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The interdependence of electronic energy, period of time, mass and internuclear distance displayed by any object, Part 2: Molecular derivation and application to chemically alike molecules

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This study, based on mere considerations induced by the Special Theory of Relativity, has previously established the following relationship between the "minimum electronic energy" E_{min}, and the related "classical vibration frequency" ω, in regards to electronic states of a given diatomic molecule: $|E_{min}| = 4\pi^2 M_0 g_k \omega^2 R_{min}^2$. Where M_0 is the reduced mass of the molecule, R_{min} the "internuclear distance" associated with ω, and g_k a Lorentz invariant dimensionless coefficient, insuring the equality; it depends only on the electronic structure of the molecule; therefore for electronic states configured similarly, we expect the coefficient g_k, to remain practically the same; it takes values, roughly around unity. The framework in question is interesting, given that, for alike electronic states of a given molecule, E_{min} versus $M_0 \omega^2 R_{min}^2$, should behave linearly. This further, should allow the determination of g_k, for the states in consideration. The expression is anyway valid for any diatomic molecule, along with a given g_k. On the other hand, the "ground states" of bonds delineating chemical similarities, display "alike electronic configurations". This means that, g_k for such bonds, should remain practically the same. Thus, regarding the ground states of such molecules, E_{min} versus $M_0 \omega^2 R_{min}^2$ should further be expected to behave linearly (the quantities of concern, now being exclusively assigned to the ground states of the molecules in question). We check this prediction successfully for the entire body of diatomic molecules and calculate g_k, for different "chemical families". The relationship we discover has got as much predictive power as that provided by the classical quantum mechanical tools; it is though incomparably simpler and faster.

Key words: Special theory of relativity, quantum mechanics.

INTRODUCTION

In this study, it has been shown earlier that the special theory of relativity (STR) imposes the following. Already at rest, the "period of time" T_0, the "characteristic length" $\mathcal{R}_0$, the "clock mass" $\mathcal{M}_0$, to be associated with the "internal dynamics" of an atomistic or molecular quantum mechanical object, and the "electronic energy" E_0, constituting the basis of the dynamics in question, ought to relate to each other, in just a given manner (Yarman, 1992a,b;1998,1999; Yarman et al., 2002a,b,c; Yarman, 2004a,b,c,d; Yarman et al., 2011) which is namely that displayed by:

$$T_0 \sim \sqrt{\frac{\mathcal{M}_0}{|E_0|}}\, \mathcal{R}_0 \; ; \tag{1}$$

(Relationship imposed by the STR).

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It can be checked that the proportionality constant, coming into play, is dimensionless; the somewhat new denominations introduced here, have been defined earlier.

Equation (1) outlines the architecture delineated by any given entity with respect to "period of time" T_0, "characteristic length" $\mathcal{R}_0$, "clock mass" M_0, and "total energy" E_0, one can associate with the "internal dynamics" of an atomistic or molecular quantum mechanical object. It can be used right away, for a set of entities, for which the dimensionless proportionality constant it involves, can be considered the same. This is the heart of the presen approach.

As stated earlier, we have arrived at Equation (1), on pure relativistic considerations,. Note then that the proportionality constant coming into play is determined to be necessarily a Lorentz invariant constant. In this study, we are going to provide a direct derivation of Equation(1), for diatomic molecules, essentially on a quantum mechanical basis, and show that the proportionality constant it involves, indeed depends only on the electronic configuration of the bond coming into play. Thus, for a set of molecules embodying electronically alike bonds, we should expect T_0 to vary linearly with respect to $\sqrt{M_0/E_0}\,\mathcal{R}_0$; this behavior yields the proportionality constant of the set of concern.

In this study, we are embarrassed to refer mainly to our previous work. The fact remains that we found practically nothing similar to the line we pursue herein. Subsequently, we will first derive Eq.(1), on a quantum mechanical basis (Sections 2 and 3), after which we draw a conclusion.

DERIVATION

Let E(R) be the electronic energy of the diatomic molecule of concern, at a given state, with respect to the internuclear distance R (Herzberg, 1964). This is a quantum mechanical output, of course. Thus, E(R) can be as usual defined as the eigenvalue of the Schrödinger equation describing just the electronic configuration of the molecule, with fixed nuclei, within the frame of the Born and Oppenheimer approximation (Born and Oppenheimer, 1927).

