Explanation of Intensity Spectral change of Bhutan, Carbon dioxide , Carbon Monoxide, Oxygen, Nitrogen Gases on the basic of Nun Equilibrium

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Abstract: *In this work attempts was made to relate temperature change to the change of spectra of some gases, which are Bhutan (C_4H_{10}), Carbon dioxide (CO2), Carbon Monoxide (CO), Oxygen (O2), Nitrogen (N2). The spectra of this gas were displayed by USB2000 spectrometer, when their temperature changes from (300 to 337) ° considerable change in the spectral intensity was observed. These changes can be explained theoretically by using non-equilibrium statistical distribution by using plasma equation, beside the laws of quantum mechanics.*
Key wards: *Temperature, spectrum, non-equilibrium statistical distribution, quantum mechanics, spectral change, intensity.*

I.   Introduction:

The temperature is the most important elements of climate that control distribution of life on the earth's surface, it is also very important in controlling the direction of wind flow from low temperature to high temperature regions. Temperature also controls the types of plants growing in each region.[1]

The Temperature difference is associated with the difference of the distribution of atmospheric pressure, which in turn controls the distribution of the wind and the associated movement of clouds and rainfall [2,3].Thus the temperature is the most important element of climate that must be studied by researchers. The rain is the most important sources of water through feeding rivers and groundwater, as it contributes to irrigate large areas of farmland, and used for drinking to humans and animals.[4,5]

Earth temperature results from the sun that gives heat and light when the sun sends the radiation to the earth's surface through the atmosphere .Some of these radiations are reflected by the atmosphere and earth, while others are absorbed by them . The visible Radiation reaches the earths in different frequencies and in different wavelengths can be converted to heat energy by the earth surface. [6][7].One can measure the temperature of the upper atmosphere by using balloons connected to thermometers or sensors by using some software. [8]   Such methods are expensive. Thus one must search for another way to measure the temperature of atmosphere layers by utilizing a new technique. Attempts were made to see how temperature change atomic spectra .In one of them the spectrum of optical pumping injection (OPIC) laser are studied at different temperatures [9].The experimental work shows parabolic increase of wave length and decrease of peak separation with temperatures. These changes were explained on the relation between change of refractive index and wavelength change, beside cavity length. In another work Bragg grating central wave length changes with temperatures is also investigated[10]. The experimental work shows increase of Bragg wave length with temperature, this change was explained on the base is of the relation of wave length change with refractive index and thermal expansion to temperature, fortunately no explanation was done by using quantum or statistical laws which are suitable for the micro world. In this work section2 is concerned with materials and methods beside results. Discussion and conclusion are in section3 and 4 respectively

II.   statistical distribution law of non- Equilibrium statistical System

The plasma equation of motion of particles in the presence of a field potential per particle V and a pressures force P beside a resistive force F_r is given by;

$$nm \frac{dv}{dt} = -\nabla p - Fr - \nabla nV \tag{2-1}$$

Where n, m stands for particle number density and particle mass respectively considering the motion to be in one dimension along the x-axis the equation of motion becomes;

$$nm \frac{dv}{dx}.\frac{dx}{dt} = -\frac{dp}{dx} - \frac{d(nV)}{dx} - F_r \tag{2-2}$$

$$nmv\frac{dv}{dx} = -\frac{dp}{dx} - \frac{dV}{dx} - F_r$$

$$n\frac{d(\frac{1}{2}mv^2)}{dx} = -\frac{dp}{dx} - \frac{d(nV)}{dx} - F_r \tag{2-3}$$

The term T stands for the kinetic energy of a single particle and can be written as;

$$T = \frac{1}{2}mv^2 = E_0 \tag{2-4}$$

The pressure P can also split in to thermal P_t and non thermal P_0 to be in the from ;

$$P = P_t + P_0 = nkT + nP_p \tag{2-5}$$

Where P_p in the non thermal pressure for one particle.

