I	Ag I , Xe VIII, Cs IX and Ba X	-0,0761	0,8326	0,9999
6	Cs I	Cs I and Ba II	-0,0329	0,8540	

Table 2 - $n_s s \rightarrow$ np (Term=$^2P^0$ y J=3/2): LAN_S vs. LAN(P50) linear regression

n	Series	Atoms	Y-intercept (Lanitos)	Slope	R^2
3	Na I	[Na I, K IX]	0,0310	0,6468	0,9976
4	K I	[K I, V V]	0,06206	0,7830	0,9992

4	Cu I	Ga III, Kr VIII, Rb IX and Sr X	-0,0232	0,8623	0,9999
5	Rb I	Rb I , Sr II, Zr IV and Mo VI	0,0884	0,8377	0,9982
5	Ag I	Ag I , Xe VIII, Cs IX and Ba X	0,0215	0,8744	1,0000
6	Cs I	Cs I and Ba II	0,2023	0,8462	

P67 P65 asymptotes in Pepliz LAN empire.

LAN(P65) vs. LAN(P50) produces lines in same Pepliz LAN empire region that tend asymptotically to their limits as n_s is increased.

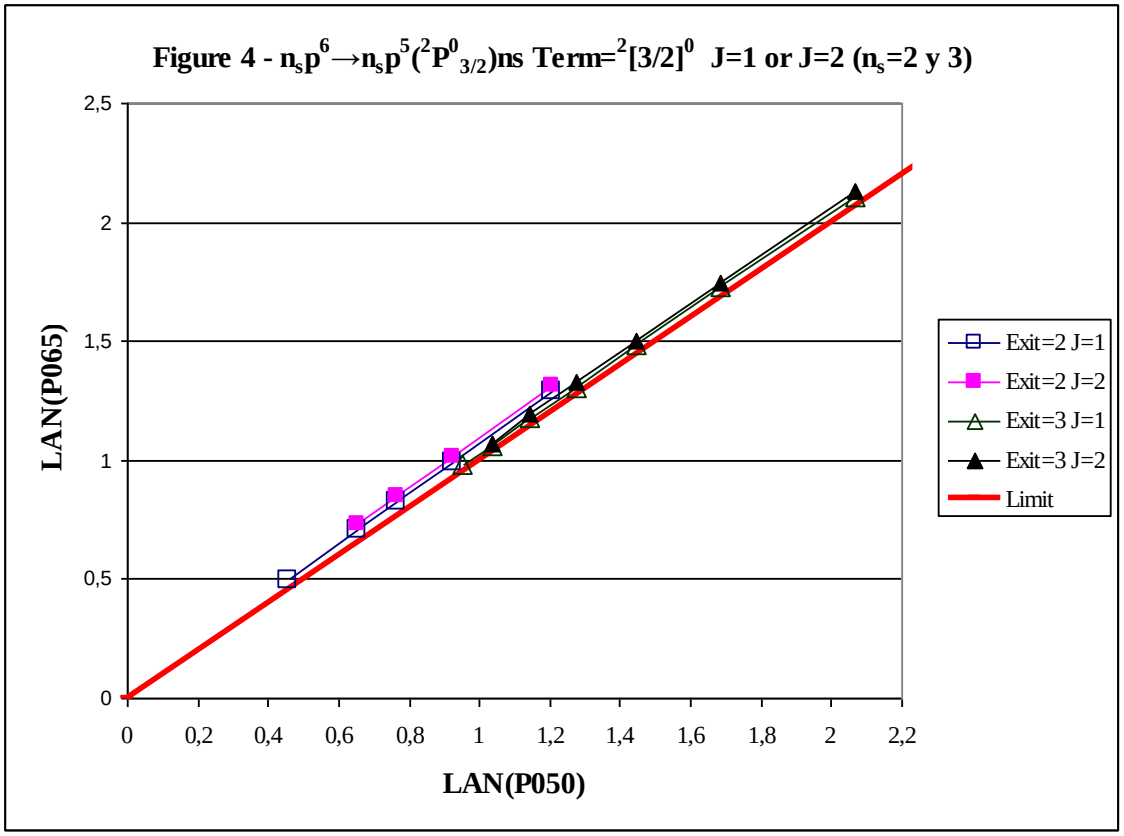
Pepliz LAN empire is region of first quadrant in LAN(P65) vs. LAN(P50) representation that is subdivided into zones. Electron jumps are located in one or other zones depending on jump type. Asymptotic behaviour of electron jump when n_s grows is observed before entering Pepliz LAN empire zones.