E(R), following Morse's parabolic approximation (Morse, 1929), can be expressed, in terms of the "force constant" k, associated with the classical vibration frequency ω (Davis, 1965), as:

$$E(R) = E_{min} + \frac{1}{2}k(R - R_{min})^2 . \qquad (2)$$

(Morse approximation to the electronic energy, versus the internuclear distance)

It should be emphasized that this relationship, does not display characteristics such as "anharmonicity" and "dissociation". Nevertheless, at a given ground or excited electronic state, Equation (2), will remain very satisfactorily correct, in regards to the lowest vibrational levels, taking place at this state, given that the Morse's parabolic approximation, is particularly valid, around E_{min}, and that we will specifically focus on the ground vibrational level at the electronic state of concern.

The parabola, approximately describing E(R) (which ought to be anyway a negative quantity, for it represents the total electronic energy of the molecule), intercepts the R axis at R_{00}, which we can define with respect to R_{min}, as:

$$R_{00} = p\,R_{min} \quad . \qquad (3)$$

[Hypothetic internuclear distance which makes the approximated E(R), vanish]

Note that this is just a definition. Note also that, there are two roots. These do not mean anything physically, since the Morse parabola is just an approximation. Yet it is still helpful to proceed with Equation (3). It is just a trick, to transform Equation (2), as we will soon make use of. The parameter p, is unknown, but we do not really have to determine it. In any case, it is perfectly legitimate to write Equation (3).

Equations (2) and (3), provide us with the possibility of expressing E_{min}, as:

$$|E_{min}| = \frac{1}{2}k(p-1)^2 R_{min}^2 . \qquad (4)$$

(Expression of the minimum energy in terms of the force constant and the minimum internuclear distance).

Next we define a new quantity g_k as:

$$g_k = \frac{(p-1)^2}{2} \quad . \qquad (5)$$

A quantum mechanical elaboration on g_k is provided in Yarman (2004c). Anyway, we expect g_k to remain practically the same, for electronic states configured similarly. We can thus write Equation (4) as:

$$|E_{min}| = kg_k R_{min}^2 . \qquad (6)$$

Thus, using the familiar expression for the classical vibration frequency (Davis, 1965);

$$\omega = \frac{1}{2\pi}\sqrt{\frac{k}{M_0}} \ , \tag{7}$$

(Classical vibration frequency)

In Equation (4), we can finally arrive at the relationship:

$$|\,E_{min}\,| = 4\pi^2 M_0 g_k \omega^2 R_{min}^2 \ . \tag{8}$$

[Equation (1) obtained, via quantum mechanical considerations regarding electronically excited states of a given molecule]

Given that the frequency is the inverse of the period of time, this relatioship is, in fact, identical to Equation (1). We have arrived to it, on the basis of a given electronic state of the molecule at hand. Thus it may be considered for all electronic states of this molecule. Thus, we can right away conjecture that the plot of $|\,E_{min}\,|$ versus $\omega^2 R_{min}^2$, should come out, as a straight line with regards to the electronic states of the given molecule, which would configured similarly. Yet the framework of Equation (8) is more general than this, for it is valid for any molecule, and any state of a given molecule. And it is interesting to consider it, when the given states are configured similarly. There are two distinct interesting sets of these. The first one, in effect, consists in the electronic excited states of a given molecule, configured similarly. That is, even if the molecule is at an excited state, the bond configuration, may remain about the same, and the coefficient g_k could then be considered as a constant. This is one thing. The second set in question, consists in the ground states of a given type of molecules, whose bond electronic configurations, are alike. This option will be considered particularly in the later part of the study.

The important thing about Equation (8) is that, it embodies no universal constant, say the Planck constant, or electric charges. It is a unique relationship, in that sense, made of four fundamental quantities, that is, mass, size, period of time (or the same frequency), and total energy. It universally displays the interrelation in between the quantities in consideration.

Recall that, we arrived at it earlier, based on mere considerations, just within the frame of the STR. In that sense Equation (8) is most general, and should hold at any level, for mass, size, period of time, and total energy, associated with that level, and it becomes interesting for any set of entities for which the proportionality coefficient g_k may be conjectured to remain the same. Though we restrict ourselves here to the study of Equation (8), with regards to diatomic molecules only.

