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POSSIBLE EXISTENCE OF I^+ RESONANCE IN CHARGE EXCHANGE REACTIONS OF SPHERICAL NUCLEI

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Charge-exchange reactions of the type (p, n), (He^3, t), or inverse β decay (ν, e^-) make it possible to investigate the isobaric configuration proton - neutron hole states (p, $\bar{n}$) of a target nucleus A(N, Z) (N > Z) [1], such as the collective configuration 0^+ states of even-even nuclei [2, 3]. Among the configuration isobaric states of other angular momenta, it is of interest to investigate the experimental possibility of existence of a collective isobaric I^+ state, which can be manifest in charge-exchange reactions of even-even nuclei A(N, Z) as "giant" I^+ resonance against the background of compound states of the odd-odd nucleus A(N - 1, Z + 1). From the microscopic point of view, such a state is one of the many configuration I^+ states of the $p\bar{n}$ type and is strongly collectivized as a result of the influence of the interaction and the existence of a layer of excess neutrons N - Z [4]. It is separated energywise from the remaining group of I^+ $p\bar{n}$ states and lies close to the analog state. The matrix element of the β decay of this state to the ground state of the target nucleus is close to the matrix element of the β decay of the analog resonance. Similar states with log ft ∿ 3 were apparently observed in Ne^{17}, Ar^{33}, and Ca^{49} [5]. For the purpose of experimentally finding such I^+ resonances, it is of interest to calculate their characteristics, and primarily their positions.

We have calculated the characteristics of these state within the framework of the theory of finite Fermi systems [6] for the medium group of spherical nuclei in the Ge - Ba region. The positions of the isobaric configuration I^+ states of the pn type were determined from the poles of the equation of the Gamow-Teller effective field or bare symmetry $\sigma\tau^+ = V^0$

$$V_{\lambda_1\lambda_2}(\omega) = e_q V^0_{\lambda_1\lambda_2} + \sum_{\lambda\lambda'} \Gamma^{\omega}_{\lambda_1\lambda_2\lambda\lambda'} A_{\lambda\lambda'} V_{\lambda\lambda'}(\omega), \quad (1)$$

$$M^2_{GT} = \sum_{\lambda\lambda'} e_q \chi_{\lambda\lambda'} A_{\lambda\lambda'} V^0_{\lambda\lambda'}, \quad (2)$$

and the matrix elements M_{GT} of the β transition to the ground state of an even-even nucleus A(N, Z) were determined from the residues $\chi_{\lambda\lambda'}$ of the field $V_{\lambda\lambda'}(\omega)$ at the pole point. λ are the quantum numbers of the single-particle scheme, $e_q = 0.9$ is the effective charge, and Γ^{ω} is the quasiparticle scattering amplitude whose spin-isospin part enters in the problem. Equation (1) describes three main types of configuration isobaric I^+ states: states of the spin-orbit type, $j = \ell + 1/2 \to j' = \ell - 1/2$, proceeding with spin flip of the charge-exchanging nucleon, states of the $j \to j$ type, with flip of the total angular momentum, and states of the spin-orbit type with inverse spin flip ($j = \ell - 1/2 \to j' = \ell + 1/2$) [3].

Elements	$g'_o = 1.0$		$g'_o = 1.3$	
	from	to	from	to
As^{72-78}	2.2	1.6	3.8	3.7
Br^{74-82}	3.1	1.6	4.0	3.6
Rb^{80-88}	3.6	1.8	4.4	3.5
Y^{86-92}	3.6	0.7	4.8	2.5
Nb^{88-96}	4.4	1.5	5.4	3.0
Tc^{92-102}	4.8	1.0	5.9	2.9
Rh^{96-106}	5.0	0.5	6.3	2.9
$Ag^{102-112}$	4.5	- 0.7	6.0	1.3
$In^{106-118}$	4.0	- 1.3	5.3	0.7
$Sb^{114-124}$	1.2	- 1.6	2.5	0.7
$I^{120-132}$	0.4	- 1.1	1.9	1.4
$Cs^{126-136}$	- 0.1	- 0.7	1.7	1.5
$La^{130-138}$	0.5	- 0.5	2.1	1.6

The I^+ resonance is outstanding among all other solutions in its matrix element and energy. Its characteristics depend strongly on the value of the spin-isospin interaction constant g'_0, which varies in different models from 1.0 to 1.5 ($g'_0 = 1.5 \pm 0.3$ in a Fermi liquid). We have calculated the characteristics of the collective I^+ resonance for two values of the constant, $g'_0 = 1.0$ and $g'_0 = 1.3$. In the region $g'_0 \geq 1.0$, its position relative to the analog resonance increases practically linearly with increasing N - Z for isotopes of one and the same element. Such a situation makes it possible to present the calculated positions of the hypothetical I^+ resonance (table), indicating the relative position ($\varepsilon_{I^+} - \varepsilon_A$, where ε_A is the energy of the analog resonance in the A(N, Z) nucleus) for the first and last of the investigated isotopes. Linear interpolation of these values with respect to N - Z gives the relative positions of the I^+ resonance in the remaining isotopes, and additional interpolation with respect to g'_0 makes it possible to take into account the variation of the position with the choice of the constant.

The ratio of the squares of the matrix elements of the β^+ decay of the collective I^+ resonance and of the analog resonance is $\sim$0.8 - 1.0 in all the cases considered.

The results can be used in experimental searches for a new class of resonant states of nuclei.

Detailed results of the calculations will be reported separately. Similar calculations for deformed nuclei were carried out in parallel in Dubna [7].

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