2-1 Plasma Statistical Equation in the Presence of Potential Field Only

When the potential is only present beside the thermal pressure term the equation of motion (2-3)read;

$$n\frac{dE_0}{dx} = -\frac{d(nV)}{dx} - \frac{d(nkT)}{dx} \tag{2-6}$$

If one assumes to change with (X) due to the change of (n) only then equation (2-6)to;

$$n\frac{dE_0}{dx} = -kT\frac{dn}{dx} - \frac{d(nV)}{dx} \tag{2-7}$$

The temperature here is assumed to be uniform; here one has two cases
either $V_T = nV$ changes with respect to X due to the change of V only . In this case equation (2-7) reads;

$$n\frac{dE_0}{dx} = -kT\frac{dn}{dx} - n\frac{dV}{dx} \tag{2-8}$$

$$n\frac{d(E_0 + V)}{dx} = -kT\frac{dn}{dx} \tag{2-9}$$

The total energy is given by;

$$E = T + V = E_0 + V \tag{2-10}$$

Therefore (2-9) becomes;

$$n\frac{dE}{dx} = -kT\frac{dn}{dx}$$

$$ndE = -kTdn$$

Integration both sides yields ;

$$-\int\frac{dE}{dx} = \int\frac{dn}{n}$$

$$\ln n = -\frac{E}{kT} + C_0$$

$$n = Ce^{\frac{-E}{kT}} \tag{2-11}$$

This is the ordinary Maxwell-Boltzmann distribution. But if V_T changes due to change of (n)only , then equation (2-7)reads;

$$n\frac{dE_0}{dx} = -kT\frac{dn}{dx} - V\frac{dn}{dx}$$

$$n\frac{dE_0}{dx} = -(kT + V)\frac{dn}{dx}$$

$$-\frac{dE_0}{(KT + V)} = \frac{dn}{n}$$

Integration both sides yields;

$$\int\frac{dn}{n} = -\int\frac{dE_0}{(kT + V)}$$

$$\ln n = -\frac{E_0}{kT + V} + C_0$$

$$n = Ce^{\frac{-E_0}{(KT+V)}} \tag{2-12}$$

The energy E_0 here stands for the kinetic energy only as shown by equation (2-4).

2-2 Plasma Statistical Equation When Thermal Pressure Changes Due to the Temperature Change

When the thermal pressure change due to the temperature change;

$$\frac{dP_t}{dx} = n\frac{d(kT)}{dx} \tag{2-13}$$

In this case the plasma equation (2-3) in the absence of a resistive force is given by;

$$n\frac{dE_0}{dx} = -\frac{dp_t}{dx} - \frac{d(nV)}{dx}$$

$$n\frac{dE_0}{dx} = -n\frac{d(kT)}{dx} - \frac{d(nv)}{dx}$$ (2-14)

Where the pressure here is assumed to be due to the thermal pressure only. If the total potential V_T is assumed to be related to the rate of change at V only, I.e.

$$\frac{dV_T}{dx} = \frac{d(nV)}{dx} = n\frac{dV}{dx}$$ (2-15)

In this case equation (2-14) reads;

$$n\frac{dE_0}{dx} = -n\frac{d(kT)}{dx} - n\frac{dV}{dx}$$
$$E_0 = -KT - V + C_0$$

Thus;

$$C_0 = E_0 + KT + V$$

One can easily deduce that C_0 is equal to the total energy E,I.e.

$$E = E_0 + V + kT$$ (2-16)

I.e. the total energy is equal to kinetic energy E_0 beside potential energy V and thermal energy kT. But if V_T change due to the rate of change of n only ,I.e.

$$\frac{dV_T}{dx} = V\frac{dn}{dx}$$ (2-17)

Equation (2-14) thus reads;

$$n\frac{dE_0}{dx} = -n\frac{d(kT)}{dx} - V\frac{dn}{dx}$$
$$n(dE_0 + dkT) = -Vdn$$
$$\int \frac{dn}{n} = -\int \frac{(dE_0 + dkT)}{V}$$
$$\ln n = -\frac{E}{kT} + C_0$$
$$n = Ce^{\frac{-(E_0 + kT)}{V}}$$ (2-18)