GROUND STATES OF DIATOMIC MOLECULES BELONGING TO A GIVEN CHEMICAL FAMILY

Equation (8) (as shown earlier), is in fact valid for any

electronic state of any given molecule. Thus, it is surely valid for the ground state of the molecule of concern. Then it becomes particularly interesting for the ground states of molecules configured similarly. The ground states of diatomic molecules belonging to a given "chemical family", constitute such states. In different terms, a chemical family embodies molecules, whose bonds are configured similarly. Molecules made of alkali atoms, for instance, constitute a chemical family.

The idea remains that, the proportioanlity constant of Equation (8) can be considered as a constant, for the set of molecules one tackles with. Let then E_0 be the magnitude of the ground state electronic energy, ϖ_0 the classical vibration frequency at E_0, and R_0 the ground state internuclear distance of the molecule of concern.

With these definitions, Equation (8) becomes:

$$|\,E_0\,| = 4\pi^2 M_0 g_k \omega_0^2 R_0^2. \tag{9}$$

[Equation (1) obtained, via quantum mechanical considerations regarding the ground state of a given molecule]

Thus, we conjecture that the plot of $|\,E_0\,|$ versus $\omega_0^2 R_0^2$, should come out as a straight line for the slope of which will furnish the coefficient g_k.

We can equally write:

$$T_0 = 2\pi \sqrt{\frac{g_k M_0}{|\,E_0\,|}} R_0 \ , \tag{10}$$

(Relationship we derived quantum mechanically and we consider for the ground states of molecules belonging to a given chemical family, where the electronic configurations of the bonds can be considered to remain the same) where T_0 is the inverse of ϖ_0; this is obviously Equation (8), where though the proportionality constant is specifically displayed.

This equation suggests that, for chemically alike molecules, the period of vibration T_0, should behave as proportionally to $\sqrt{M_0 / |\,E_0\,|} R_0$. The reason we originally considered Equation (10), instead of Equation (9), is simply that, it expresses the elementary quantity of "period of time", in terms of the elementary quantities "space" (size), and "mass" (reduced mass), next to "energy". As explained through the Introduction earlier, the frame displayed by Equation (10) is Lorentz invariant.

The fact that the mentioned quantities are structured in the given way, insures the end results of the STR, were the molecule brought to a uniform translational motion (Herzberg, 1964; Born and Oppenheimer, 1927), or the
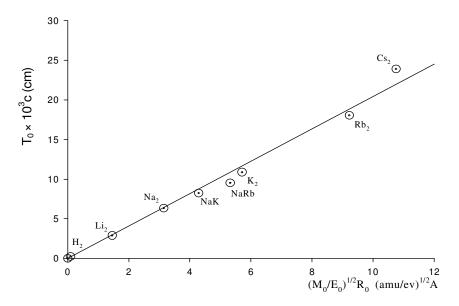
Figure 1. Classical vibration period versus $(M_0/E_0)^{1/2}R_0$ for alkali molecules.
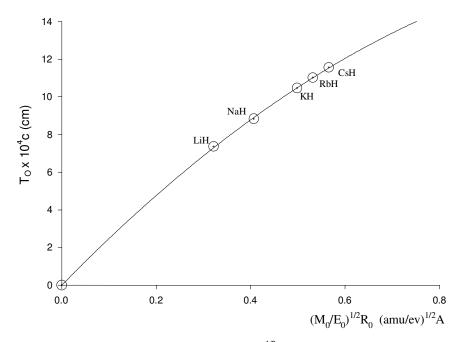

Figure 2. Classical vibration period versus $(M_0/E_0)^{1/2}R_0$ for alkali hydrides.

end results of the General Theory of Relativity, were the molecule embedded in a gravitational field, in fact any field the object may interact with, and this is how originally, we have arrived straight at Equation (10).

We have calculated the magnitude of the electronic energy, at the ground state of the diatomic molecule AB (made of the atoms "A" and "B"), in consideration, from the relationship:

$$E_0 = I_{0A} + I_{0B} + D_0 , \qquad (11)$$

Where D_0 is the dissociation energy of the diatomic molecule AB, and I_{0A} and I_{0B} are respectively the ionization energies of the atoms, A and B (CRC, 2009). All of the quantities here are evidently positive, and below, when chiefly in the tables and in the figures, we will write E_0, we will refer to the magnitude of the energy of concern (and not to the algebraic value of it).