Asymptotic behaviour in $n_sp^6 \rightarrow n_sp^5(^2P^0_{3/2})ns\ ^2[3/2]^0$ and J=1 or J=2

$np^5(^2P^o_{3/2})$ is chosen option because IE has its value in [11]. Two configuration options within IE are possible when excited electron is taken to ns: $n_ss^2n_sp^5(^2P^o_{3/2})ns$ with Term=$^2[3/2]^0$ and J=2 or J=1 (n_s=start n). E_k is only slightly higher when J=1 and for this reason, both linearities run practically superimpose towards one of Pepliz LAN empire limits. Both options and for first two start n, that is, $2p^6$ and $3p^6$, are in **Figure 4**. For example, "ns=2 J=1" is start n equal to 2 (Isoelectronic series with Ne I: $2s^22p^6$) and whose excited state has J=1.

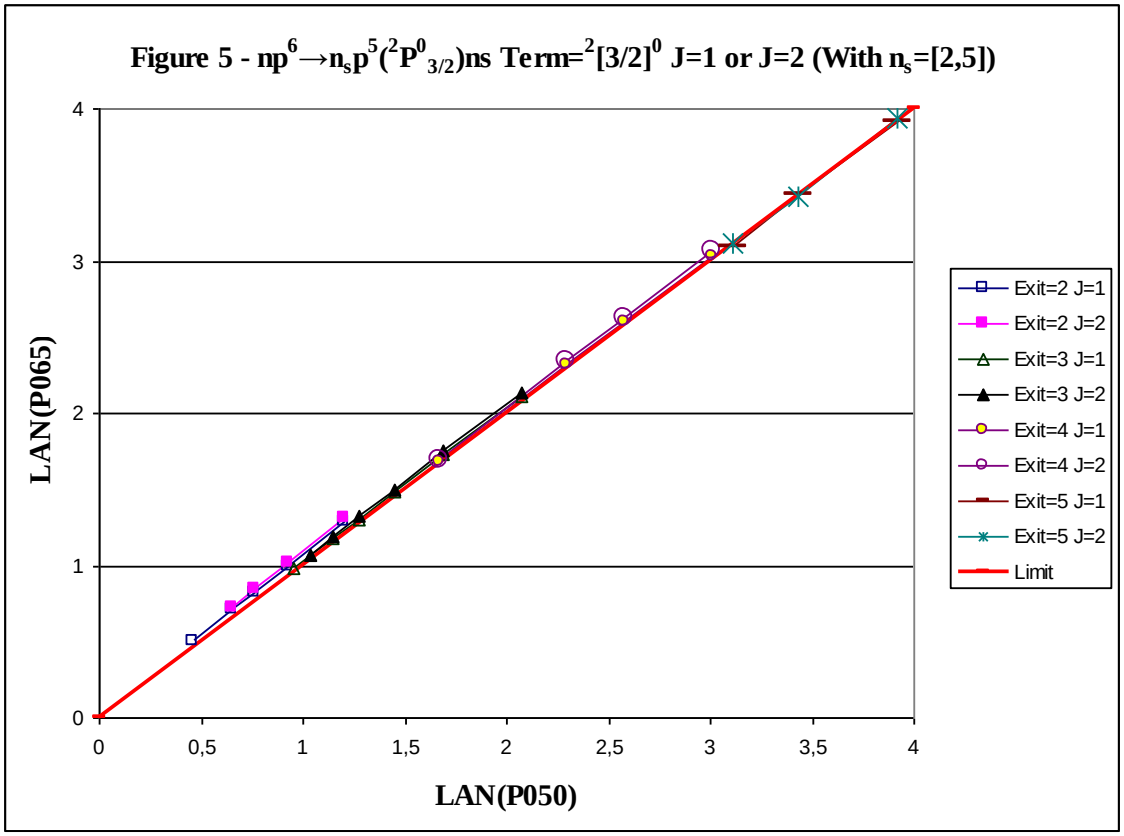
Ne I isoelectronic series are made up for all atoms that have first two E_k ($2p^6 \rightarrow 3s$, 4s and $2p^6 \rightarrow 4s$, 5s) because are indispensable for LAN(P65) calculation:

