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Towards laser cooling and trapping of aluminium monofluoride with high density STEFAN TRUPPE, SILVIO MARX, SEBASTIAN KRAY, MAXIMILIAN DOPPELBAUER, SIMON HOFSAESS, H. CHRISTIAN SCHEWE, Fritz Haber Institute of the Max Planck Society, BORIS SARTAKOV, General Physics Institute, Russian Academy of Sciences, GERARD MEIJER, Fritz Haber Institute of the Max Planck Society — The aluminum monofluoride molecule (AlF) is an excellent candidate for laser cooling and magneto-optical trapping. All Q-lines of the $A^1\Pi, v' = 0 \leftarrow X^1\Sigma^+, v'' = 0$ band near 227.5 nm are rotationally closed and can be used for laser cooling. With a calculated Franck-Condon factor of 0.99992, each molecule can scatter on average 10^4 photons from a single laser. This corresponds to a velocity change of 382 m/s, sufficient to slow a cryogenic buffer gas or a supersonic molecular beam. AlF is a closed shell molecule with a binding energy of 7 eV and the $A^1\Pi, v = 0$ state has a lifetime of 1.9 ns. This permits efficient production and slowing of the molecules and results in a large capture velocity of the magneto-optical trap (> 50 m/s), an excellent basis to trap AlF molecules with high density. We present spectroscopic results necessary for laser cooling and trapping experiments. We determine the rotational and hyperfine energy levels in $X^1\Sigma^+, v = 0$ and $a^3\Pi, v = 0$ with kHz and in $A^1\Pi, v = 0$ with MHz accuracy and infer precise spectroscopic constants for all three states. We determine the transition strengths between these states, measure their magnetic g-factors, their electric dipole moments and the lifetime of the $A^1\Pi, v = 0$ state.

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