If the change of V_T with respect to (x) is due to the change of both (n) and (V) with respect to (x);

$$\frac{dV_T}{dx} = \frac{d(nV)}{dx} = n\frac{dV}{dx} + V\frac{dn}{dx}$$ (2-19)

Inserting (2-19) in (2-14) yields;

$$n\frac{dE_0}{dx} = -n\frac{d(kT)}{dx} - n\frac{dV}{dx} - V\frac{dn}{dx}$$
$$nd(E_0 + kT + V) = -Vdn$$
$$\int \frac{dn}{n} = -\int \frac{d(E_0 + kT + V)}{V}$$
$$\ln n = -\frac{(E_0 + kT + V)}{V} + C_0$$

$$n = Ce^{\frac{-(E_0 + kT + V)}{V}}$$ (2-20)

Thus for non-uniform temperature systems, and non-uniform potential energy per particle, the statistical distribution low is described by (2-20). This relation is different from that obtained in (2-11), where the temperature is assumed to be uniform.

2-3 Plasma Statistical Equation When Thermal Pressure Change Due to the Change of Both (n) and (T)
When the thermal pressure changes due to the change of both (n) and (T), in this case the plasma equation (2-14) is given by ;

$$n\frac{dE_0}{dx} = -n\frac{d(kT)}{dx} - kT\frac{dn}{dx} - \frac{d(nV)}{dx}$$ (2-21)

If the total potential V_T is assumed to be related to the rate of change of (V) only ,I.e

$$\frac{dV_T}{dx} = \frac{d(nV)}{dx} = n\frac{dV}{dx}$$ (2-22)

In this case equation (2-21) reads;

$$n\frac{dE_0}{dx} = -n\frac{d(kT)}{dx} - kT\frac{dn}{dx} - n\frac{dV}{dx}$$

$$n(dE_0 + d(kT) + dV) = -kT\,dn$$

$$\int \frac{dn}{n} = -\int \frac{(dE_0 + d(kT) + dV)}{kT}$$

$$\ln n = -\frac{(E_0 + kT + V)}{kT} + C_0$$

$$n = Ce^{\frac{-(E_0 + kT + V)}{kT}} \tag{2-23}$$

But if   change due to the rate of change on n only , I.e.

$$\frac{dV_T}{dx} = \frac{d(nV)}{dx} = V\frac{dn}{dx} \tag{2-24}$$

In this case equation (2-21) reads;

$$n\frac{dE_0}{dx} = -n\frac{d(kT)}{dx} - kT\frac{dn}{dx} - V\frac{dn}{dx}$$

$$n(dE_0 + d(kT)) = -(kT + V)dn$$

$$\frac{dn}{n} = -\frac{(dE_0 + d(kT))}{(kT + V)}$$

$$\int \frac{dn}{n} = -\int \frac{(dE_0 + d(kT))}{(kT + V)}$$

$$\ln n = -\frac{(E_0 + kT)}{(kT + V)} + C_0$$

$$n = Ce^{\frac{-(E_0 + kT)}{(kT + V)}} \tag{2-25}$$

If the change of V_T with respect to x is due to the change of both n and V with respect to , then ;

$$\frac{dV_T}{dx} = \frac{d(nV)}{dx} = n\frac{dV}{dx} + V\frac{dn}{dx} \tag{2-26}$$

  Inserting (2-26) in (2-21) yields;

$$n\frac{dE_0}{dx} = -n\frac{d(kT)}{dx} - kT\frac{dn}{dx} - n\frac{dV}{dx} - V\frac{dn}{dx}$$

$$n(dE_0 + dV + d(kT)) = -(kT + V)dn$$

$$\int \frac{dn}{n} = -\int \frac{(dE_0 + dV + d(kT))}{(kT + V)}$$

$$\ln n = -\frac{(E_0 + kT + V)}{(kT + V)} + C_0$$

$$n = Ce^{\frac{-(E_0 + kT + V)}{(kT + V)}} \tag{2-27}$$

III.   Variation of Spectral Intensity of Some Gases with temperature
(3-1)Materials and methods:
The following Apparatus   and Instruments are used in the experiment

