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MUTIPLE PLASMON SATELLITES OF TRANSITION METAL

Dr. Ajay Vikram Singh[1]

Abstract-

Relative intensity & energy sepration of multiple plasmon satellites of $L\beta_1$ X-ray emission line of transition element have been calculated . The theorital values are fairly close with the values estimated from Surendra Poonia & S.N.Soni.

Keywords - Double plasmon satellites , Relative Intensity & Energy Sepration

Introduction-

Multiple plasmon loss peaks in the energy loss spectrum of fast charged particle,after passing through a thin metallic foil were interpreted as due to multiple scattering of single plasmon process . in these interpretation the possibility of multiple plasmon excitations in a single scattering process was totally ignored. In 1970 Ashley and Ritchie calculated for the first time the probability of double plasmon excitation in a single process and found that at an energy distance of $2\hbar\omega_p$ Two processes will contribute

(1) - Single plasmon $\hbar\omega_p$ scattering two times

(2) - Double plasmon scattered one time.

Multiple plasmon loss peaks have been observed in soft X-ray appearance-potential spectra (SXAPS) by Bradshaw & Mensel (5) , in characteristic energy loss spectra by Von Koch (6) and

[1] **Associate Professor , Physics (Applied Science Department),Rajarshi Rananjay Sinh Institute of Management & Technology,Amethi UPTU**

Henrich (7) in Auger spectra by Jenkins et al. (8,10) and Dufour et al. (9) and in photo emission spectra by Smith and Spicer(11) During the last two decades several workers (2,3,12) have also observed X-ray satellites at an energy distance of $2\hbar\omega_p$ from the main emission line . Although Arakawa and Williams (2) have tried to explain such satellites due to double ionization process , initially proposed by Hayasi (13) but Asley and Ritchi's(4) theoretical calculation , and Spence and Spargo's (14) experimental work led us to assign the aforesaid X-ray satellites as double plasmon satellites.

MATHEMATICAL CALCULATION

The energy sepration (ΔE) of these double plasmon satellites from their parent line has been calculated using the formula given by

$$\Delta E = 2\hbar\omega_p = 57.6\,(Z\sigma/\omega)^{1/2}\ \text{ev} \quad 1$$

Where Z = No.of unpaired electrons taking part in plasma oscillation

σ = Specific gravity

ω = Molecular Weight

Further Surendra Poonia & S.N.Soni. (1) have also observed some X-ray satellites but we have explained $L\beta_1$ satellites which are at energy distance $2\hbar\omega_p$

respectively from plasmon theory We would guess on the first sight the envolvement of plasmon exitation in these satellites from the energy sepration of these satellites alone

Our calculated values of ΔE have been compared with the **Surendra Poonia & S.N.Soni** experimental value. And We have also calculated the relative intensity of plasmon satellites, which is different in different processes. If the excitation of plasmon occurs during the transport of the electron through the solid, it is known as extrinsic process of plasmon excitation. The plasmon can also be excited by another method known as intrinsic process. In this process, excitation of plasmon takes place simultaneously with creation of a hole. Bradshaw et al have further divided core hole excitation into two classes,

1 - Where the number of slow electrons are conserved.

2 - Where the number of slow electrons are not conserved

The Author has calculated relative intensity in both the cases with new modification in the light of Bradshaw [12] and Lengreth [13] work, which explains that not only intrinsic process but extrinsic process and their relative contribution may also contribute in relative intensities. The combined effect of intrinsic and extrinsic plasmon excitation intensity variation was suggested by Lengreth as**:**

$$\mathbf{I} = \frac{Is}{Im}$$

$$= \alpha^{n} \sum_{m=0}^{n} \frac{(\frac{\beta}{\alpha})^{m}}{m!} \qquad \mathbf{2}$$

