The photon-plasmon transitions and diagnostics of the space plasma turbulence

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We present a new approach to treating the space plasma turbulence, based on using to make diagnostic data regarding the photon-plasmon transitions. The theoretical definition of characteristics for these transitions is caried out within consistent theoretical approach, based on the Gell-Mann and Low formalism (energy approach in QED theory). We apply it to calculation of such transitions (Ps) with emission of photon and Langmuir quanta. It is well known that the positronium Ps is an exotic hydrogen isotope with the atomic mass M=2m$_e$ $\sim$1 milli-amu and ground state binding energy of E=6,8 eV. The hfs states of Ps differ in spin S, life time t and mode of annihilation: para-Ps (S=0; t=1,25$\cdot 10^{-10}$n^3 s ; 2γ annihilation) and ortho-Ps (S=1,t=1.4$\cdot 10^{-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 ($1.8\cdot 10^{-3}$ s^{-1}) is significantly less than probability of the three-photon annihilation directly from 2^3s_1level ($8.9\cdot 10^5$ s^{-1}), i.e. it is usually supposed that the ortho-Ps annihilates from 2^3s_1state. 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. Standard S-matrix calculation with using an expression for tensor of dielectric permeability of the isotropic space 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 $5.2\cdot 10^6\cdot U_L$(s^{-1}), where U_L is density of the Langmuir waves energy. Our value is correlated with estimate, available in literature [3]: P(ph-pl)=$6\cdot 10^6\cdot U_L$ (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 demonstrated how the considered transition may control the population of 2^3s_1 level and search of the long-lived Ps state that is further used for diagnostics of the space plasma turbulence.

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