FORWARD-ANGLE SCATTERING AND NUCLEAR-RESONANCE EFFECT IN ELECTRON CAPTURE IN H^+ + N COLLISIONS.

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The ionization process is well described by the theory, so the effect of a nuclear resonance on the k-shell ionization in an ion-atom collision has been successfully explained. But for the charge exchange process in such a collision the theory has been improved only recently, raising up experimental studies on a possible enhanced effect of a nuclear resonance on the inner shell electronic capture. Such an effect has been first found for the nuclear elastic scattering resonance $^{14}N(p,p)$, E_r = 1.058 MeV, at a backward angle of 150°[1], then at 30° in the reaction $^{20}Ne(p,p)$ at E_r = 1.955 MeV resonance[2] and at last in the reaction $^{22}Ne(p,p)$, E_r = 1.510 MeV, at 150°[3].

We have studied the dependence on projectile energy of the total probability for electron capture at 30° in the vicinity of the nuclear scattering resonance $^{14}N(p,p)$ at E_r = 1.058 MeV. An electrostatic method has been used to separate energetically the scattered H^+ and H° (neutral hydrogen atom) detected in a surface barrier detector. The apparatus Fig. 1 consists of a cylindrical capacitor. Its inner electrode was set to a negative potential -V(40 kV $\leqslant$ V $\leqslant$ 48 kV) with the respect to the grounded external plate. To ensure the single atomic collision condition a gas jet target J was used. The residual pressure in the diffusion chamber was kept at 2.10^{-4} Torrs. To shield the detector from the flow of electrons taking place in the existing plasma, we have set in front of it a collimating tube T, 5 mm in diameter, 3 cm long, in the gap of a permanent magnet M, and a 250 $\mu g/cm^2$ copper foil F.

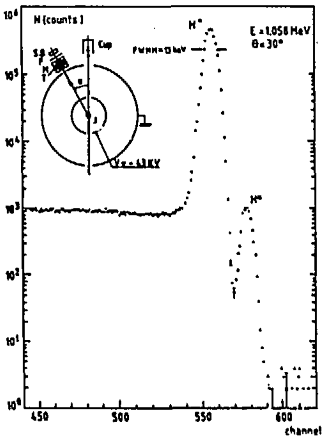

Fig. 1 : Experimental set up and spectrum

On a spectrum (Fig. 1) can be seen the H° peak, at the nominal energy E and the H^+ peak at the energy E-e.V, these H^+ ions being decelerated by the electrostatic field. The good separation between these two peaks must be noticed, the scale being logarithmic, with the absence of background beyond the H° peak. Therefore the areas of the two peaks can be extracted without spectrum fitting. The total capture probability equals the area of the H° peak divided by the total area of the two H^+ and H° peaks.

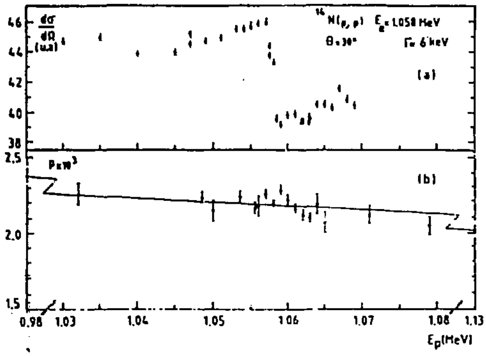

Fig. 2 : a) Elastic scattering excitation function.
b) Total capture probability. The full line locates the mean value of P accross the resonance, obtained from data at lower and higher energies.

The differential cross section for scattering and the charge transfer probability measured near the $^{14}N(p,p)$ resonance at 1.058 MeV and 30° in the laboratory are shown in Fig. 2.

The near resonance energy region has been scanned by varying the electrostatic potential, without changing the accelerator settings. The errors bars are standard deviations. The total probability for electron capture is changing at most by 3 per cent accross the resonance. This result can be compared with the one obtained in the ^{20}Ne case, where a large variation was recently observed[2]. It has also to be compared with the result obtained for the same resonance but à 150° where the effect of the resonance on the total probability capture has been shown to be quite large.

The analysis of these recent experimental results are in progress.

References

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