The value of β is taken as $\beta = 0.12r_s$ which is purely intrinsic, $r_s = (47.11/\ \hbar w_s)^{2/3}$ is dimensionless parameter and $\alpha = 0.47\ r_s^{1/2}$ in the place of $\alpha = (1+l/L)^{-1}$ used by Pardee et. al.(14) . The equation (2) contains a series of terms. The first term of the equation is purely extrinsic, while second term is purely intrinsic. The other terms are containing the relative contributions of both extrinsic and intrinsic. The specialty of this formula is that each term alone or simultaneously with other terms is able to give the relative intensity. This formula also includes both the categories mentioned by Bradshaw and gives better results as compared than traditional methods for calculation of the relative intensity

Conclusion - Surendra Poonia & S.N.Soni **(1)** have calculated the relative intensity of large no. of X-ray satellites but in the absence of any experimental values to compare with . it is difficult to comment any thing about his theory but for **$L\beta_1$ satellites** we have calculated & estimated values agrees well with the calculated values of Surendra Poonia & S.N.Soni Thus for these satellites both theory can be equally good

Hence we have established beyond doubt that the observed satellites **$L\beta_2$** may be due to absorption of **double plasmon**

Energy sepration ΔE at $L\beta_1$ satellite of 4-d Transistion element

Relative Intensity of $L\beta_1$ satellite of 4-d Transition element

S. No.	NAME	Z	W	σ	Exp. Value of Single Plasmon ($L\beta_1'$)	Author Value of Single Plasmon ($L\beta_1'$) ħws	Exp. Value of Double Plasmon ($L\beta_1''$)	Author Value of Double Plasmon ($L\beta_1''$) 2 ħws
1	Ru(44)	1	101.07	12.45	7.15	6.18	14.30	13.67
2	Rh(45)	1	102.91	12.41	7.07	7.96	14.14	14.36
3	Pd(46)	1	106.42	12.02	6.84	7.95	13.68	14.15
4	Ag(47)	2	107.87	10.5	8.99	9.06	17.98	16.53
5	Cd(48)	2	112.41	8.64	7.98	8.97	15.96	16.45

S.No.	NAME	Surface Energy	Rs	α	β	Author intensity	Exp. Intensity	Satell. Name	Symbol
1	**Ru(44)**	**7.15**	**3.52**	**0.88**	**0.4218**	**0.63478**	**0.662679**	**Single Plasmon ($L\beta_1'$)**	**β +β2/2α+ 0.1**
						1.285462	**1.318182**	**Double Plasmon ($L\beta_1''$)**	**2*(β+0.1+β2/2α)**
2	**Rh(45)**	**7.07**	**3.54**	**0.88**	**0.4248**	**0.63457**	**0.676354**	**Single Plasmon ($L\beta_1'$)**	**β +β2/2α+ 0.1**
						1.298745	**1.331572**	**Double Plasmon ($L\beta_1''$)**	**2*(β+0.1+β2/2α)**
3	**Pd(46)**	**6.84**	**3.62**	**0.89**	**0.4342**	**0.68745**	**0.636632**	**Single Plasmon ($L\beta_1'$)**	**β +β2/2α+ 0.1**
						1.31245	**1.348597**	**Double Plasmon ($L\beta_1''$)**	**2*(β+0.1+β2/2α)**
4	**Ag(47)**	**8.99**	**3.02**	**0.82**	**0.3622**	**0.61457**	**0.655285**	**Single Plasmon ($L\beta_1'$)**	**β +β2/2α+ 0.1**
						1.21478	**1.253659**	**Double Plasmon ($L\beta_1''$)**	**2*(β+0.1+β2/2α)**
5	**Cd(48)**	**7.98**	**3.27**	**0.85**	**0.3918**	**0.26457**	**0.235294**	**Single Plasmon ($L\beta_1'$)**	**β - 0.1**
						1.69845	**1.741176**	**Double Plasmon ($L\beta_1''$)**	**3*(β+0.1+β2/2α)**

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