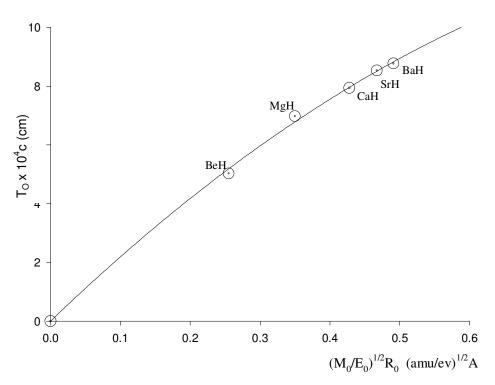The attached figures (Figures 1 to 11), successfully

Figure 3. Classical vibration period versus $(M_0/E_0)^{1/2}R_0$ for BeH-like hydrides.
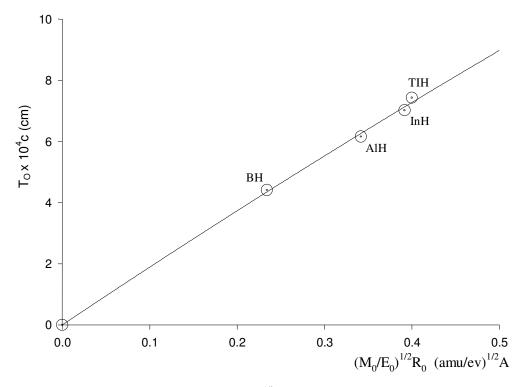
Figure 4. Classical vibration period versus $(M_0/E_0)^{1/2}R_0$ for BH-like hydrides.

display our prediction for all of the diatomic molecules, reassembled on the basis of their chemical similarities (Davis, 1965; Spirko et al., 1993; Diemer et al., 1984). Data used to draw these figures are reassembled in
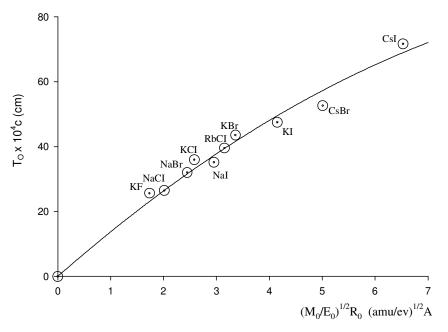
Figure 5. Classical vibration period versus $(M_0/E_0)^{1/2}R_0$ for alkali halogens.
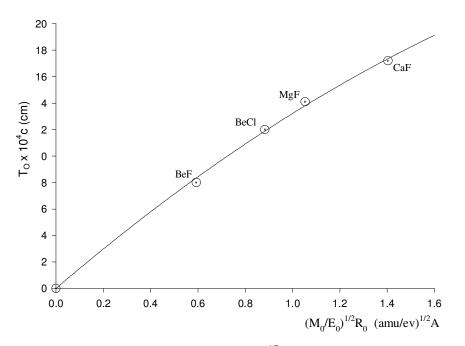

Figure 6. Classical vibration period versus $(M_0/E_0)^{1/2}R_0$ for BeF-like molecules.

Tables 1 to 11 (Herzberg, 1991). For each chemical family of concern, g_k is calculated and presented in Table 12.

CONCLUSION

In the earlier part of this work, we had derived Equation (1) within a most general framework, through simple considerations, based on just the STR. Here, to have a cross check, we have derived this relationship, for a diatomic molecule, based on simple quantum mechanics, and landed at Equation (10). The advantage of it is that, it does not embody any universal constants (such as the Planck Constant, for instance); in other terms, it is free of any such constants. It is based on four fundamental

Figure 7. Classical vibration period versus $(M_0/E_0)^{1/2}R_0$ for BF-like molecules.

