Autoionizing Rydberg Series (*np'*, *nf'*) of Ar Investigated by Stepwise Excitations with Lasers and Synchrotron Radiation

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Resonant excitation by synchrotron radiation and subsequent ionization by a tunable laser is used to study the photoionization of even-parity states in noble gases. High resolution laser system was used to probe autoioning states of argon. By tuning synchrotron radiation, Ar was excited to Ar* resonance state, we further excite the Ar* to autoionzing states with a tunable laser within the wavelength region of 11800 ~ 13200 cm^{-1}.

The intermediate states are $3p^5_{1/2}\ 3d'[3/2]_1$, $5d'[3/2]_1$, $5s'[1/2]_1$, $7s'[1/2]_1$, $3p^5_{3/2}\ 6d[1/2]_1$, $6d[3/2]_1$, and $8s[3/2]_1$, and the ARS are $3p^5_{1/2}\ np'[1/2]_0$, $[1/2]_1$, $[3/2]_1$, $[3/2]_2$, and $nf'\ [5/2]_2$. With a specific intermediate state, the accessible states are very limited so that each ARS spectrum is simple and easy to identify up to very high *n* members, which are not yet well studied. In this experiment, excitation bands that are broader than atomic lines are observed. These bands are tentatively assigned to photodissociation of Ar_2^+ excited in high vibrational levels.

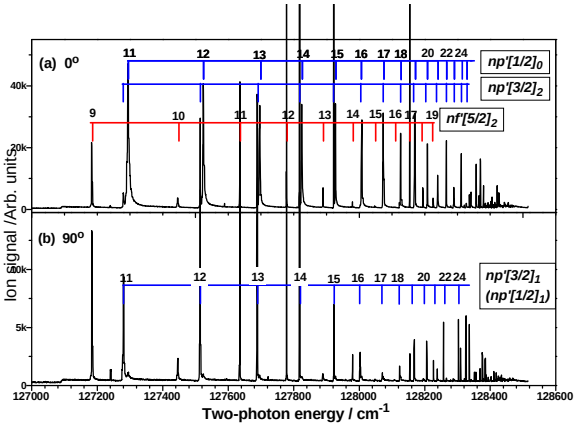

Figure 1. Two-photon ionization spectrum produced via $3p^5_{1/2}\ 5s'\ [1/2]_1$ intermediate state. The energy is a sum of Ti:S laser and the intermediate state . The polarization vectors of two light beams are parallel. The positions of autoionization Rydberg states, $3p^5_{1/2}\ np'\ [1/2]_0$, $3p^5_{1/2}\ np'\ [3/2]_2$ and $3p^5_{1/2}\ nf'\ [5/2]_2$, are indicated.

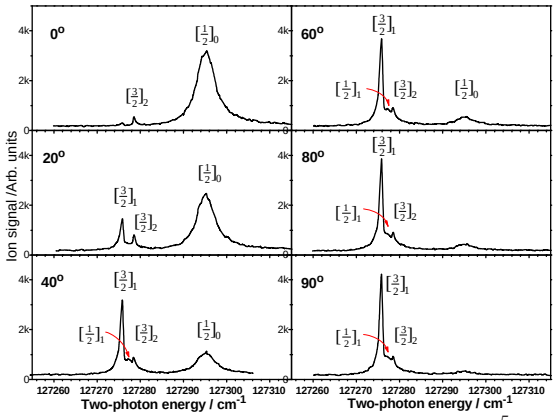

Figure 2. Two-photon ionization spectrum of $3p^5_{1/2}\ 11p'$ produced via $3p^5_{1/2}\ 3d'\ [3/2]_1$ intermediate state. The energy is a sum of Ti:S laser and intermediate state. The angles between the polarization vectors of two light beams vary from 0° to 90° as indicated.

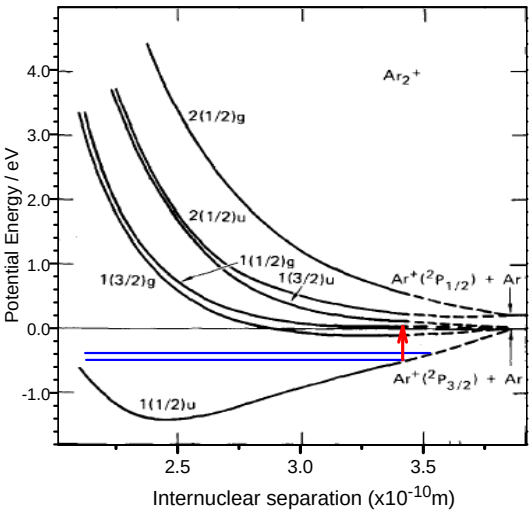

Figure 3. The proposed transitions for the highly-vibrational excited Ar_2^{+}* dimer. The potential curves are adopted from J.T. Moseley *et al*, Chem. Phys. **67**, 1659 (1978).