n_s=2 J=1 [Ne I, Al IV] and S VII
n_s=2 J=2 [Ne I, Al IV]
n_s=3 J=1 [Ar I, Cr VII]
n_s=3 J=2 [Ar I, V VI]



Featured comments of Figure 4:

A) P65 Linearity between $LAN_{n\rightarrow\infty}$ and LAN(P050) is observed with four possibilities.
B) Lines go in pairs according to their start n and come together as go towards (0,0) point.
C) Higher z_s within same isoelectronic series provide greater approach towards limit to finally conclude together in (0,0).
D) 2 lines with n_s=3 are closer to limit than when n_s=2. In this case, limit is LAN(P65)=LAN(P50) line and is exposed later. This asymptotic approach to limit as n_s increases is P67, P65 asymptotes in Pepliz LAN empire, and is corroborated with **Figure 5** where two subsequent n_s are incorporated. For output from $4p^6$, Kr I isoelectronic series is included with Kr I, Rb II, Sr III and Mo VII and $5p^6$ has Xe I, CsII and Ba III. Progressive approach towards limit is fulfilled and Xe I isoelectronic series is already on LAN(P65)=LAN(P50) line. Some atom with elevated Z can exceed limit and should be considered E_o relativistic excess [8] and [9] that can affect LAN_R amplitude (difference between LAN_R of two points) and consequently to LAN(P65) extrapolated value.



P68 Pepliz LAN empire limits

s^x, p^x → s, p electron jumps are subdivided into three groups according to limits established in Pepliz LAN empire map:

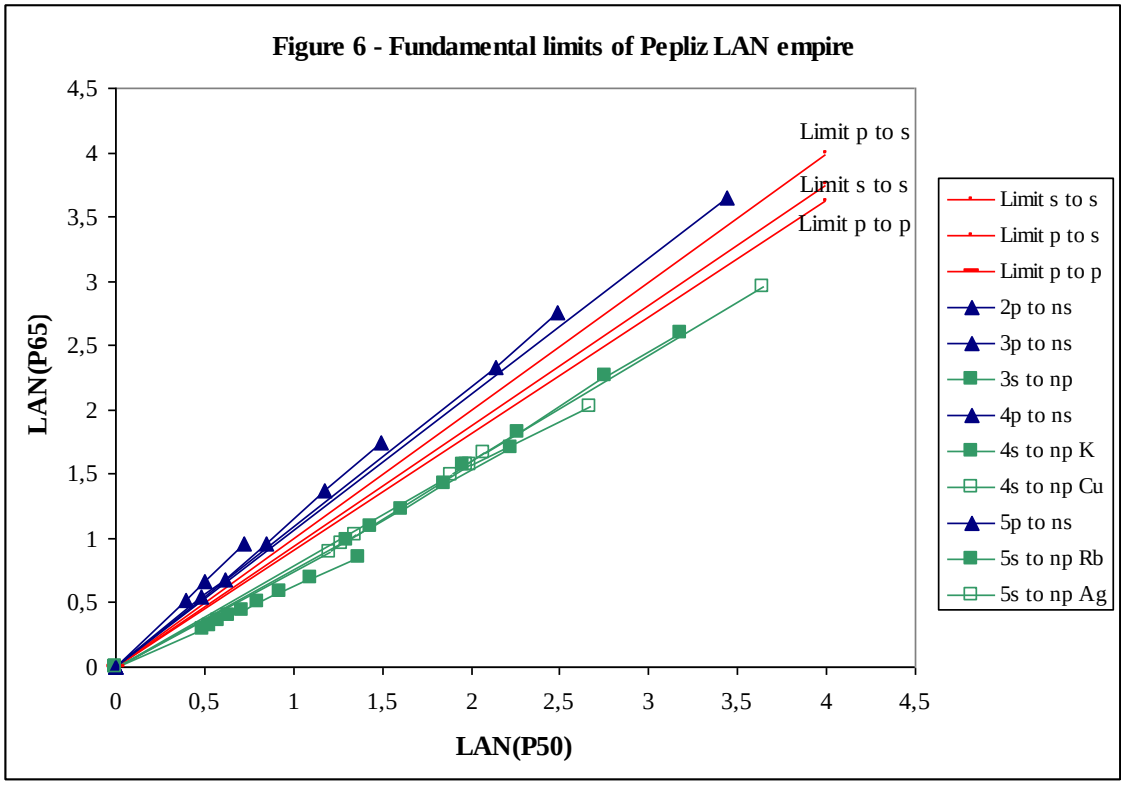
$$p^x \rightarrow s$$
$$s^x \rightarrow s$$
$$s^x, p^x \rightarrow p$$