Figure 8. Classical vibration period versus $(M_0/E_0)^{1/2}R_0$ for CO -like molecules.

quantities, mass (clock mass), space (clock size), time (clock period of time), and energy (energy, on which the clock labor takes place). The proportionality constant coming into play is dimensionless. We have shown in the
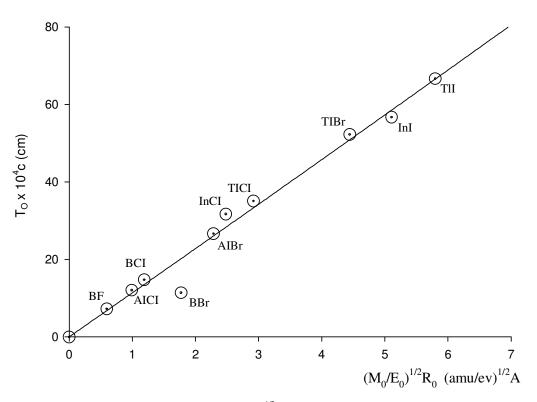
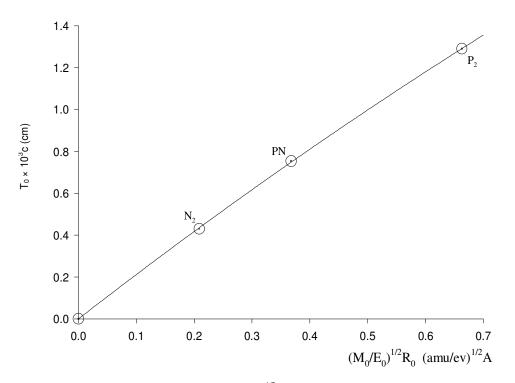**Figure 9.** Classical vibration period versus $(M_0/E_0)^{1/2}R_0$ for N_2 -like molecules.
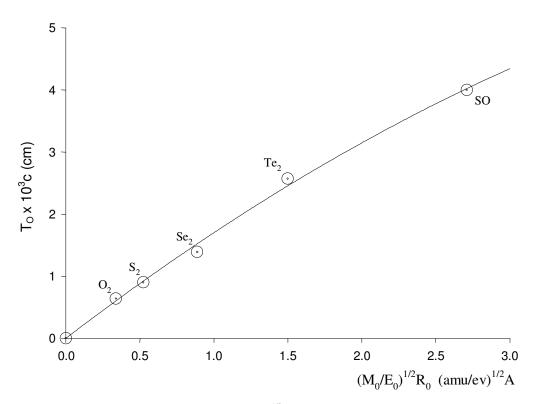
Figure 10. Classical vibration period versus $(M_0/E_0)^{1/2}R_0$ for O_2 -like molecules.

earlier part that, it must be also Lorentz invariant. Furthermore here on the basis of a diatomic molecule, we have shown that, it depends only on the electronic configuration of the molecule. Thus for bonds of
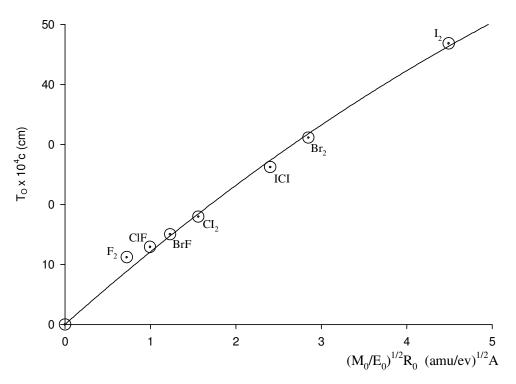
Figure 11. Classical vibration period versus $(M_0/E_0)^{1/2}R_0$ for halogens.

Table 1. Data for Figure 1.

Molecules	$T_0\, x10^3 c\ (cm)$	$\mathcal{M}_0$ (amu)	$\mathbf{R}_0$ (A)	E_0 (ev)	$\dfrac{T_0}{\mathcal{R}_0}\sqrt{\dfrac{E_0}{\mathcal{M}_0}}$	|Relative error| as referred to the average
H_2	0.24	0.5	0.74	31.64	2.58	0.26
Li_2	2.89	3.51	2.67	11.81	1.99	0.03
Na_2	6.34	11.49	3.08	11.01	2.01	0.02
K_2	10.88	19.49	3.92	9.19	1.91	0.07
NaK	8.06	14.48	3.50	10.03	1.92	0.06
NaRb	9.54	17.86	2.64	4.40	1.79	0.13
Rb_2	18.06	42.47	4.21	9.64	1.96	0.04
Cs_2	23.91	66.47	4.65	12.55	2.22	0.08
Average					2.04	0.09

Table 2. Data for Figure 2.

