Influence of external fields on the hydrogen atom in some problems of astrophysics

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Investigation of the cosmic microwave background (CMB) formation processes is one of the most actual problem at present time. In view of detailed theoretical description of the CMB we analyzed the response of the hydrogen atom to the external photon fields. Field characteristics are defined via conditions corresponding to the recombination era of universe. Approximation of three-level atom with the different schemes of levels (Ξ-, V- and Λ-scheme) was used to describe the "atom - fields" interaction. It is found that the phenomena of the electromagnetically induced transparency (EIT) take place when the CMB radiation is considered as a source of field. Modification of the optical depth entering in the Sobolev escape probability is required

$$p_{ij}(\tau_S) \to p_{ij}\left(\tau_S \cdot (1+f)\right) \tag{1}$$

It is shown that the additional terms expressed by the function f contribute on the level of 1% in resonance [1], [2].

The effects of influence of an external field on the hydrogen atom in astrophysics can be addressed to investigation of the interstellar medium (ISM). In particular, modification of the Sobolev escape probability Eq. (1) can be applied for the theoretical description of the 21 cm line profile in the ISM. As the another kind of phenomenon we have evaluated the Bloch-Siegert shift for the different values of magnetic field's strengths when the stars with the strong surface magnetic fields are taken as a powerful pumping source of radiation. It is found that the additional shift of resonant frequency should be taken into account in the search for the time variation of the fundamental constants. The influence of the electromagnetic field should be considered carefully in each special case for the frequency determination [3].

References
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