(3-1-1)Apparatus   and Instruments:
        USB2000 Fiber Optic Spectrometer (Ocean Optics), Thermometer, Heater, Laptop, Source of Helium Neon laser -133, Power supply, Connect cable, Origin program which specialist draw, analyze and address the different data and Test tubes (Borosilicate Glass) .
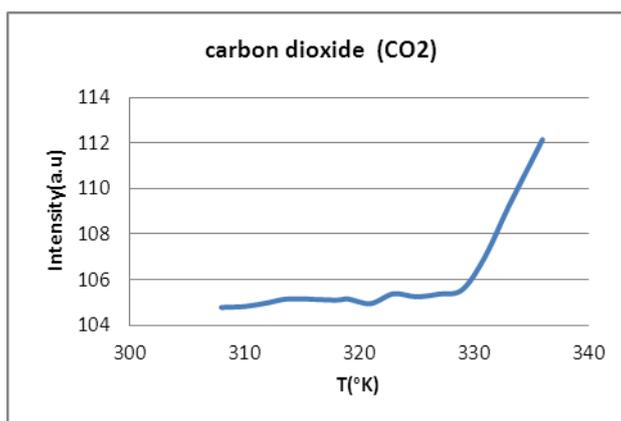
(3-1-2) gases:
Bhutan $(C4_4 H_{10})$, carbon dioxide (CO_2),Carbon Monoxide (CO), nitrogen (N_2) ,oxygen (O_2)

(3-1-2) Experiment set up
        Glass tube is filled by gases, each gas should be heated in steps about one or two degrees and the spectrum are recorded at each degree by using thermometer. Helium-133 beams is directed to incident on the glass tube, the spectrum of each gas including the intensity and band width is recorded for each temperature by using USB2000 Fiber Optic Spectrometer. The relations are drawn between intensity and line width of the transmitted radiation from each gas and temperature.

(3-2) Results

Table (3-2-1): spectrum of Bhutan (C_4H_{10}) at different temperatures

T = temperature **λ**= wavelength
I = Intensity **A** = area **W**=width

T(K)	λ (nm)	A(m²)	W (nm)	I(a.u)
300	630.73	4390.43	6.92	126.8
301	630.78	2536.69	6.96	125.89
303	630.83	2282.57	7.07	125.74
305	630.79	1645.95	7.03	125.79
307	630.78	1645.9	7.02	125.79
309	630.84	1855.9	7.16	125.13
311	630.78	1888.66	7.1	124.64
313	630	1698.66	7.03	124.79
315	630.83	1482.01	7.003	124.53
317	630.86	1560.78	7.03	123.96
318	630.84	1717.5	7.04	123.5
319	630.89	2037.01	7.08	123.46
320	630.95	1310.88	6.95	117.62
323	631.01	1265.28	7.02	116.95
324	631.01	1276.02	7.05	116.65

Fig (3-2-1-1) Relation between Intensity and temperature

Table (3-2-2): spectrum of Carbon dioxide (CO_2) at different temperatures

T(K)	λ(nm)	A(m^2)	W(nm)	I(a.u)
308	631.09	6721.97	7.09	104.78
310	630.69	3971.93	6.56	104.82
312	630.71	2990.83	6.61	104.98
314	630.68	2313.09	6.67	105.16
318	630.67	2672	6.59	105.105
319	630.73	2562.34	6.62	105.16
321	630.77	2788.17	6.63	104.95
323	630.75	2604.82	6.71	105.38
325	630.81	2746.3	6.76	105.25
327	630.75	2630.97	6.68	105.37
329	630.77	2896.99	6.58	105.56
331	630.66	3235.75	6.72	107.02
333	630.7	2852.53	6.67	109.16
336	630.64	2867.93	6.73	112.15