Molecules	$T_0\, x10^4 c\ (cm)$	$\mathcal{M}_0$ (amu)	$\mathcal{R}_0$ (A)	E_0 (ev)	$\dfrac{T_0}{\mathcal{R}_0}\sqrt{\dfrac{E_0}{\mathcal{M}_0}}$	|Relative error| as referred to the average
LiH	7.36	0.88	1.59	21.48	22.90	0.07
NaH	8.83	0.97	1.89	20.93	21.70	0.02
KH	10.46	0.98	2.24	19.79	20.98	0.02
RbH	11.01	0.99	2.37	19.66	20.70	0.03
CsH	11.55	1.00	2.49	19.39	20.43	0.04
Average					21.34	0.03

Table 3. Data for Figure 3.

Molecules	$T_0 \, x10^4 c \; (cm)$	$\mathcal{M}_0$ (amu)	$\mathcal{R}_0$ $_0$ (A)	E_0 (ev)	$\dfrac{T_0}{\mathcal{R}_0}\sqrt{\dfrac{E_0}{\mathcal{M}_0}}$	|Relative error| as referred to the average
BeH	5.03	0.91	1.34	25.11	19.72	0.05
MgH	6.98	0.97	1.73	23.72	19.95	0.06
CaH	7.94	0.98	2.00	21.4	18.55	0.02
SrH	8.53	0.99	2.15	20.96	18.26	0.03
BaH	8.77	1.00	2.23	20.62	17.86	0.05
Average					18.87	0.04

Table 4. Data for Figure 4.

Molecules	$T_0 \, x10^4 c \; (cm)$	$\mathcal{M}_0$ (amu)	$\mathcal{R}_0$ $_0$ (A)	E_0 (ev)	$\dfrac{T_0}{\mathcal{R}_0}\sqrt{\dfrac{E_0}{\mathcal{M}_0}}$	|Relative error| as referred to the average
BH	4.41	0.92	1.23	25.39	18.84	0.03
AlH	6.16	0.97	1.65	22.63	18.03	0.02
InH	7.02	0.99	1.84	21.85	17.93	0.02
TlH	7.43	1.00	1.87	21.87	18.58	0.01
Average					18.34	0.02

Table 5. Data for Figure 5.

Molecules	$T_0 \, x10^4 c \; (cm)$	$\mathcal{M}_0$ (amu)	$\mathcal{R}_0$ $_0$ (A)	E_0 (ev)	$\dfrac{T_0}{\mathcal{R}_0}\sqrt{\dfrac{E_0}{\mathcal{M}_0}}$	|Relative error| as referred to the average
CsF						
CsBr	52.63	49.92	3.14	19.61	10.50	0.16
CsI	71.63	64.94	3.41	17.72	10.98	0.12
NaCl	26.46	13.95	2.51	21.68	13.14	0.05
NaBr	31.98	17.86	2.64	20.80	13.07	0.04
NaI	35.15	19.45	2.90	18.75	11.90	0.05
KF	25.64	12.78	2.55	27.66	14.79	0.18
KCl	35.95	18.59	2.79	21.72	13.93	0.11
KBr	43.55	26.26	2.94	20.11	12.96	0.03
KI	47.48	29.89	3.23	18.12	11.45	0.09
RbCl	39.53	25.07	2.89	21.09	12.55	0.00
Average					12.57	0.08

molecules configured similarly, one should expect that the coefficient in question, must remain the same, for such bonds will bear alike electronic configurations. Molecules, such as alkali molecules, belonging to a given chemical family well fulfill the characteristic of being made of alike bonds.

Figures 1 to 11, plotted for molecules belonging to a given *chemical family,* show that, Equation (10), implying the constancy of the quantity, $(T_0/R_0)(\sqrt{M_0/|E_0|})\{(cm^{-1}x10^3 c/ \overset{o}{A} \sqrt{amu/ev}\}$, for members of a given *chemical family,* indeed holds satisfactorily; this constancy C, turns out to be $C = 2\pi\sqrt{g_k}$; where Å stands for Angstrom, and c for the speed of light. More specifically, g_k, stays indeed fairly

Table 6. Data for Figure 6.

