Innovative Approach

New Experimental Results and Analysis of Anomalous Phenomenon in Gas Discharge

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Abstract

Counts and energy Spectrums of x–ray have been registered in gas glow discharge system [1], there were some anomalies in about 100 energy spectrums. When discharge voltage was 4–14kv, there were 30–300kev continuous x–ray, their intensities were 10%–1000% of background. According to registered energy spectrums the energy dependence of the mass attenuation cross section (μ/ρ) could be obtained, it was different than standard $(\mu/\rho)^*$, sometime negative absorption was detected. We suggested some explanation of above anomalies.

Keywords: Cold Fusion, gas discharge, anomaly of x–ray, negative absorption

Experiment:

Electrodes (Pd, Nb, Ta or other metal) were fixed to both ends of a glass reaction bulb. The thickness of the glass wall of bulb was 2.0± 0.2mm, the voltage V and current I of discharge were 4–18KV, 1–50mA(50Hz) respectively: The pressure of discharge gas (D_2, H_2, air, Ar…) was dynamic (flowing) low pressure(< 100Pa).

The x–ray measurement system was composed of a high pure Ge detector (GMX200) made in ORTEC company of U.S.A., a pulse shape analyser (CANBERRA, 2160A) and a IBM–PC / XT computer. The detector sensitive volume was 102 cm^3, the measuring range was 5 KeV to 1.64Mev, the relative efficiency is 20%. The Ge detector was placed in a lead shielded cabin so that the background was 10 ~ 11counts / sec within 24 to 4096 channels. We used ^{152}Eu and ^{241}Am source to calibrate the energy Ex and detection efficiency ε_i of x–ray detector, the results were described as table 1, the error and the drift of energy during a week was less than 0.5KeV.

Using different thickness (L) metal attenuator (Cu, Al, Cd foil), the (μ/ρ)(Ex) of source x–ray could be obtained, it was consistent with the standard value [2] (error ~ 15%). In air discharge there was not anomaly of x−ray.

Results:

There were some anomalous phenomenon in many energy spectrums of x−ray, table 2−5 described the typical spectrums, there were high energy x−ray; in the energy interval $Ex \quad / (\sqrt{2} ev \quad)$ = 3~ 20 (V denoted alternating voltage, e denoted electron charge), the intensities of x−ray were 10%~ 1000% of background. To test the character of x−ray, we used different thickness (L) metal attenuating foil (Cu, Al, Pb, Cd foil) in front of the detector, the mass attenuation cross section $(\mu / \rho)(Ex)$ might be obtained (see table 6−9): $\frac{\mu}{\rho} = \frac{1}{\rho(L_1 - L_2)} lg\left[\frac{N_1(Ex) - N_0(Ex)}{N_2(Ex) - N_0(Ex)}\right]$, $N_1(Ex)$, $N_2(Ex)$ were the Intensities of x−ray of energy Ex as metal attenuating foil of thickness L_1, $L_2$was used respectively. $N_0(Ex)$ was the Intensities of background, ρ was the density of metal foil. In Comparison with the standard value $(\mu / \rho)^*$ of handbook [2], (μ / ρ) was very different: at low energy (<20KeV) $(\mu / \rho) / (\mu / \rho)^* \approx 0.01 \sim 0.5$, at high energy (>30KeV) $(\mu / \rho) / (\mu / \rho)^* \approx 2 \sim 100$, for some energy spectrums (μ / ρ) might be negative at some energy interval, and (μ / ρ) depended not only Ex and atomic number Z (as standard value $(\mu / \rho)^*$) but also V,L⋯.

In some special cases (table 10), as $L_1 > L_2$, the corresponding total count rate of x−ray $\Sigma_1 > \Sigma_2 (\Sigma = \int \frac{dN(E_x)}{dE_x} dE_x)$. So the average effective attenuation cross section $(\lg[(\Sigma_1 - \Sigma_0) / (\Sigma_2 - \Sigma_0)] / \rho(L_1 - L_2))$ was negative. It was very anomalous.

For reducing the electromagnetic disturbance effect upon measuring result, some steps were adopted. In short time interval (100~ 300sec) only changing the thickness L, the change of energy spectrum and intensity of x−ray was regular (not random) and might be repeated. This meant the counts of x−ray were not affected by electromagnetic disturbance obviously. For check and comparison, we also applied thermoluminescent dosimeters (TLD) and NaI detector to measurement of x−ray dose, TLD was not affected by electromagnetic noise. Using Pb attenuation foil of 5mm thickness , TLD recorded the intensity of 4 times background; Using Pb attenuation foil of 1,2,6mm thickness simultaneously, the discharge voltage was 14kV, TLD recorded the intensity of 77.6, 35.1, 8.6 mR (milli Rongen) respectively, the background was about 2.4 mR. So we might obtain the average mass attenuation cross section: $(\bar{\mu} / \rho) = 0.734(1 \sim 2mm), 0.367(2 \sim 6mm) cm^2 / g$, the corresponding x−ray energy was 214 keV and 277 keV, this strongly supported above measuring results about there were 100~ 300keV high energy x−ray in the low voltage gas (D_2,H_2) discharge.