All these jumps present LAN(P65) vs. LAN(P50) linearity with gradual approach to limit, called internal limit, when:

* Z is increased within isoelectronic series.
* Start n grows. This fact also implies that, for same z_s, Z is higher and therefore is related to previous point.

Fundamental limits of Pepliz LAN empire are schematized in **Figure 6**. These Fundamental limits are described below in new postulates that depend on P68. There are two large blocks of electron jumps represented: $n_sp \rightarrow ns$ and $n_ss \rightarrow np$. Different n_s of same block have been represented equal to show limit more uniformly and direct. Different isoelectronic series can be intuited with following concept: $\uparrow n_s$ (with same z_s)$\rightarrow\uparrow$LAN. These two large blocks of electron jumps represented, $n_sp \rightarrow ns$ and $n_ss \rightarrow np$, have been the only ones expressly integrated into Figure 6 because are so-called external limits of Pepliz LAN empire. $n_ss \rightarrow np$ presents more points than $n_sp \rightarrow ns$

because there are more isoelectronic atoms with first two E_k in [11]. On the other hand, internal limits are those indicated as "Limit" in Figure 6 and are three for s^x, $p^x \rightarrow$ s, p.



P69 Internal limit of Pepliz LAN empire in $n_sp^x \rightarrow n_sp^{x-1}ns$

$n_sp^x \rightarrow n_sp^{x-1}ns$ tends to internal limit (7):

$$(7)\ LAN(P65) = \frac{16}{16} LAN(P50) = LAN(P50) \quad n_sp^x \rightarrow n_sp^{x-1}ns \text{ internal limit}$$

Therefore "Limit p to s" of Figure 6 is LAN(P65)=LAN(P50). $n_sp^6 \rightarrow n_sp^5(^2P^o_{3/2})ns$ has been seen that tends to this internal limit and, in general, all n_sp^x a $n_sp^{x-1}ns$ also have it as trend limit.

P70 Internal limit of Pepliz LAN empire in $n_ss^x \rightarrow n_ss^{x-1}ns$

$n_ss^x \rightarrow n_ss^{x-1}ns$ tend to internal limit (8):

$$(8)\ LAN(P65) = \frac{15}{16} LAN(P050) \qquad n_ss^x \rightarrow n_ss^{x-1}ns \text{ internal limit}$$

This internal limit is "Limit s to s" in Figure 6 and descends LAN(P50)/16 with respect to P69 Internal limit of Pepliz LAN empire in $n_sp^x \rightarrow n_sp^{x-1}ns$. P70 is trend limit for $n_ss^2 \rightarrow n_ssns$ and $n_ss \rightarrow ns$. P37 is checked with electron jumps corresponding for start n equal to 3 (n_s=3). $3s^2 \rightarrow 3sns$ can have two possibilities according to spins are parallel

(Term=^{3}S and J=1) or anti- parallel (Term=^{1}S y J=0). 3s→ns (Term=^{2}S and J=1/2) joins previous two and are three lines drawn in **Figure 7**. These three lines approach P70 Internal limit of Pepliz LAN empire as z_s increases. **Table 4** contains three isoelectronic series.

