Errata

Erratum: Effect of electronic alignment upon the reaction $2Na^*(^2P_{3/2}) \rightarrow Na_2^+ + e^-$ [Phys. Rev. A 31, 1362 (1985)]

Erhard W. Rothe, R. Theyunni, Gene P. Reck, and C. C. Tung

The alignment dependence of the associative ionization cross section for two excited ($3p$) sodium atoms has been studied experimentally and theoretically.[1-4] Because the results from new experiments[1] disagreed with ours,[3] we reexamined our work and discovered an error.

The problem was a defective window in the vacuum wall which was used to transmit linearly polarized laser light. This window caused partial depolarization as well as a polarization-dependent light intensity at the Na beam. We had carefully checked a window early in our work. Unfortunately, that window, which was excellent, was accidentally replaced before the experiments were done. The data previously reported[3] are an artifact of the bad window.

Our apparatus was subsequently modified by replacing the thermal Na oven by a charge exchange source for eV-range Na atoms. This can also be used as an effusive thermal source. We repeated the experiment using this source (at $T \sim 500$ K) *and the good window*, and obtained results in reasonable agreement with those of other laboratories.[1] A data set is shown in Fig. 1. As in Refs. 1, 3, and 4, these data were fit to $I(\theta) = 1 + r_1 \cos(2\theta) + r_2 \cos(4\theta)$. Table I shows that the new values for r_1 and r_2 are in substantial agreement with those reported in Ref. 1.

As described in Ref. 3, r_1 and r_2 can be interpreted in terms of normalized ionization probabilities, c^* and e^*, for two $3p$ sodium atoms each of which can have $m_l = 0$ or ± 1 along the internuclear axis. In this case

$$I(\theta) = c^* W_{\infty\infty} + W_{88} + e^* W_{8\infty} ,$$

where the θ-dependent W's are joint probabilities of laser exciting two Na^*, at large separation, which have the relative lobe alignments shown in the subscripts. We obtain[5] $c^* = 3.35 \pm 0.17$ and $e^* = 1.5 \pm 0.7$. Negative values of e^*, which appeared to invalidate the use of an m_l description of data from Refs. 3 and 4, do not result from our new data or from those in Ref. 1.

The r_1, r_2, c^*, and e^* are shown in Table I. If we assume that the data of Ref. 1 replace those of Ref. 4, then all c^* and e^* are positive and the m_l representation is not excluded.[3,4]

The larger value for c^* in all cases indicates that the $\infty\infty$ alignment is best for the ionization process. If the interpretation
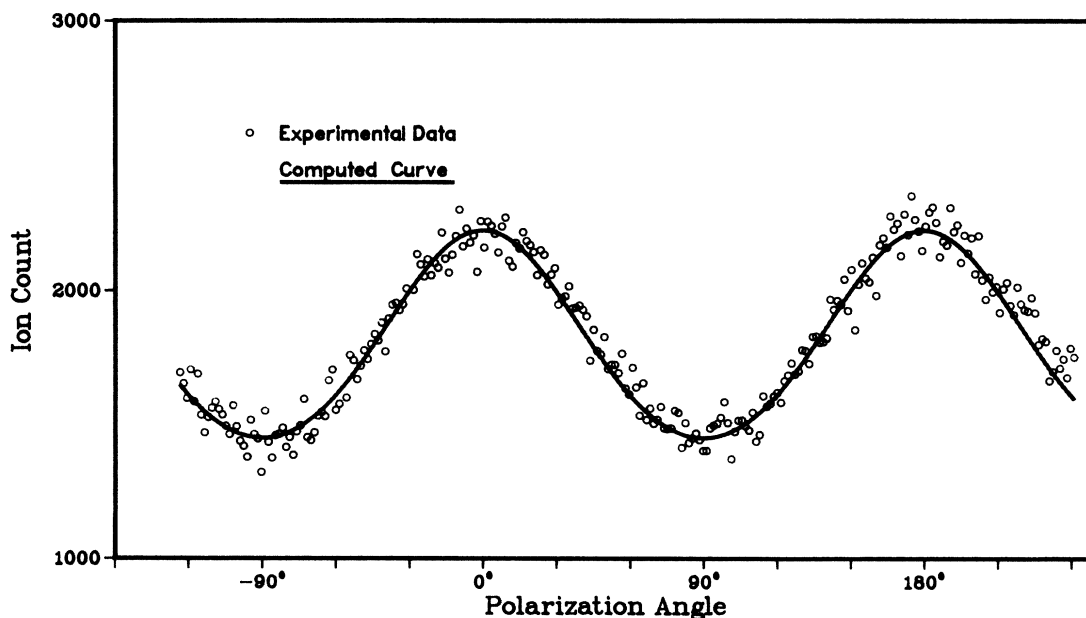

FIG. 1. A data set of Na_2^+ as a function of θ. The open circles represent the measured number of Na_2^+ ions; the solid line is our fit to those points using $k[1 + r_1\cos(2\theta) + r_2\cos(4\theta)]$, where k is a normalization constant, which is 1836 ions for this data set.