Fig(3-2-2-1) relationship between intensity and temperature

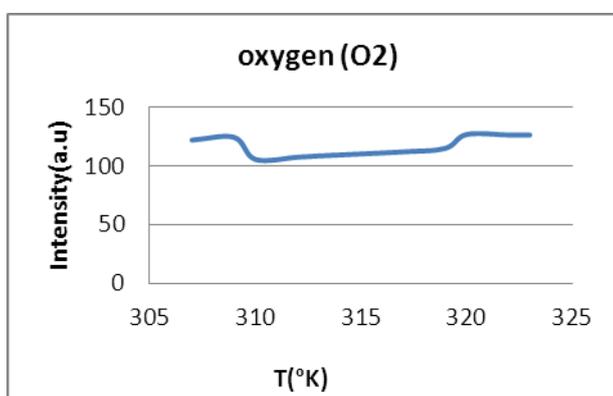**Table (3-2-3): spectrum of Carbon Monoxide (CO) at different temperatures**

T(K)	λ (nm)	A(m^2)	W(nm)	I(a.u)
305	630.81	7727.23	7.19	127.88
308	630.83	17902.95	7.52	128.35
310	631.15	23879.64	7.95	127.71
314	631.24	28752	8.02	127.72
316	630.95	35431.03	7.82	128.63
317	630.87	33455.02	7.63	129.07
318	630.97	35343.99	7.67	128.96
319	630.75	36682	7.59	128.89
320	630.5	31212.8	6.31	128.81
321	630.54	30925.51	6.29	129.12
323	630.53	35011.42	6.37	129.37
324	630.62	29236.35	6.28	132.05
325	630.62	30482.95	6.83	132.47
326	630.61	32561.45	6.4	134.94
328	630.6	28986.9	6.43	136.16

Fig(3-2-3-1) relationship between intensity and temperature

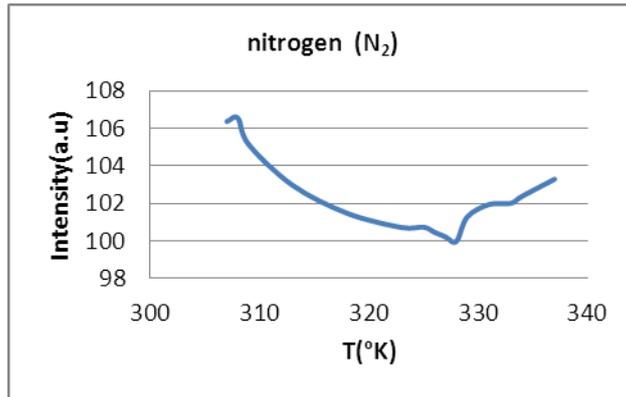**Table (3-2-4): spectrum of Oxygen (O₂) at different temperatures**

T(K)	λ (nm)	A(m²)	W (nm)	I(a.u)
307	630.38	6.33	8357.87	121.82
309	630.39	6.45	8237.15	124.16
310	630.36	6.29	10776.64	105.39
312	630.39	6.34	9984.4	107.28
313	630.33	6.26	10333.1	108.35
317	630.36	6.36	10055.14	111.84
319	630.25	6.29	8871.58	114.79
320	630.1	6.37	10285.94	126.56
322	630.17	6.31	6953.2	126.2
323	630.14	6.37	7661.5	126.12

Fig(3-2-4-1) relationship between intensity and temperature

Table (3-2-5): spectrum of Nitrogen (N₂) at different temperatures

T(K)	λ (nm)	A(m2)	W(nm)	I(a.u)
307	630.57	13210.75	6.46	106.37
308	631.05	22845	7	106.55
309	631.17	19689.5	7.03	105.14
313	631.14	26622.9	7.06	102.97
318	631.03	37660.7	7.02	101.47
323	631.04	22161.25	7.04	100.71
325	631.02	17831.8	6.99	100.73
326	631.15	20802.4	6.99	100.46
327	631.07	20115.56	7.05	100.21
328	631.05	23555.87	7.12	99.97
329	631.07	13968.94	6.99	101.27
331	631.1	13849.26	7.07	101.94
333	631.13	13601.3	7.07	102
334	631.15	14948.05	7.06	102.37
337	631.01	13328.25	7.02	103.29

Fig(3-2-5-1) relationship between intensity and temperature

IV. Theoretical Interpretation

The behavior of gases can be explained by using statistical physics .This explanation is related to the fact. That gas consists of a large number of atoms and molecules. The electrons and atoms of gases can also be explained by using the laws of quantum mechanics. This is not surprising, since atomic and sub atomic microscopic particles are explained by using the laws of quantum mechanics.