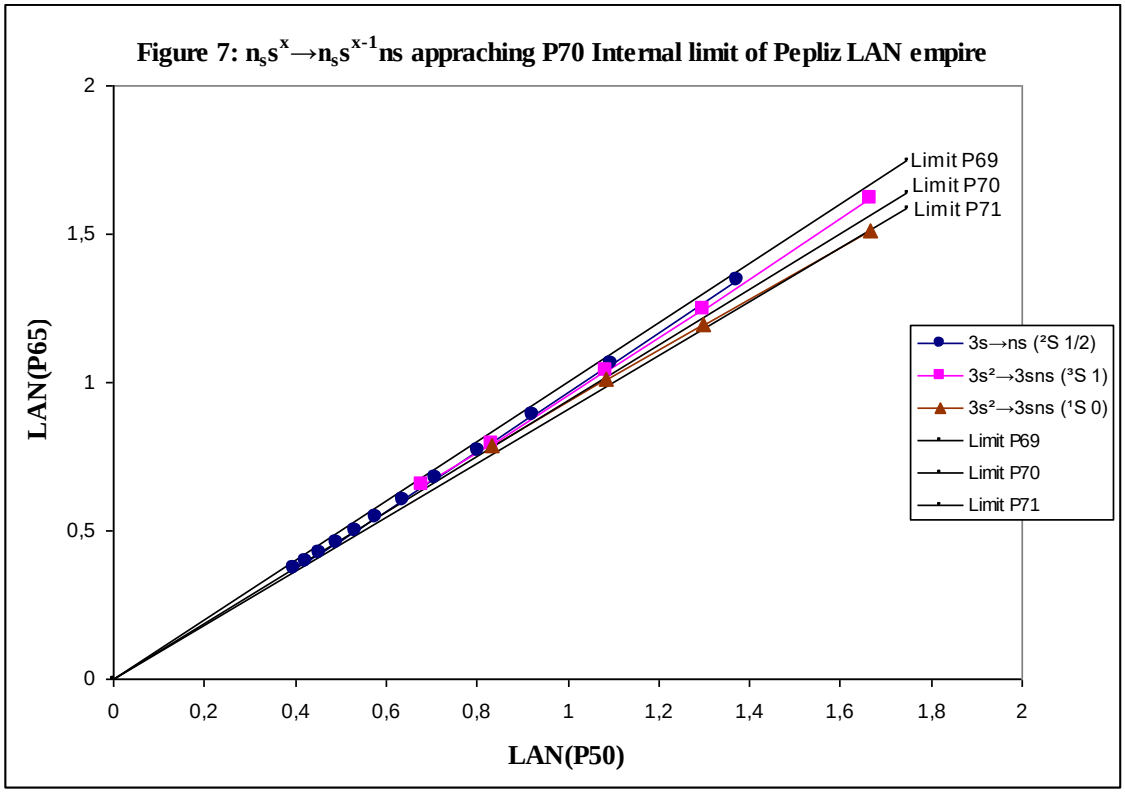
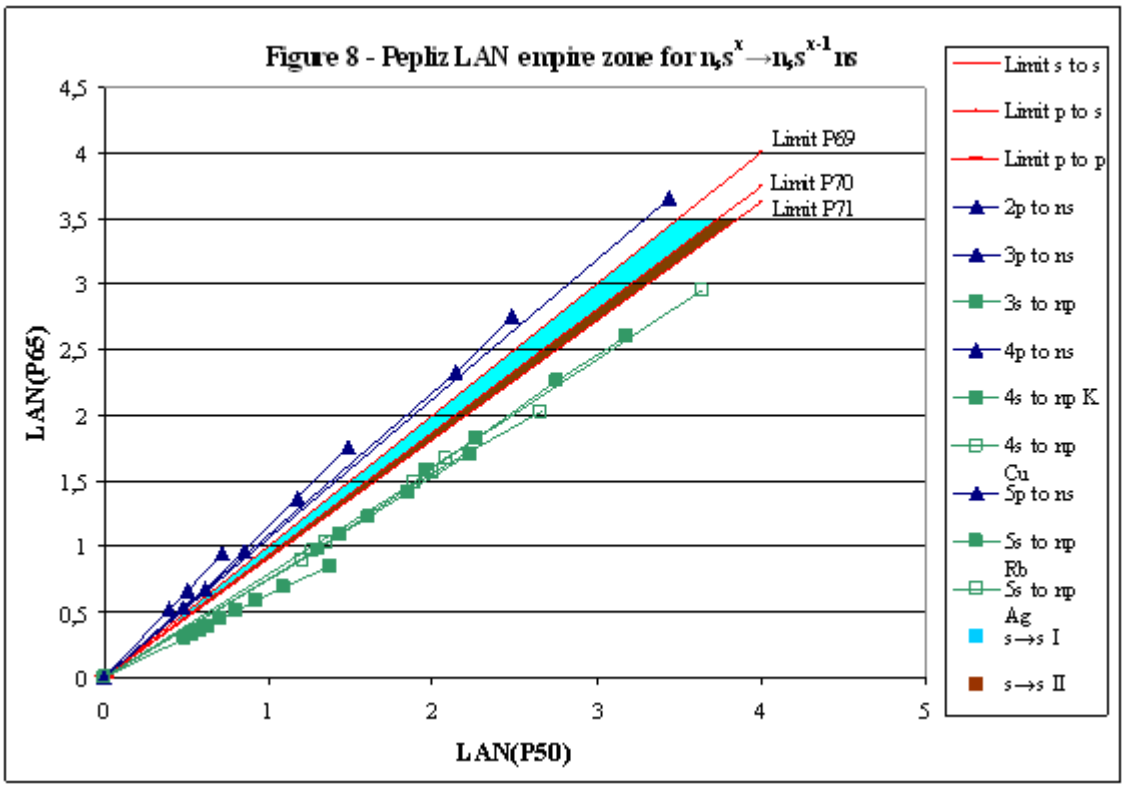


