9. Anisotropy of Electron Emission from Aligned States Produced by Slow Ion-Atom Collisions

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An ejected electron spectroscopic study has been carried out on Li^++ Ne and Na^++He collisions, paying special attension on the collision energy dependence of the angular distribution of differential cross sections for the electron emission. The ion impact energy has been varied from 0.4keV up to 7.0keV. Ejected electrons have been observed for the angles from 5 deg. to 115 deg. with respect to the direction of the incident ion beam.

1) Li^++Ne collisions ; We have analyzed the ejected electron spectra for the autoionization process, $Ne^{**}2p^4 3s^2\ {}^1D$ --- $Ne^+ 2p^5\ {}^2P + \varepsilon p, \varepsilon f$.

In Fig.1, we show differential cross sections against the electron emission angle by open circles at Li^+-impact energies from 0.5 to 5.0 keV.

The differential cross section $d\sigma_e/d\Omega$ of the electron emission may be written as, $d\sigma_e/d\Omega = (\sigma_t/4\pi)\ \{1+\beta_2 P_2(\cos\theta)+\beta_4 P_4(\cos\theta)\}$, (1) where σ_t is the total emisson cross section, P_ℓ is the ℓ'th order Legendre polynomial, θ is the electron emission angle, and β_ℓ is the ℓ'th anisotropy parameters. In Fig.1, we show the results of a fitting calculation using equation (1) in full curves. In Fig.2 (A) and (B), we show the experimental results of the anisotropy parameters β_2 and β_4, respectively, as a function of the impact energy. We find a minimum in the β_2 curve at around 0.5keV. On the other hand, there exist two minimums in the curve of β_4 at around 5 keV and the energy region from 0.5 to 1.0 keV. The parameter β_4 is found to be comparable with β_2 in magnitudes. The present experimental results suggest strongly a presence of non-negligible f-wave contribution in the Ne-autoionizing processes because, roughly speaking, β_4 indicates the magnitude of the interference between the p- and f-waves, in the emitted electrons.

By a theoretical consideration, anisotropy parameters are formulated as follows, $\beta_\ell = C_\ell\ (1/\sigma_t)\int P_\ell(\cos\Theta)(d\sigma_i/d\Omega')d\Omega'$, (2) where Θ is the Li^+-scattering angle, $d\sigma_i/d\Omega'$ is the center of mass differential cross section of scattered ions, and constant C_ℓ may be determind according to the contribution from p and f-waves, respectively.

We have derived this relation under the assumption, firstly that the

$Ne^{**}2p^43s^2\ ^1D$ autoionizing state is excited by a transition between the quasimoleculer states owing to the radial coupling in the vicinity of the avoided crossing between the initial and final potential energy curves, and secondly that it obtains a complete a_ignment with respect to the quasimolecular axis, i.e., the line connecting Li^+ and Ne.

Results of our calculations of β_2 and β_4 using equation (2) is shown in Fig.3 (A) and (B), respectivly. The features of the energy dependence of β_2 and β_4 are reproduced well, although absolute values and energies for which the minimums occur in the theoretical curves are slightly different from the experimental ones. From these results, we may conclude that there exists a decisive alignment of the $Na^{**}\ 2p^43s^2\ ^1D$ autoionizing state with respect to the quasimolecular axis, which reflects to·the specific angular distributions of electron emission obsreved.

2) Na^++He collisions ; Because the ejected electron from the Na^{**} autoionizing state is of only p-wave content, this collision system is a good test to check the validity of the method described above. The experiments and analiysis of this system is in progress. I expect to present results on this system at final examination.

REFERENCE

1) H.Sakaue et al., Abstracts of Contributed Papers, XV ICPEAC (Brighton, 1987) 469.

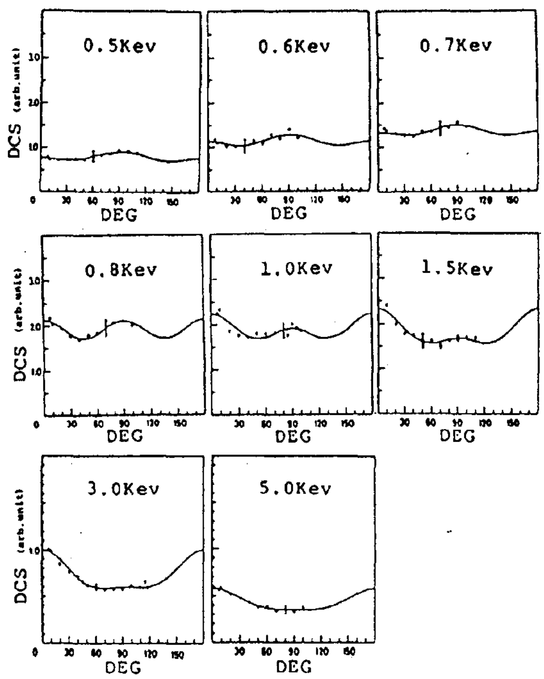

Fig.1. Angular distributions of differential cross sections for electron emission from the Ne^{**} $2p^43s^2\ ^1D$ state.

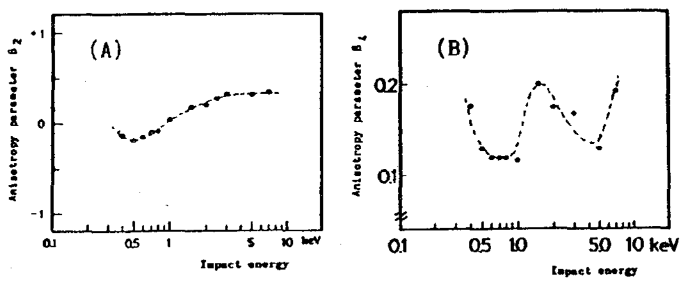

Fig.2. Anisotropy parameters β_2 (A) and β_4 (B) as function of impact energy.

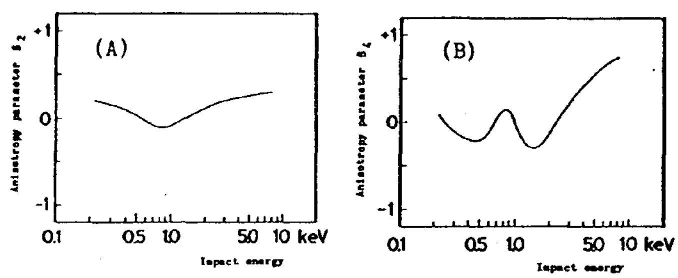

Fig.3. Anisotropy parameters β_2 (A) and β_4 (B) obtaind by the theoretical calculation.