(4-1) thermal Equilibrium statistical Interpretation

According to Maxwell distribution the density of particles is given by

$$n = n_0 e^{-\frac{E}{KT}} \qquad (4\text{-}1)$$

It is quite natural to assume that the density of photons emitted n_p is proportional to the exited atoms or electrons density I. e

$$n_p = C_0 n = C_0 n_0 e^{-\frac{E}{KT}} \qquad (4\text{-}2)$$

Where C_0 is a constant

Assume that the spectrum is formed due to the emission of free electrons surrounding the positive ion of the gas. In this case the potential is negative and attractive. By neglecting kinetic term, when the potential is very high in this case

$$E = -V_0 \qquad (4\text{-}3)$$

Therefore equation becomes (4-2)

$$n_p = C_0 n_0 e^{\frac{V_0}{KT}} \qquad (4\text{-}4)$$

$$V_0 \sim \frac{9 \times 10^9 \times (1.6)^2 \times 10^{-38}}{r_0} \sim \frac{10^{-28}}{r_0}$$

$$\frac{V_0}{k} \sim \frac{10^{-5}}{r_0}$$

$$For \qquad r_0 \sim 10^{-5}m \qquad \frac{V_0}{k} \sim 1 \qquad (4\text{-}5)$$

The light intensity of the emitted photons is given by

$$I = C n_p = C C_0 n_0 e^{\frac{V_0}{KT}} = I_0 e^{\frac{V_0}{KT}} \qquad (4\text{-}6)$$

By a suitable choice of (4-5) and using (4-6) parameters one can choose

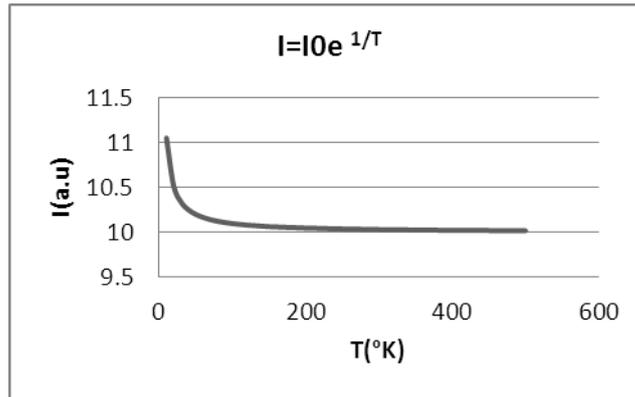$$I = I_0 e^{\frac{1}{T}}, \qquad I_0 = 10 \qquad (4\text{-}7)$$

Fig (4-1)

(4-2)Non- Equilibrium statistical system

      The work done by Suhair Salih Makawy Suliman [9] shows that for non-Equilibrium systems where the temperature, potential are no longer constant, but worry with position, the number density is given by

$$n = n_0 \, e^{-\frac{E}{\bar{E}}} \qquad \qquad (4\text{-}8)$$

Where E stands for non-uniform varying energy, while $\bar{E}$ represents the uniform energy .If one assumes that the electrons are affected by the bulk potential of positive ions, which is attractive, then

$$\bar{E} = -V_0 \qquad \qquad (4\text{-}9)$$

$$E = kT \qquad \qquad (4\text{-}10)$$

Sub situating (4-2) and (4-10) in (4-8) yields

$$n = n_0 \, e^{\frac{kT}{V_0}} \qquad \qquad (4\text{-}11)$$

In view of equations (4-2), (4-6) and (4-7) .The light intensity is given by

$$I = I_0 \, e^{\frac{kT}{V_0}} \qquad \qquad (4\text{-}12)$$

Using(4-5)