Molecules	$T_0 \, x10^4 c \; (cm)$	$\mathcal{M}_0$ (amu)	$\mathcal{R}_0$ $_0$ (A)	E_0 (ev)	$\dfrac{T_0}{\mathcal{R}_0}\sqrt{\dfrac{E_0}{\mathcal{M}_0}}$	|Relative error| as referred to the average
BeF	8.00	6.11	1.36	32.14	13.49	0.02
BeCl	12.00	7.17	1.70	26.58	13.59	0.03
MgF	14.10	10.60	1.75	29.26	13.39	0.02
CaF	17.20	12.88	2.02	26.68	12.25	0.07
Average					18.87	0.04

Table 7. Data for Figure 7.

Molecules	$T_0 \, x10^4 c \; (cm)$	$\mathcal{M}_0$ (amu)	$\mathcal{R}_0$ $_0$ (A)	E_0 (ev)	$\dfrac{T_0}{\mathcal{R}_0}\sqrt{\dfrac{E_0}{\mathcal{M}_0}}$	|Relative error| as referred to the average
BF	7.26	6.72	1.26	30.01	12.18	0.07
BCl	12.06	8.38	1.72	25.25	12.17	0.07
BBr	14.77	9.66	1.88	24.20	12.43	0.09
AlCl	20.95	15.24	2.13	22.04	6.44	0.44
AlBr	26.64	20.11	2.29	20.19	11.67	0.02
InCl	31.71	26.82	2.31	23.28	12.79	0.12
InI	56.72	60.32	2.86	18.93	11.11	0.03
TlCl	35.09	29.87	2.55	22.81	12.03	0.05
TlBr	52.27	57.98	2.68	21.10	11.77	0.03
TlI	66.67	78.31	2.87	19.19	11.50	0.01
Average					11.41	0.09

Table 8. Data for Figure 8.

Molecules	$T_0 \, x10^4 c \; (cm)$	$\mathcal{M}_0$ (amu)	$\mathcal{R}_0$ $_0$ (A)	E_0 (ev)	$\dfrac{T_0}{\mathcal{R}_0}\sqrt{\dfrac{E_0}{\mathcal{M}_0}}$	|Relative Error| as referred to the Average
CO	4.67	6.86	1.13	94.28	15.32	0.00
CS	7.86	8.73	1.53	77.13	15.27	0.00
SiO	8.13	10.18	1.51	80.63	15.15	0.00
SiS	13.43	14.93	1.93	64.79	14.49	0.05
GeO	10.23	13.15	1.65	79.47	15.24	0.00
SnO	12.27	14.09	1.84	76.30	15.52	0.02
SnS	20.62	25.25	2.06	58.65	15.26	0.00
PbO	14.00	14.85	1.92	75.47	16.44	0.08
PbS	23.49	27.72	2.39	60.82	14.56	0.05
Average					15.25	0.02

the same for a given chemical family, and varies between, approximately, 0.3 and 1, with regards to the entire body of the chemical families we have considered.

One can show that g_k happens to be roughly, inversely proportional to the *dissociation energy* of the molecule (Yarman, 2004c). It is indeed easy to see that,

Table 9. Data for Figure 9.

Molecules	$T_0 \, x10^3 c \ (cm)$	$\mathcal{M}_0$ (amu)	$\mathcal{R}_0$ (A)	E_0 (ev)	$\frac{T_0}{\mathcal{R}_0}\sqrt{\frac{E_0}{\mathcal{M}_0}}$	|Relative error| as referred to the average
N_2	0.43	7.00	1.09	190.53	2.06	0.02
P_2	1.29	15.49	1.89	125.87	1.94	0.04
PN	0.75	9.65	1.49	158.29	2.05	0.01
Average					2.02	0.02

Table 10. Data for Figure 10.

Molecules	$T_0 \, x10^3 c \ (cm)$	$\mathcal{M}_0$ (amu)	$\mathcal{R}_0$ (A)	E_0 (ev)	$\frac{T_0}{\mathcal{R}_0}\sqrt{\frac{E_0}{\mathcal{M}_0}}$	|Relative error| as referred to the average
O_2	0.64	8.00	1.21	102.56	1.90	0.13
S_2	1.39	15.99	1.89	72.46	1.60	0.06
Se_2	2.57	39.97	2.15	82.22	1.71	0.02
Te_2	4.00	63.83	2.59	58.35	1.48	0.12
SO	0.90	10.66	1.49	86.43	1.72	0.03
Average					1.67	0.07

Table 11. Data for Figure 11.

