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Laser Cooling of Molecules and Atoms in the deep-UV Spectral Range

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Ultracold polar molecules promise many new applications in fundamental physics and chemistry. In particular, aluminium monofluoride (AlF) is a promising candidate for preparing a dense, ultracold gas by direct laser cooling. AlF can be produced very efficiently in a bright, pulsed cryogenic buffer gas molecular beam[1]. A strong optical cycling transition in the deep UV ($A^1\Pi \leftarrow X^1\Sigma^+$, λ = 228 nm) allows molecules to be stopped within a few cm [2]. This is the first step to bringing the molecules into the ultracold regime in a magneto-optical trap (MOT). We use cadmium (Cd) atoms to characterize our setup. Cd shares many properties with the more complex case of AlF, making it an excellent dummy system. Cd has a strong cooling transition ($^1P_1 \leftarrow {}^1S_0$, λ = 229 nm) and weak intercombination lines that can be used for narrow line cooling, precision spectroscopy, and metrology – ideal for sensitive searches for BSM physics.[3, 4]

References

[1] S C Wright, M Doppelbauer, S Hofsäss, H C Schewe, B Sartakov, G Meijer, and S Truppe. Cryogenic buffer gas beams of AlF, CaF, MgF, YbF, Al, Ca, Yb and NO – a comparison. *arXiv 10.48550/ARXIV.2209.06564*, 2022.

[2] S Hofsäss, M Doppelbauer, S C Wright, S Kray, B G Sartakov, J Pérez-Ríos, G Meijer, and S Truppe. Optical cycling of AlF molecules. *New Journal of Physics*, 23(7):075001, June 2021.

[3] B Ohayon, S Hofsäss, J E Padilla-Castillo, S C Wright, G Meijer, S Truppe, K Gibble, and B K Sahoo. Isotope shifts in cadmium as a sensitive probe for physics beyond the standard model. *arXiv 10.48550/ARXIV.2208.13599*, 2022.

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