Quasimolecular emission near the Xe($5p^5 6s\ ^{1,3}P_1 - 5p^6\ ^1S_0$) and Kr ($4p^5 5s\ ^{1,3}P_1 - 4p^6\ ^1S_0$) resonance lines induced by collisions with He atoms

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Abstract. This study is devoted to the theoretical investigation of the quasimolecular emission of Xe*-He and Kr*-He collision pairs near the Xe ($5p^5 6s\ ^{1,3}P_1 - 5p^6\ ^1S_0$) and Kr ($4p^5 5s\ ^{1,3}P_1 - 4p^6\ ^1S_0$) resonance atomic lines. The potential curves of the quasimolecules Xe($5p^5 6s$) + He and Kr($4p^5 5s$) + He have been obtained with the use of the effective Hamiltonian and pseudopotential methods. Based on these potential curves the processes of quasimolecular emission of Xe*+He and Kr*+He mixtures have been considered and the spectral distributions $I(\hbar\Delta\omega)$ of photons emitted have been obtained in the framework of quasistatic approximation.

1. Interaction potential curves

The potential curves of the interaction of excited atoms Kr($4p^5 5s$) and Xe($5p^5 6s$) with He atoms in the ground state were calculated in [1, 2] in the framework of the method of the effective Hamiltonian in the formulation [3] and the pseudopotential method [3]. Previously, these potential curves have been already applied for the calculations of absorption spectra of Xe + He and Kr + He mixtures and the results obtained are in good agreement with the experimental data [4]. For the ground states the potential curves determined from the experimental data in [5] have been used.

The interaction potential curves for excited and ground states and the difference potentials are shown on figure 1 and figure 2 for for Kr + He and Xe + He respectivelly.

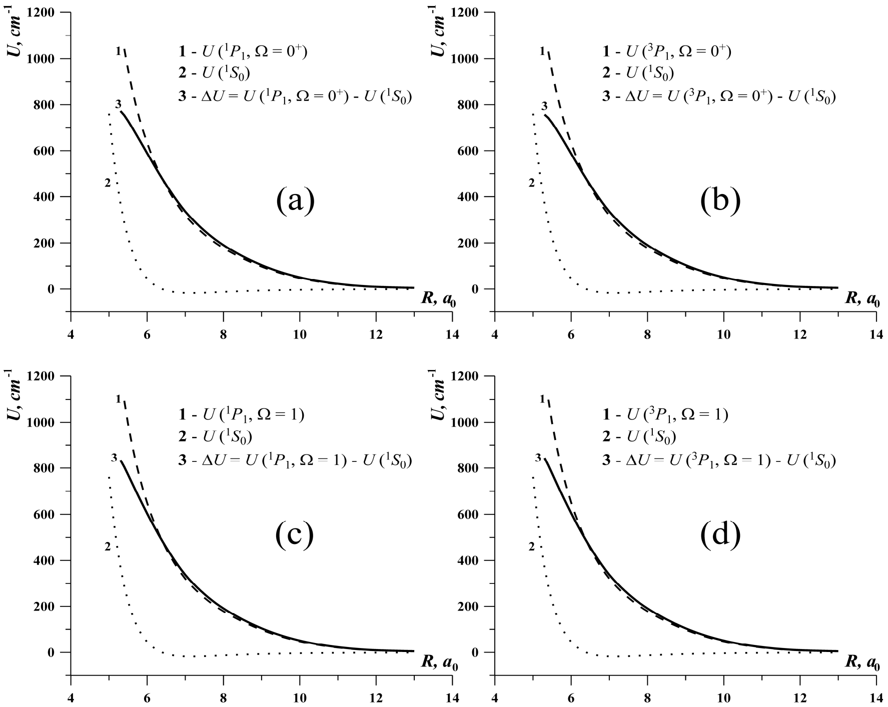

Figure 1. The interaction potential curves for the excited states $^1P_1\Omega=0^+$ (a), $^3P_1\Omega=0^+$ (b), $^1P_1\Omega=1$ (c) and $^3P_1\Omega=1$ (d) (lines 1, dashed), ground states (lines 2, dotted) and the corresponding difference potentials ΔU (lines 3, solid) for Kr-He quasimolecule.