Table 4 - Isoelectronic series for electron jumps that meet P70 Internal limit of Pepliz LAN empire in $n_s s^x \rightarrow n_s s^{x-1} ns$				
Series	Electron Jump	Term	J	Atoms included
Na	$3s \rightarrow 3sns$	^{2}S	1/2	[Na I, Ti XII]
Mg	$3s^2 \rightarrow 3sns$	^{3}S	1	Mg I, Al II, Si III, S V and Ar VII
Mg	$3s^2 \rightarrow 3sns$	^{1}S	0	Mg I, Al II, Si III, S V

These three lines have aforementioned approximation to P70 Internal limit of Pepliz LAN empire as z_s increases and, additionally, are located between P69 and P71 internal limits. These two limits, named as global internal limits for Pepliz LAN empire, are really external for $n_s s^x \rightarrow n_s s^{x-1} ns$. Pepliz LAN empire zone that belong to $n_s s^x \rightarrow n_s s^{x-1} ns$ is coloured in **Figure 8** and this zone is divided into two subzones:

* Blue zone for $3s^2 \rightarrow 3sns$ (Term=^{3}S and J=1) and 3s→ns (Term=^{2}S and J=1/2) between P69 and P70.
* Brown zone for $3s^2 \rightarrow 3sns$ (Term=^{1}S y J=0) between P70 and P71.