$$\frac{V_0}{k} \sim 1$$

Whe*n*

$$V_0 \sim k \sim 1 \times 10^{-22} \qquad \qquad (4\text{-}13)$$

In this case equation (4-12) becomes

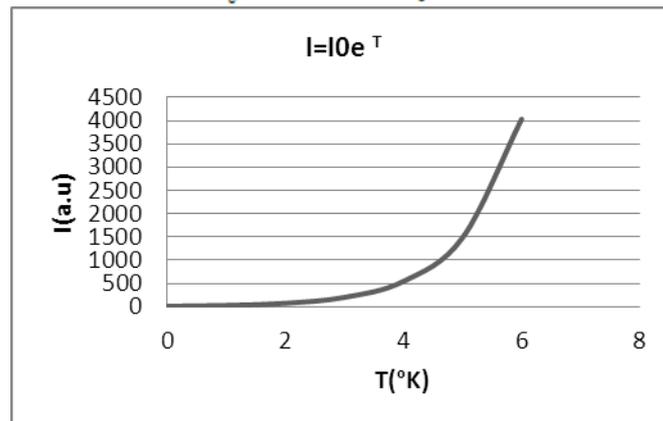$$I = I_0 \, e^{T} \qquad \qquad I_0 = 10 \qquad \qquad (4\text{-}14)$$

Fig (4-2)

When the electron energy is equal to thermal energy, beside energyV_r resulting from repulsive force
In this case

$$E = kT + V_r \qquad \qquad (4\text{-}15)$$

If the back ground is the attractive uniform potential as in equation (4-2) then

$$n = n_0 \, e^{\frac{V_r + kT}{V_0}} \qquad \qquad (4\text{-}16)$$

Assuming that

$$V_r \sim 100 V_0$$
$$V_0 \sim 100K \sim 10^{-21}$$ (4-17)

Using relations (4-2), (4-6), (4-16) and (4-17) yields

$$I = I_0 e^{\frac{V_r + KT}{V_0}}$$

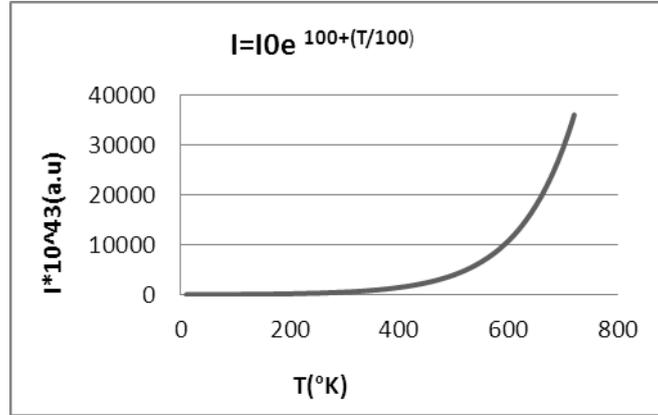$$I = I_0 e^{100 + \frac{T}{100}} \quad , I_0 = 10$$ (4-18)

I=I0e^(100+(T/100))

Fig (4-3)

If the energy resulting from the repulsive electron gas is assumed to be uniform, then

$$\bar{E} = V_r$$ (4-19)

When the electron energy is the thermal, beside the energy resulting from attractive ions V_0 then

$$E = KT - V_0$$ (4-20)

In this case equation (4-8) reads

$$n = n_0 e^{\frac{V_0 - KT}{V_r}} = n_0 e^{\frac{V_0}{V_r} - \frac{kT}{V_r}}$$ (4-21)

In view of equations (4-2), (4-6) and (4-21), one gets

$$I = I_0 e^{\frac{V_0}{V_r} - \frac{kT}{V_r}}$$ (4-22)

Assuming

$$V_0 \sim 5 V_r$$

$$V_r \sim k$$ (4-23)

