

Self-Diffusion Coefficient of a Weakly Ionized Cesium Monatomic Gas: Symmetry Effects

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Cesium has been in the last few years a good candidate for several experiments, such as BEC and atomic cooling. Setting up a database of the transport properties of Cs atoms is therefore more than necessary. The quantum-mechanical computation of the diffusion coefficient, D , begins with the determination of the singlet and triplet potential-energy curves which, in this work, separate asymptotically like $\text{Cs}(6s) \text{Cs}(6s)$. The knowledge of these potentials should lead to the numerical integration of the Schrodinger equation and, thus, to the determination of the phase shifts. Ignoring the indistinguishability of the interacting atoms, the cross section effective in diffusion is calculated for one molecular state, singlet or triplet, and the coefficient of diffusion is determined according to the Chapman-Enskog method. In reality, the colliding atoms, considered in this study, are identical. Hence, the wave function of the diatomic system should be symmetrized. In such a case, quantum mechanics leads to symmetric and antisymmetric diffusion cross sections, as described by Karstis and Schultz [1], and the average diffusion cross section is recalculated by taking into account the Cs nuclear spin and the statistical weight of each molecular state. The evaluation of the self-diffusion coefficient of a dilute gas, made up of Cs monatoms, is in a first step carried out without considering the symmetry effects. The results are compared with those of Nieto de Castro et al. [2]. The agreement is generally excellent. Furthermore, the calculations show that the variation law of the diffusion coefficient in the temperature range 500 to 3000 K is of the form AT^α . Our fitting procedure yields $\log_{10}A = -10.495 \pm 0.009$ and $\alpha = 1.945 \pm 0.003$. In a second step, we have performed the calculations when the symmetry effects are not neglected. The calculations show that the constant, A , has the same value as previously, but α has a lower value.

[1] Karstis and Schultz *At. Plasma-Mater. Interaction Data Fusion* **8**, 1 (1998).

[2] Nieto de Castro et al. *Ber. Bunsenges. Phys. Chem.* **94**, 53 (1990).