P71 Internal limit of Pepliz LAN empire in $n_sp^x \rightarrow n_sp^{x-1}np$ and $n_ss^2 \rightarrow n_ssnp$

$n_sp^x \rightarrow n_sp^{x-1}np$ and and $n_ss^2 \rightarrow n_ssnp$ is limited by $n_ss^2 \rightarrow n_ssns$ (Term=^{1}S y J=0) empire zone and limit has been approximated to (9) although should be considered problems in $n_ss^2 \rightarrow n_ssns$ (Term=^{1}S y J=0) data especially when $n_s \neq 3$. Decrease is only 1/32 with respect to predecessor limit (P70) and, consequently, (1+1/2)/16 with P69.

$$(9)\ \mathrm{LAN(P65)} = \frac{14+1/2}{16}\mathrm{LAN(P50)} \qquad n_sp^x \rightarrow n_sp^{x-1}np \text{ and } n_ss^2 \rightarrow n_ssnp \text{ internal limit}$$

Decline again of 1/16 with respect to predecessor limit (P70) and, consequently 2/16 with P69, is discarded. Although option indicated in (9) is the one maintained, fundamental fact is that $n_sp^x \rightarrow n_sp^{x-1}np$ and $n_ss^2 \rightarrow n_ssnp$ should not be crossed with $n_ss^2 \rightarrow n_ssns$ (Term=^{1}S y J=0).

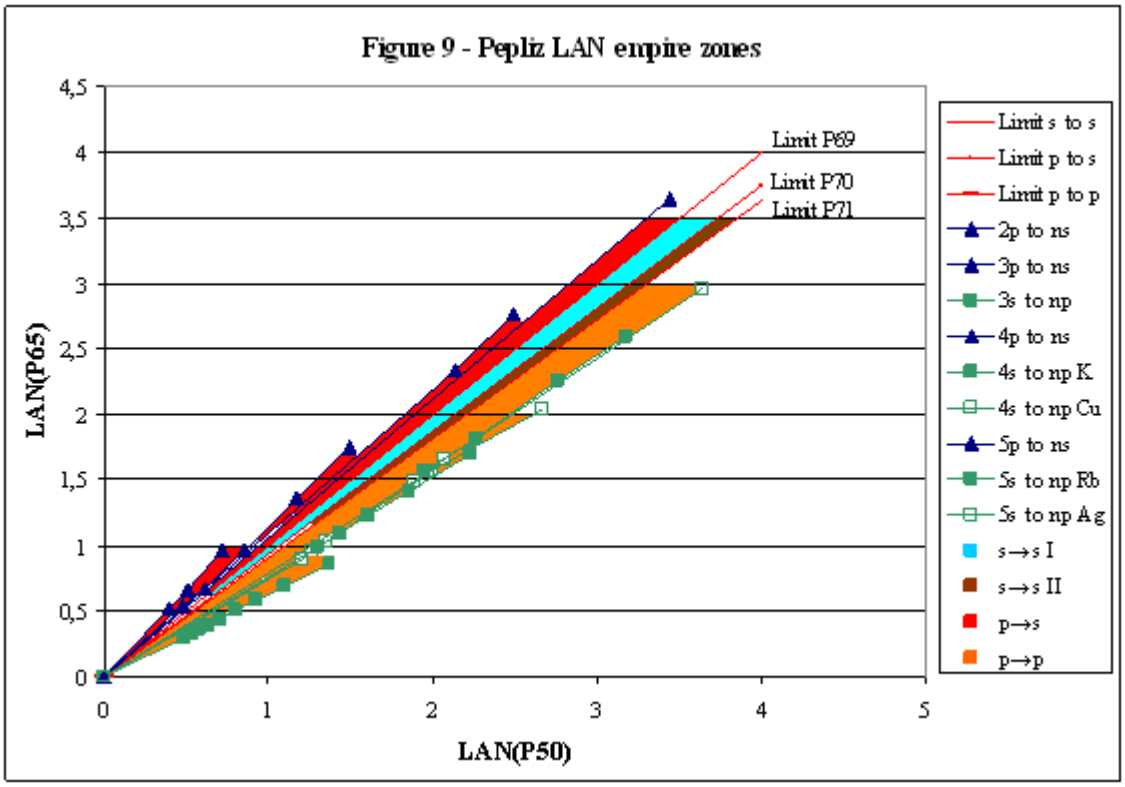
Previous jump to ns as first step must be considered in P69. Its study and application is postponed for later article.

P72 External limit of Pepliz LAN empire for $n_sp^x \rightarrow n_sp^{x-1}ns$.

External limit of Pepliz LAN empire for $n_sp^x \rightarrow n_sp^{x-1}ns$ is created by np→ns.