One gets the light intensity in the form

$$I = I_0 e^{5 - T} \qquad I_0 = 2$$ (4-24)
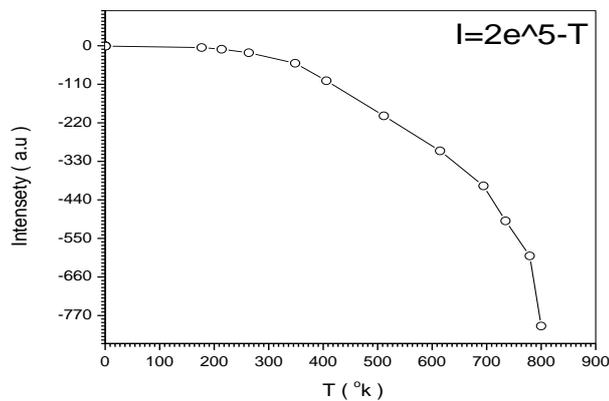
I=2e^5-T

Fig (4-4) One can assume gas where the thermal equilibrium

$$\bar{E} = KT$$

And assuming electron repulsive back ground

$$E = V_r$$

Thus equation (4-8)reads

$$n = n_0\, e^{\frac{-V_r}{KT}} \tag{4-25}$$

For

$$V_r \sim k \tag{4-26}$$

Using also equations (4-2) and (4-6) one gets

$$I = I_0 e^{-\frac{1}{T}} \tag{4-27}$$

Set

$$I_0 = 10e$$
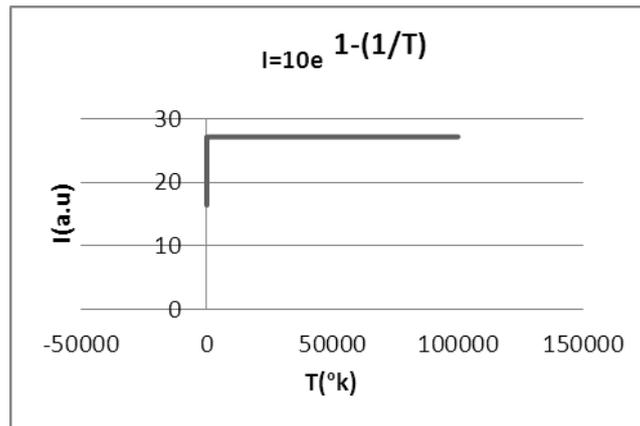$$I = 10e\, e^{-\frac{1}{T}} = 10e^{1-\frac{1}{T}} \tag{4-28}$$

Fig (4-5)

V. Dissection:

Fig (3-2-1-1) shows the Relation between Intensity and temperature for Bhutan (4_4H_{10}),the curve of this relation resembles that of fig(4-4).This means the Bhutan gas the homogenous repulsive electron gas potential is almost constant compared to attractive ion potential and temperature.

Fig (3-2-2-1) shows the Relation between Intensity and temperature for Carbon dioxide (CO_2) which has a curve that resembles the curve in figs (4-2)and (4-3) .This indicates that the attractive positive ions looks homogeneous and stable compared to temperature. This is not surprising since the gas was heated at the bottom by a heater. This means that the bottom is hotter than the top part of the gas .Thus the temperature is not uniformities

In Fig (3-2-3-1) the Relation between Intensity and temperature for Carbon Monoxide (CO) which is displayed in this fig, resembles the curve of figs (4-2) and (4-3). This is not surprising, since for both figures the statistical distribution is based on the homogeneity of the ionic field and non-homogeneity of temperature. The non-homogeneity of temperature results again from the fact that the bottom of the gas exposed to a heater is very hot compared to the top of the gas.

However Fig (3-2-4-1) shows that the Relation between Intensity and temperature for Oxygen (O_2) can be easily explained by fig (4-5) where the repulsive homogeneous electron field dominates, compared the attractive ionic field. Fig (3-2-5-1) shows for Nitrogen (N2) it spectrum is displayed by the Relation between Intensity and temperature. The curve of this relation resembles fig (4-1) which shows homogeneity of temperature compared to less homogenous attractive crystal field.

VI. Conclusion:

The new statistical non-equilibrium model based on plasma equation that relates to the intensity of atomic spectra to the gas temperature can successfully describe the dependence of atomic spectra on temperature. The promotion of these models in the future may successfully be capable of determining the atmospheric temperatures of deferent layers.

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