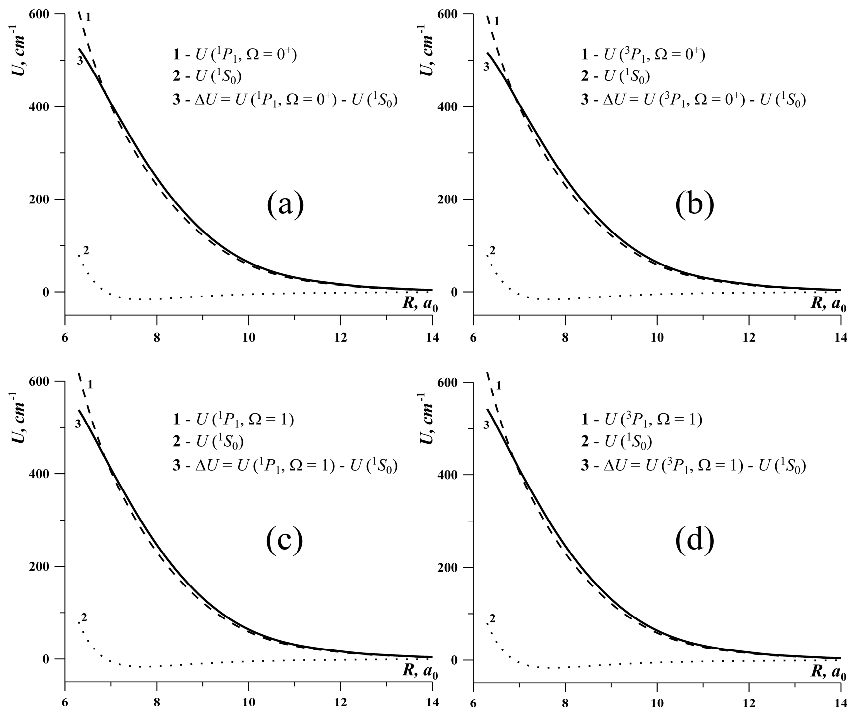

Figure 2. The interaction potential curves for the excited states $^1P_1\Omega=0^+$ (a), $^3P_1\Omega=0^+$ (b), $^1P_1\Omega=1$ (c) and $^3P_1\Omega=1$ (d) (lines 1, dashed), ground states (lines 2, dotted) and the corresponding difference potentials ΔU (lines 3, solid) for Xe-He quasimolecule.

2. Quasimolecular emission of Xe* + He and Kr* + He collision pairs

Based on the potential curves described in section 1 the processes of quasimolecular emission of Xe* + He and Kr* + He mixtures have been considered and the spectral distributions $I(\hbar\Delta\omega, \text{cm}^5)$ of photons emitted have been obtained in the framework of quasistatic approximation [6]. The calculated emission spectra $\lg(I/I_0)$, where $I_0 = 10^{-35}$ cm^5, for the temperature T = 300 K are presented on figure 3 and figure 4 for Kr*+He and Xe*+He respectivelly.

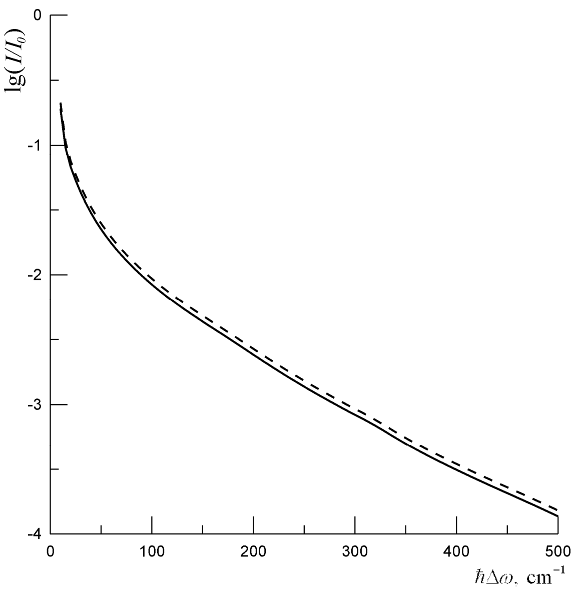

Figure 3. The emission spectra of Kr*+He near the resonance atomic lines $^1P_1 - {}^1S_0$ (solid line) and $^3P_1 - {}^1S_0$ (dashed line).

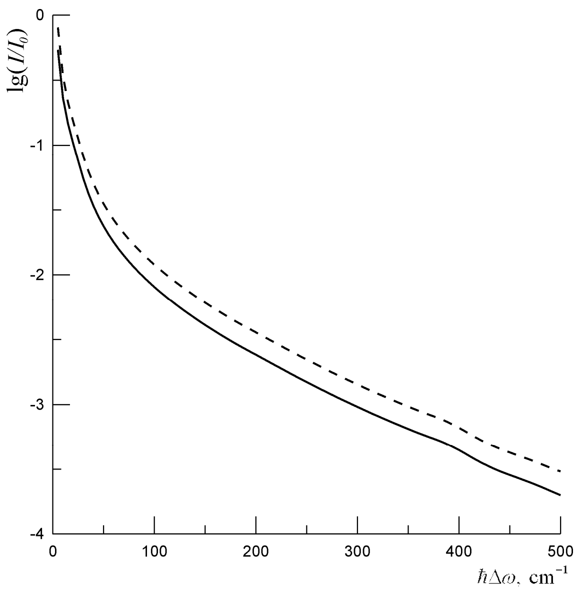

Figure 4. The emission spectra of Xe*+He near the resonance atomic lines $^1P_1 - {}^1S_0$ (solid line) and $^3P_1 - {}^1S_0$ (dashed line).

References

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