Molecules	$T_0 \, x10^4 c \ (cm)$	$\mathcal{M}_0$ (amu)	$\mathcal{R}_0$ (A)	E_0 (ev)	$\frac{T_0}{\mathcal{R}_0}\sqrt{\frac{E_0}{\mathcal{M}_0}}$	|Relative error| as referred to the average
F_2	11.21	9.50	1.44	37.59	15.50	0.28
Cl_2	17.96	17.49	1.99	28.4	11.50	0.05
Br_2	31.15	39.96	2.28	25.59	10.93	0.09
I_2	46.87	63.47	2.67	22.44	10.44	0.10
BrF	15.04	15.35	1.76	31.42	12.23	0.01
ClF	12.93	12.31	1.63	32.99	12.98	0.08
ICl	26.23	27.42	2.32	25.56	10.92	0.09
Average					12.07	0.11

the greater p (Equation 3), the smaller is the dissociation energy.

Thus, as one can observe from Table 12; g_k decreases as the bond becomes stronger. This is why we would like to call it bond looseness factor (Herzberg, 1964) Briefly speaking, the higher, the number of the covalent bonds, making the overall bond of the diatomic molecule, the smaller will g_k be. Or the smaller the number of free electrons an atom possesses, the looser will be the bond it will make, with say, a halogen atom, thus the higher will g_k be, etc.

At any rate our goal here, was not really to disclose just a molecular characteristic; the property (Equation 10), we came to unveil was in fact a mean to show that matter, more specifically molecules, ought to be built in a unique manner in order to insure the end results of the STR,

Table 12. The constant g_k for different families.

Family	Average of $C = \dfrac{T_0 x 10^4 c}{R_0}\sqrt{\dfrac{E_0}{M_0}}\left(\dfrac{cm\,x\,ev^{1/2}}{A\,x\,amu^{1/2}}\right)$	Standard deviation on $C = 2\pi\sqrt{g_k}$	Dimensionless constant g_k
H_2	20.48	0.32	1.01
N_2	20.17	0.05	1.06
O_2	16.70	0.19	0.64
F_2	12.07	0.38	0.32
LiH	21.34	0.09	1.10
BeH	18.87	0.01	0.93
BH	18.34	0.04	0.90
CO	15.25	0.11	0.62
CsF	12.57	0.32	0.37
BeF	13.18	0.08	0.45
BF	11.41	0.48	0.36

were the object at hand, brought to a uniform translational motion, or those of the General Theory of Relativity, were the object, embedded in a gravitational field, in fact in any field it interacts with.

It is henceforth question of a distinct architecture framing how the main quantities, that is, mass (clock mass), space (characteristic length), time (period of time), and energy (base of the clock labor in quesiton, carried by the clock mass), painting the internal dynamics of the object in hand, are structured, in regards to each other.

Along this line, one can write Equation (1), even without any knowledge of quantum mechanics, at once, just the way we did in the earlier part of this work. This, in effect, represents a Lorentz invariant cast (as we have shown in the earlier part of this work). Thus, it is nothing else, but a matter of intuition, to write it down.

Testing it, is further, a matter of an easy exercise, given that the classical vibrational period of time T_0, versus the quantity $\sqrt{M_0/|E_0|}R_0$, should behave linearly, were the proportionality constant coming into play, remained the same for a selected set of molecules, which indeed happens to be the case for molecules belonging to a given chemical family.

This is what we have shown in this article, which would have otherwise turned out to be a mathematical impossibility, throughout much too cumbersome quantum mechanical setups; our approach both relativistically and quantum mechanically furthermore, seem to bear, as much prediciuve power, as that of the corresponding classical quantum mechanical setups.

Let us mention the following, for those who are not much familiar with the usual spectroscopic practice: In our plots, the dimension of the classical vibrational period T_0 is provided in "cm" unit; in other words, a period that would have normally been expressed in "seconds", is here, multiplied by kc, that is, the "specified number" k × the "speed of light" expressed in cm/second; thus to transform the unit of the given classical vibrational period, back to "second-unit", one has to divide it by kc.

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