The formation of chemically bound argon via photoexcitation of Ar-I_2 van der Waals complex

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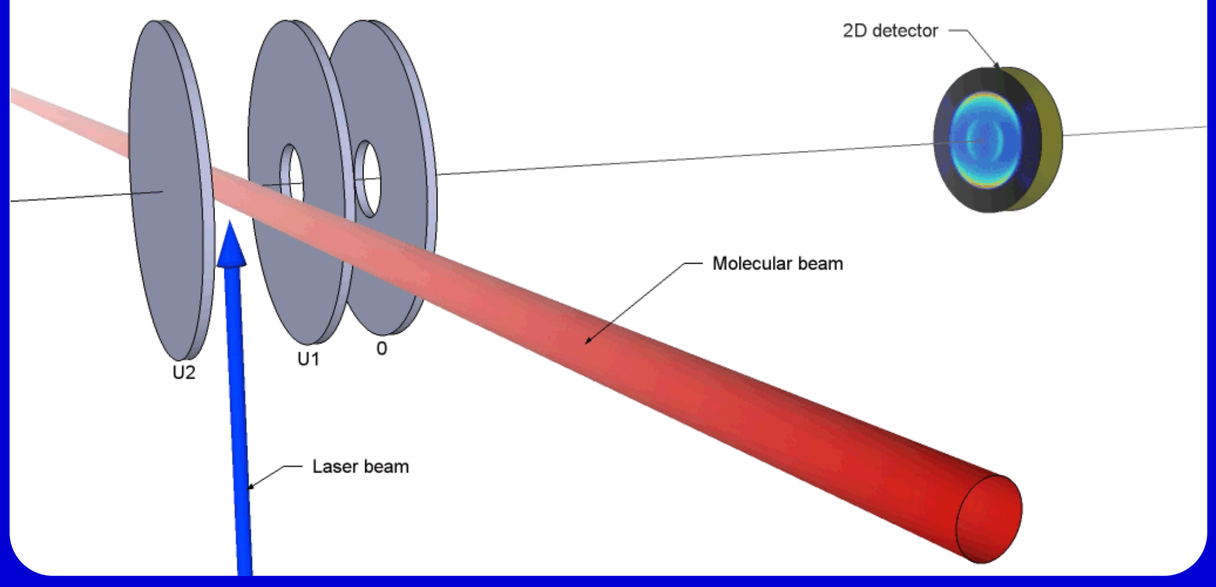
Introduction

Van der Waals complex Ar-I_2 is a model system for a study of the influence of weakly bonded molecular environment on the photochemistry and photophysics of molecules. Earlier studies of this complex reported in literature were focused only on processes including transition to the first excited states of iodine molecule. In the current work of the photo-induced processes following the excitation of the complex Ar-I_2 into high-lying Rydberg states and ion-pair states are investigated. Ar-I_2 van der Waals complex has been generated in supersonic molecular beam. Ions Ar^+ and ArI^+ were observed in a mass-spectrum at Ar-I_2 van der Waals complex photoexcitation by laser radiation with wavelength ~270 nm (hv≈4.6 eV). It should be noted that ionization potential of argon is 15.7 eV that requires four photons of radiation used. The four-photon ionization of free Ar atoms is not possible in our experimental condition (nanosecond laser with pulse energy about 1 mJ). Velocity map of Ar^+ (see fig. 1) have rings as in case of diatomic molecule dissociation. It means that Ar^+ is formed from photodissociation of parent ArI^+ ion where argon ion is covalently bound. The photon energy dependence of the channels giving rise to Ar^+ ions with different kinetic energy has been also investigated. The mechanism of covalently bound Ar^+ ions formation is suggested.

