PHOTON-PLASMON TRANSITION 2^3S_1-1^3S_1 IN THE POSITRONIUM: S-MATRIX FORMALISM CALCULATION

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It is well known that the positronium Ps is an exotic hydrogen isotope with the atomic mass $M=2m_e\sim1$ milli-amu and ground state binding energy of E=6,8 eV. The hfs states of Ps differ in spin S, life time t and mode of annihilation: para-Ps (S=0; $t=1{,}25\cdot10^{-10}n^3$ s ; 2γ annihilation) and ortho-Ps (S=1,$t=1.4\cdot10^{-7}n^3$ s ; 3γ annihilation). As a rule, probabilities of the cascade radiation transitions are more than the annihilation probability. The ortho-Ps atom has a metastable state 2^3s_1 and probability of two-photon radiation transition from this state into 1^3s_1 state ($1.8\cdot10^{-3}$ s^{-1}) is significantly less than probability of the three-photon annihilation directly from 2^3s_1 level ($8.9\cdot10^5$ s^{-1}), i.e. it is usually supposed that the ortho-Ps annihilates from 2^3s_1 state. Another situation may take place in plasma, where it is arisen the competition process of destruction of the metastable level – the photon-plasmon transition 2^3s_1-1^3s_1 with emission of photon and Langmuir quanta. In this paper we develop a new approach to calculation of the probability of the photon-plasmon transition in the Ps. In the theory of radiative and nonradiative decay of the quasistationary states of multielectron atom it is well known an energy approach (c.f. [1,2]), based on the adiabatic Gell-Mann and Law formula for the energy shift with electrodynamic scattering matrice. The method is a consistently electrodynamic one, allowing for the uniform consideration of a variety of induced & spontaneous processes. Earlier it has been with great success used in calculation of the radiation transition probabilities and oscillator strengths for different atomic and ionic systems [1-4]. The approach represents the decay probability as an imaginary part of energy shift dE, which is defined by S-scattering matrix of second (and higher) orders. Standard S-matrix calculation with using an expression for tensor of dielectric permeability of the isotropic plasma and dispersion relationships for transverse and Langmuir waves [3] allows getting the corresponding probability P(ph-pl). Numerical value of P(ph-pl) is $5.2\cdot10^6\cdot U_L$ (s^{-1}), where U_L is a density of the Langmuir waves energy. Our value is correlated with estimate, available in literature [3]: P(ph-pl)=$6\cdot10^6\cdot U_L$ (s^{-1}). Comparison of the obtained probability with the life time t(3γ) allows getting the condition of predominance of the photon-plasmon transition over three-photon annihilation. It is very important that considered transition may control the population of 2^3s_1 level and search of the long-lived Ps state can be used for diagnostics of the plasma turbulence.

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