SPECTROSCOPIC STUDIES OF ALUMINUM MONOFLUORIDE WITH RELEVANCE FOR LASER COOLING AND TRAPPING

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Aluminum monofluoride (AlF) is an excellent candidate for laser cooling on any Q-line of the $A^1\Pi$ - $X^1\Sigma$ transition and trapping at high densities.[a]

In preparation for cooling and manipulation experiments, it is necessary to know the detailed energy structure of the involved states, as well as their lifetimes, dipole moments and the Franck-Condon factors of their transitions.

The metastable $a^3\Pi$ state is the ideal starting point for extensive spectroscopic investigations. Therefo re, this presentation will focus on the $a^3\Pi \leftarrow X^1\Sigma^+$ transition. The energy levels in the $X^1\Sigma^+, v'' = 0$ state and within each Ω manifold of the $a^3\Pi, v' = 0$ state were determined with a relative accuracy of a few kHz, using laser-radio-frequency multiple resonance and ionization detection schemes in a jet-cooled, pulsed molecular beam. All spectroscopic parameters relevant for describing the rotational and hyperfine structure were determined by fitting the eigenvalues of the molecular Hamiltonian to the data.

With this knowledge, the measured hyperfine structure in the $A^1\Pi$ state could be assigned. The dipole moments of the $X^1\Sigma^+$, $A^1\Pi$ and $a^3\Pi$ states were determined by recording cw excitation spectra in electric fields up to 150 kV/cm.

The $A^1\Pi$ - $a^3\Pi$ band was observed for the first time. Measurements on the transition strength showed that it is no significant loss channel for the $A^1\Pi$ - $X^1\Sigma$ laser cooling transition.

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[a] Truppe et al., Phys. Rev. A 100, 052513 (2019)