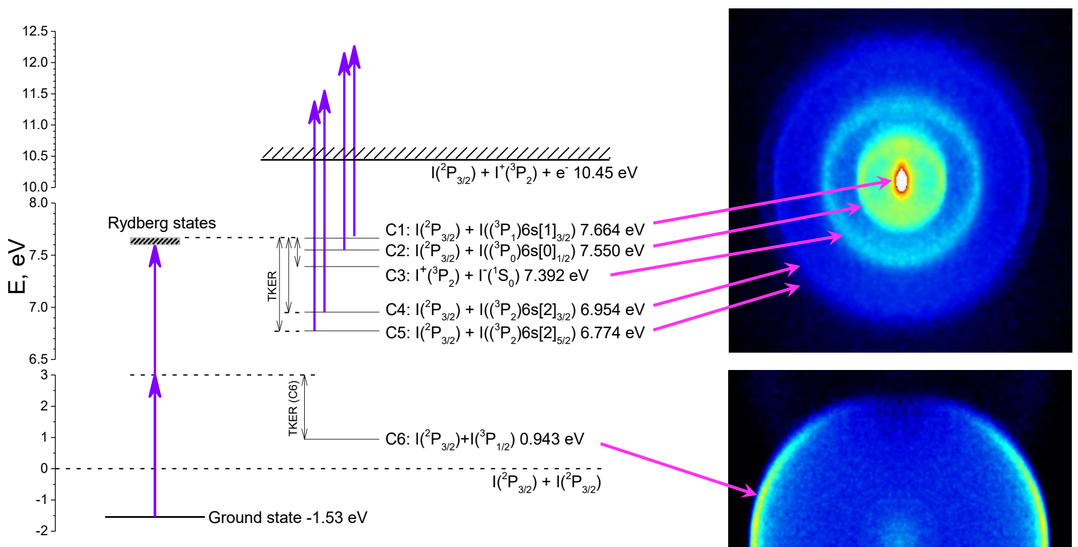
A.S. Bogomolov, N.V. Dozmorov, S.A. Kochubei, A.V. Baklanov, J. Chem. Phys. 155, 124308 (2021)

Experimental setup

1. Formation of cold molecules or van der Waals complex in supersonic molecular beam
2. Photoexcitation of van der Waals complex
3. Velocity map imaging technique (VMI) was used for ions registration

