Comment on "Laser-Induced Continuum Structure in Xenon"

Hutchinson and Ness[1] have reported laser-induced structure in the continuum of Xe. Having performed detailed calculations, we find that their data and qualitative interpretation do not correspond to the theoretically expected structure.

Following their notation,[1] the process under consideration is depicted in Fig. 1(a) which contains, in addition, transitions (dashed lines) not included in Ref. 1. The most important of these additional transitions are the Raman coupling between the states $6p$ and $10p$, and the ionization of state $6p$ induced by laser ω_d. Contrary to the expectation in Ref. 1, the Raman coupling via the discrete states below the ionization threshold is as important as anything else in this problem, even though such discrete states are *not* near resonance.[2]

The problem involves three discrete states $5p^6(^1S_0)$, $5p^5 6p(^1S_0)$, and $5p^5 10p(^1S_0)$ and three continua. One of the transitions [see Fig. 1(a)] falls between the two fine-structure thresholds $[P_{3/2}]$ and $[P_{1/2}]$ (which bracket a series of autoionizing resonances), and plays a crucial role in this experiment.

To demonstrate the size of the difference between theory and experiment, we have plotted in Fig. 1(b) one set of the experimental data on the same scale with the theoretical prediction as a function of $\delta = E_a - E_b + \hbar\omega_1 - \hbar\omega_d$ for ω_1 fixed at $2\hbar\omega_1 = E_a - E_g$ as in the experiment. Since Ref. 1 does not provide any indication of the absolute value of the scanned frequency ω_d, we have chosen to identify our $\delta = 0$ with the center of what they have chosen to identify as the main feature of induced structure in the continuum. We have explored the entire range of intensities employed in the experiments without any appreciable effect on the discrepancy. Moreover, if we construct a q parameter by simply including only the paths assumed by Hutchinson and Ness[1] to be significant, and use their expression $(q+e)^2/(1+e^2)$, the resulting line shape looks neither like the data nor like our complete time-dependent theory [Fig. 1(b)] including all paths. ac Stark shifts were found negligible.

Pondering possible causes of the discrepancy, we note that the pressure of 5–10 Torr employed in the experiment implies a large percentage of ionization (65% to 70%) which at that pressure translates into 10^{17} charges per cm^3, with unknown complications on the process under consideration.

One possibility of qualitative reconciliation of theory with experiment would require that the main broad peak of the data be considered extraneous to the effect sought, and the theoretical minimum be identified with the shallow experimental minimum at $\delta \cong -23$ GHz. Reconciliation of the vertical scales and of the widths of the minima would still have to be addressed, a task best accomplished at low pressure (inherent in all theories of the effect, including Ref. 1), and with absolute wavelength calibration.

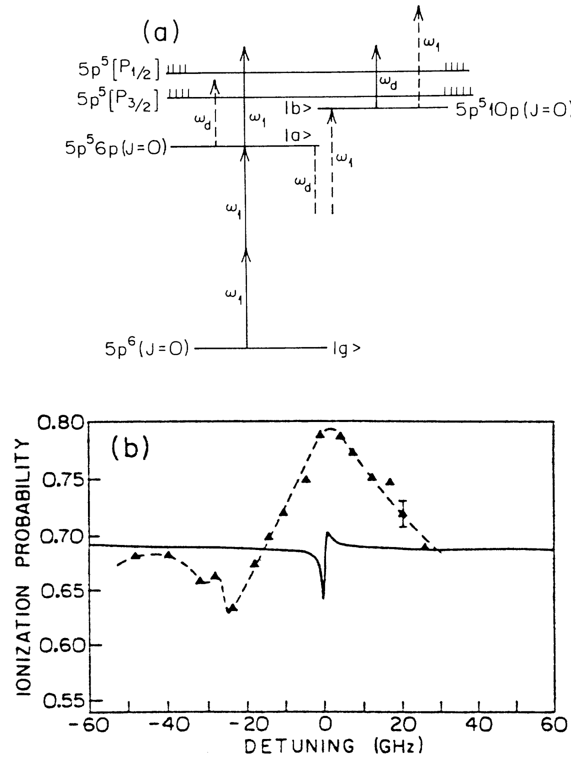

FIG. 1. (a) Schematic diagram of levels and transitions involved in the process. (b) Comparison of theory (solid line) with experimental data, at the intensities $I_1 = 30$ MW/cm^2, $I_d = 80$ MW/cm^2. Vertically, theory and experiment have been matched at the background. The published experimental data did not contain a horizontal or a vertical scale.

This work was supported in part by the National Science Foundation, under Grant No. PHY-83-06263 and in part by U.S. Department of Energy Grant No. DE-FG03-87ER60504.

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Received 26 May 1988
PACS numbers: 32.80.Rm, 32.80.Dz

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