Analysis and discussion

From above measuring results. we might think that the x−ray emission spectrum N(Ex) included two parts: $N(E_x) = Nn(E_x) + Na(E_x)$, Nn(x) was the normal x−ray of gas discharge, or called beam−target x−ray, Na(Ex) was anomalous part, according to our supposition [3], some quasis table compact small deuterium (hydrogen) atom or molecule (denoted by De^*, Pe^* De^*De^*, Pe^*Pe^*, D denoted deuterium nucleus, P was proton, $e^*$was electron) Could be produced in the low voltage gas discharge, the dimension R of De^*, $Pe^*$was much more less than Bohr radius R_B, R / R_Bmight be 0.01~0.1 or less, so De^*, Pe^*could penetrate thick metal foil and interact with metal atom, when it broke up very nearby the nucleus of metal atom, the electron was accelerated by Coulomb field of nucleus, and x−ray were emitted, because electron might move very nearby nucleus and Z> >1, so high energy x−ray could be emitted. In metal attenuation foil on the one hand x−ray were absorbed (mainly was photoelectric absorption), and on the other hand, x−ray were produced simultaneously, in the result negative absorption might appear.

Supposing the current of quasi stable compact small neutral particle ($De^*, Pe^*, \cdots$) was n_0, its attenuation cross section was $\alpha(\omega)$, it depended some parameters ω (for example: radius, energy ···), the attenuation of neutral particle current in metal foil accompanied the emission of new x–ray: We might obtain the expression:

$$N_a(E_x,x) = n_0 \int G(\omega) g(\omega, E_x) \frac{e^{-\mu(E_x)x} - e^{-\alpha(\omega)x}}{\alpha(\omega) - \mu(E_x)} d\omega$$

$G(\omega)$ was the distribution function of small neutral particle, $g(\omega, E_x)$ was the distribution function of emitting x–ray when the neutral particle of ω–characteristic was attenuated. X denoted the thickness of metal attenuation foil.

In low energy, $Nn(E_x)$ and $Na(E_x)$ both contributed to x–ray emission spectrum $N(E_x)$ effectively (in many cases, $Nn(E_x)$ might be main), But in high energy interval, or when the metal attenuation foil attenuated the low energy x–ray to very great extent, then the measuring x–ray was $Na(E_x)$ mainly, the character of $Na(E_x)$ was represented by factor $S(x)$ mainly

$$S(x) \equiv \frac{e^{-\mu(E_x)x} - e^{-\alpha(\omega)x}}{\alpha(\omega) - \mu(E_x)} = \begin{cases} \dfrac{e^{-\alpha(\omega)x}}{|\alpha(\omega) - \mu(E_x)|} & when \quad \mu \gg \alpha \\ \dfrac{e^{-\mu(E_x)x}}{|\alpha(\omega) - \mu(E_x)|} & when \quad \mu \ll \alpha \end{cases}$$

The value of $S(x)$ was maximun at $x_m = lg[\mu(E_x)/\alpha(\omega)] / [\mu(E_x) - \alpha(\omega)]$. as $L_1 < L_2 < x_m$, $Na(E_x, L_1) < Na(E_x, L_2)$, so the negative absorption might appear.

In summary, because the existence of $Na(E_x, x)$, above anomalies of x–ray might be explained qualitatively.

In future, we should discriminate $Nn(x)$ and $Na(x)$ in detail, research the character of $Na(x)$ and test the existence of quasi stable compact small neutral particle directly.