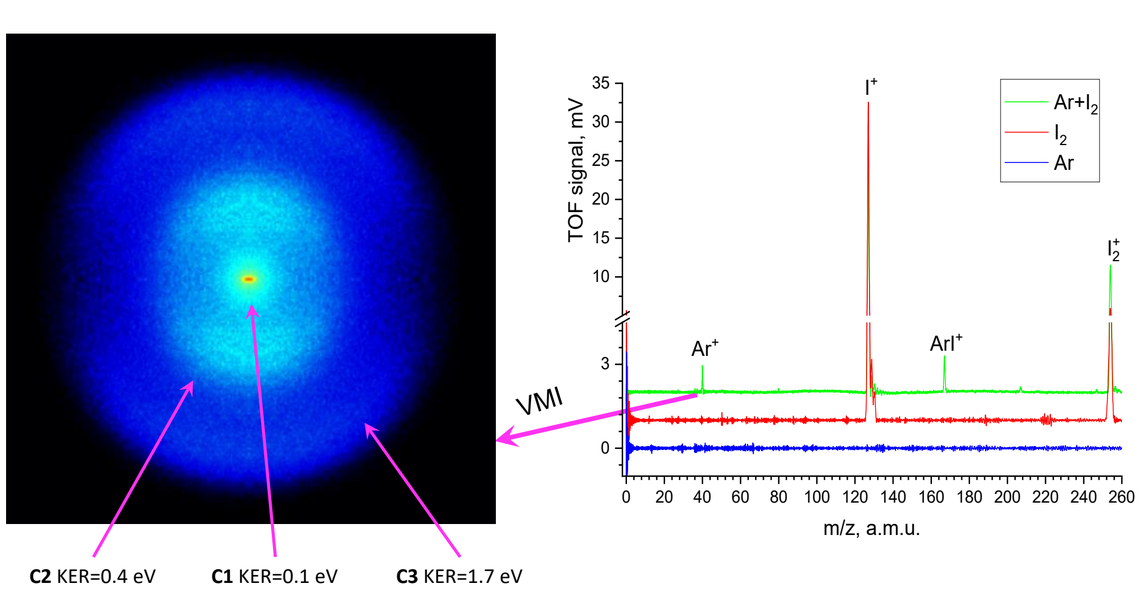


Isolated iodine molecule photodissociation



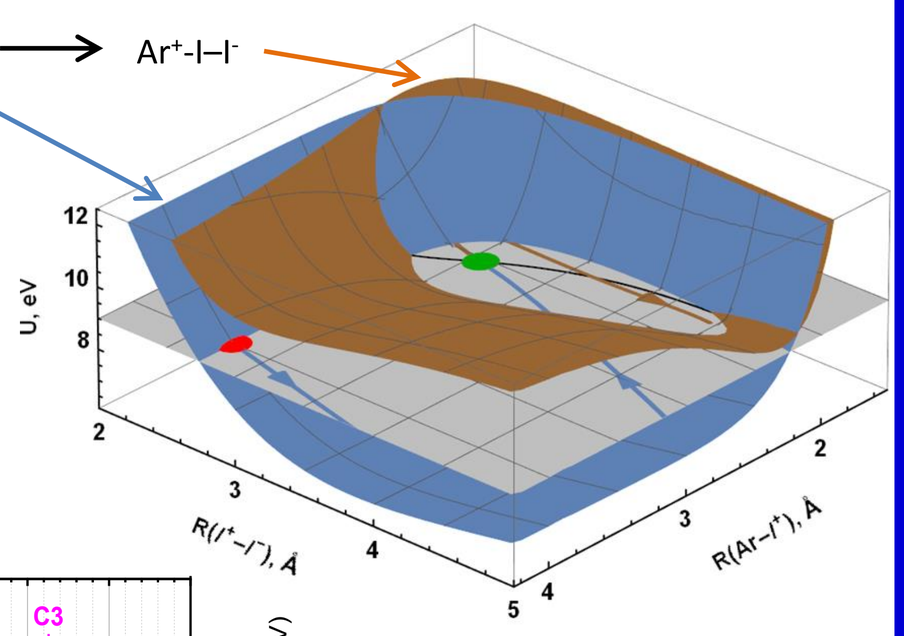
[2] A.S. Bogomolov, B. Gruener, S.A. Kochubei, M. Mudrich, A.V. Baklanov, *J. Chem. Phys.* **140**, 124311 (2014)

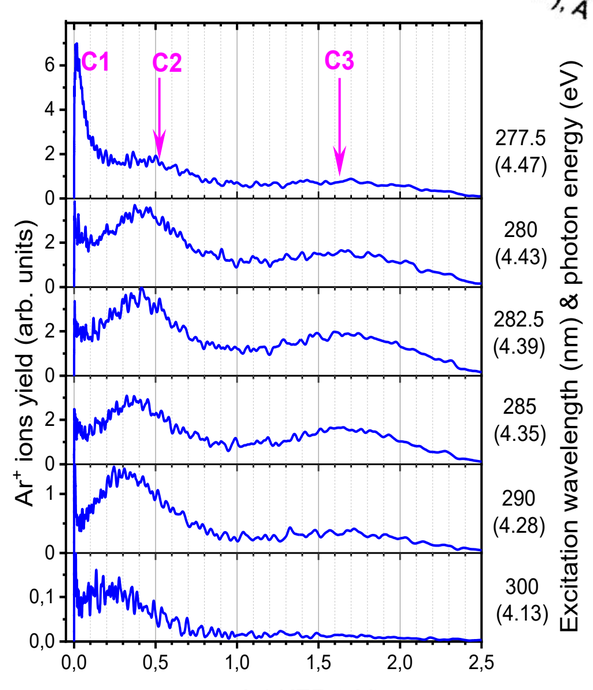
Results and discussion

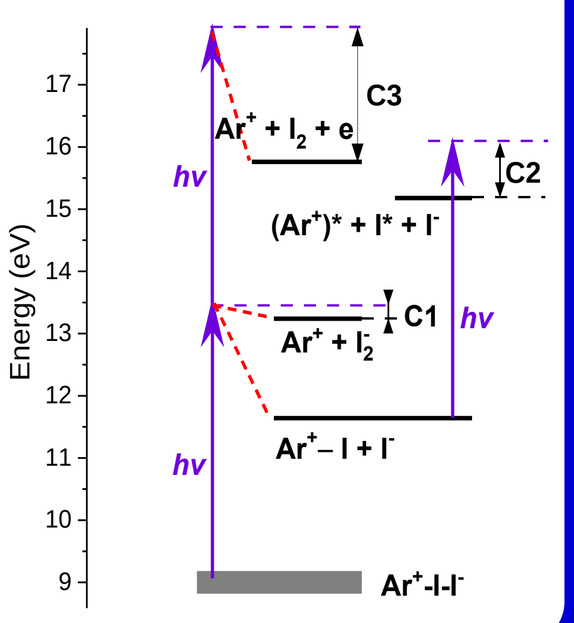


I_2-Ar + 2*hv* ⟶ Ar – I^+–I^-

Ar – I^+–I^- ⟶ Ar^+-I–I^-







Conclusions

- We observed the formation of Ar^+ ions with high kinetic energy at the Ar–I_2 complex photodissociation
- The Ar^+-I–I^- intermediate are formed as a result of Ar–I_2 photoexcitation
- Photochemistry of Ar^+-I–I^- is similar with photochemistry of isoelectronic ion $(Cl\text{-}I\text{-}I)^-$
- The obtained results are promising approach to production of noble gas compounds

Acknowledgments

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