After P69, P70 and P71 which are internal limits constructed with straight lines, external limits are marked by concrete electron jump (in P72 case, np→ns). All

$n_sp^x \rightarrow n_sp^{x-1}ns$ are included between its internal limit (limit p to s or P69 internal limit) and its extern limit (np→ns or P72 external limit). Pepliz LAN empire zone that belong to $n_sp^x \rightarrow n_sp^{x-1}ns$ is colored red in **Figure 9**.



P73 External limit of Pepliz LAN empire for $n_sp^x \rightarrow n_sp^{x-1}np$ and and $n_ss^2 \rightarrow n_ssnp$.

External limit of Pepliz LAN empire for $n_sp^x \rightarrow n_sp^{x-1}np$ and $n_ss^2 \rightarrow n_ssnp$ is created by ns→np.

In n_s=4, K I and Cu I isoelectronic series are distinguished with filled and empty squares respectively. Likewise, Rb I and Ag I isoelectronic series are differentiated in n_s=5. As in previous point, these electron jumps are included between its internal limit (limit p to p or P71 internal limit) and its external limit (np→ns or P73 external limit). Pepliz LAN empire zone that belong $n_sp^x \rightarrow n_sp^{x-1}np$ and $n_ss^2 \rightarrow n_ssnp$ is colored orange in **Figure 9**.

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Abbreviations Table
Following Table indicates abbreviations used in this theory and its use in article in question is marked with X. 15, 16, 17 and 18 are [6] [7] [8] and [9] respectively. 19 is present article.

Abbreviation	**15**	**16**	**17**	**18**	**19**	**Meaning**
AC				X		Actual Change
AFEC		X	X			FEC adapted
BES						Born Electronic System
E_{dR}	X		X	X	X	Reference destiny energy
E_{dR}^*			X	X		Reference destiny energy with ER_{dR}
E_{dRI}				X		Ideal E_{dR} obtained from extrapolation of others E_{dR} satisfying Relation of Riquelme de Gozy
E_{jRI}						Ideal jump energy obtained from E_{dRI}
E_k	X	X	X		X	Reference Jump energy
$E_{k\text{-}SPA}$						E_k from LAN-SPA equality
E_o	X		X	X	X	1s OES Ionization energy
E_o^*			X	X		1s OES Ionization energy with ER_o
E_{oT}			X	X		1s theoretical ionization energy
EC						Energetic correlation in SPA
ER			X	X		Excess Relativistic
ER_{dR}			X	X	X	Excess Relativistic of E_{dR}
ER_o			X	X	X	Excess Relativistic of 1s ionization energy (E_o)
FEC	X	X	X			Fundamental Energetic Correlation
FPG				X	X	Relation of Flui Piep de Garberí
IE	X	X	X	X	X	Ionization energy
LAN	X	X	X	X	X	Serelles Secondary Lines Factor

LAN_M			X	X		LAN with modification
$LAN_{n\to\infty}$					X	LAN when $n\to\infty$
LAN_R*			X			LAN with reference data and considering ER
LAN_R	X	X	X	X	X	LAN with reference data
LAN_I LAN_{RI}	X					Ideal LAN obtained from E_d or E_{dRI}
LAN_S					X	LAN when $n=n_{START}=n_S$ and $E_k=0$
LAN(P50)			X		X	Initial LAN value in ns to ns jump. LAN with IE
LAN(P65)					X	Another denomination for $LAN_{n\to\infty}$
n	X	X	X	X	X	Principal quantum number
$n_{initial}$ or n_s	X	X	X	X	X	n of non-excited electron
OES						Origin Electronic System
PEC			X			Primitive energetic correlation of SPA
Piepflui			X			Constant spacing in Silpovgar IV
RC			X			Relative Change
RG	X			X	X	Relation of Riquelme de Gozy
SPA	X	X	X	X	X	Relation of Silva de Peral y Alameda
Z			X		X	Atomic Number
z_o	X			X	X	1s Origin charge according to P46
z_s	X		X	X	X	Start charge according to P46

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