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Table 7 (μ/ρ) (Cm^2/g) of Cu

E(KeV)	8.	15.	25.	35	45	55	65	75	85
Exp 1	13.15	8.688	9.47	10.01	8.85	7.87	4.99	4.80	4.25
Exp 2	14.93	43.54	11.28	7.92	7.26	5.00	4.23	4.89	4.64
Exp 3	17.82	30.45	22.46	37.02	29.1	22.54	21.52	14.51	15.55
Exp 4	3.28	7.83	4.97	2.34	1.64	1.84	2.40	2.73	2.98
Exp 5	19.02	22.01	15.02	26.58	22.65	15.76	10.03	5.52	4.56
Exp 6	25.58	27.85	19.15			5.38	-2.07	0.050	3.66
Exp 7	20.92	13.94	11.75			11.46	7.108	0.83	-1.66
Ref [2]	53.2	74.1	17.5	6.57	3.36	1.80	1.08	0.693	0.472

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E(KeV)	95	125	175	225	275	325	375	425	475
Exp 1	3.79	3.39	4.52	4.66	5.49				
Exp 2	4.61	-0.034	-3.44	-4.75	-7.42				
Exp 3	22.83	19.54		30.89	45.2				
Exp 4	2.82	4.11	1.25	0.77	-3.60	-5.00	-4.60	-9.20	-3.43
Exp 5	-1.65	2.82	-18.77						
Exp 6	5.17	3.10	1.22	11.32					
Exp 7	0.36	0.81	22.33	-18.95					
Ref [2]	0.34	0.149	0.05273	0.026	0.0139	8.3×10^{-3}	5.36×10^{-3}	3.79×10^{-3}	2.75×10^{-3}

Table 8 (μ/ρ) (Cm^2/g) of Al

E(KeV)	8.	15.	25.	35	45	55	65	75	85
Exp 1	28.6	26.15	9.23	10.39	12.78	18.83	24.8	28.66	
Exp 2	35.73	32.37	45.61	46.13	47.94	60.5	61.6	42.03	28.77
Ref [2]	49.6	7.47	1.54	0.532	0.26	0.133	0.077	0.0483	0.0321

Table 9 (μ/ρ) (Cm^2/g) of Cd

E(KeV)	8.	15.	25.	35	45	55	65	75	85	95	125	175
Exp 1	1.21	0.43	0.12	-0.17	1.69	0.68	2.25			3.31	3.22	0.48
Exp 2	0.27	0.57	1.38	0.32	0.31	0.31	0.44	0.62	0.60	0.46	0.45	0.14
Ref [2]	225	39.6	9.68	25.1	13.4	7.51	4.63	3.10	2.12	1.53	0.704	0.261

Table 10, Average negative absorption of X-ray

E(KeV)	8.	15.	25.	35	45	55	65	75	85	95	175	$(\mu/\rho)_{av}$
$(\mu/\rho)_{Al}$	0.18	-8.70	-17.83	-6.46	-6.32	-13.24		-12.35	-25.57			-7.76
$(\mu/\rho)_{Al}$	1.08	-3.59	-9.52	-5.66	-4.96	0.23	0.89	0.65	2.01	-2.69		-1.43
$(\mu/\rho)_{Al}$	6.68	-12.31	19.37	27.40	-37.11	13.94	-3.81	-34.66	-57.35			-11.46
$(\mu/\rho)_{Cu}$	-6.19	-6.14	-4.29	-3.51	-3.52	5.58	7.24	3.04	0.41	1.19	-4.83	-5.18

Fig. 1 Average Counts of X-ray for Experiments Pd122nd and Pd125th

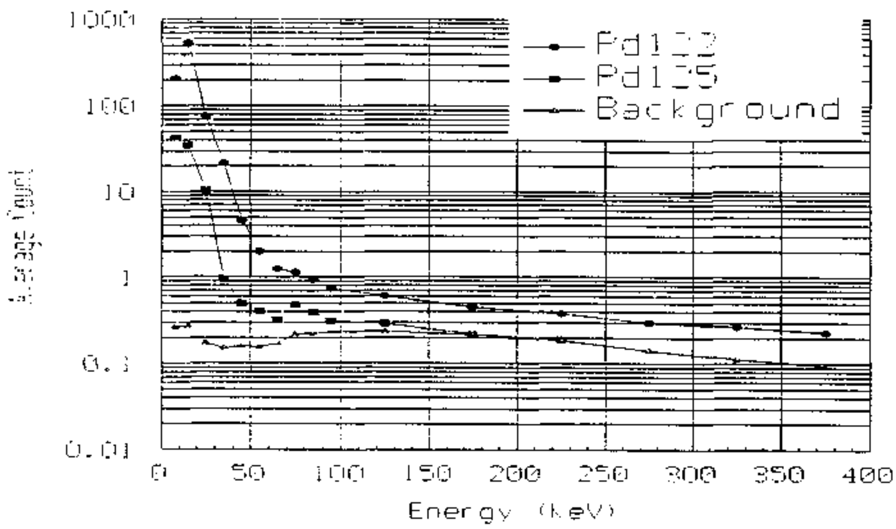

Fig. 2 Average Counts of X-ray for Experiments Nb60th