High-resolution spectroscopy of the ground and low-lying excited states of $MgNe^+$ and $MgXe^+$

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Diatomic molecules RgM consisting of a rare-gas atom Rg and an alkaline-earth-metal atom M and their singly and doubly-charged cations RgM^+ and RgM^{2+} have unusual chemical properties related to the low first and second ionization energies of M and the high ionization energy of Rg. The second ionization energy of Mg is lower than the first ionization energy of Ar. Consequently, $MgAr^{2+}$ is thermodynamically stable and Rydberg series of $MgAr^+$ can be observed that converge on the $X^{2+}\ ^1\Sigma^+$ ground state of $MgAr^{2+}$ [1]. Similar behavior is expected in MgNe because of the even higher first ionization energy of Ne. In MgKr and MgXe, however, the second ionization energy of Mg is higher than the first ionization energy of the rare gas, and $MgKr^{2+}$ and $MgXe^{2+}$ are predicted to be metastable. In this contribution, we focus on the two extreme cases MgNe and MgXe. We present the results of spectroscopic investigations of $MgNe^+$ and $MgXe^+$ in their ground and low-lying electronically excited states that extend earlier studies of these cations [2,3].

PFI-ZEKE photoelectron spectra of the $X\ ^2\Sigma^+$ ground state were recorded from the a $^3\Pi_0$ metastable state. Spectra of the lowest vibrational levels of $MgNe^+$ and $MgXe^+$ enabled the determination of the adiabatic ionization energy of metastable MgNe and MgXe. With a resonant two-photon (1 + 1′) excitation scheme, the PFI-ZEKE photoelectron spectrum of the $X\ ^2\Sigma^+$ state starting from the $X\ ^1\Sigma^+$ ground state of MgNe was recorded as well, giving access to the adiabatic ionization energy of the neutral ground state and the lowest singlet-triplet interval in the neutral molecule. Using isolated-core multiphoton Rydberg dissociation spectroscopy [4], transitions to electronically excited states of $MgNe^+$ and $MgXe^+$ were observed that are associated with the Rg + Mg^+ (3p) dissociation limit. These states are the lowest members of Rydberg series converging on the ground state of $MgNe^{2+}$ and $MgXe^{2+}$. These studies represent the first steps towards studying the doubly charged cations $MgNe^{2+}$ and $MgXe^{2+}$.

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