Towards a molecular MOT of YbF

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The magneto-optical trap has been a powerful tool for producing ultracold atoms for a huge variety of applications. Magneto-optical trapping of molecules is new and is important for many applications including precision measurement, quantum simulation, quantum information processing and ultracold chemistry. Recently, such a molecular MOT has been demonstrated [1].

The molecular species, ytterbium fluoride (YbF) has been used to measure the electron's electric dipole moment (eEDM) [2]. Laser cooling of YbF is feasible by addressing the set of transitions illustrated in Fig. 2 [3]. We are building an experiment where YbF molecules will be captured and cooled to low temperatures in a MOT, and then launched into a fountain [4], as illustrated in Fig. 1. This fountain apparatus will greatly lengthen the transit time of the molecules through the eEDM experiment, which will allow us to make a new eEDM measurement with increased precision over the best previous measurement [5].

We will present our scheme for the YbF MOT, our work towards building the laser system and molecular source, and first results towards laser cooling of this molecule.

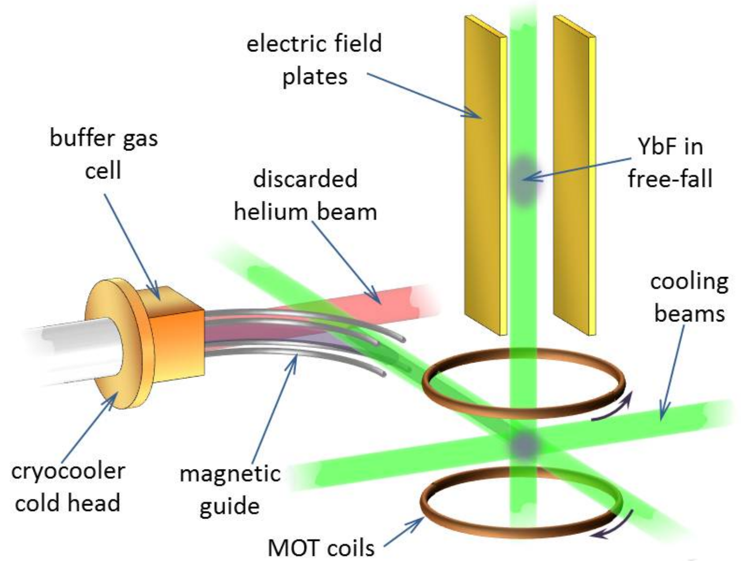

Figure 1: *Schematic of the experimental design. YbF molecules are produced in a thermal beam from a cryogenic buffer gas source; the molecules are cooled by collisions with helium at 4 K. The YbF is deflected out of the beam and is brought to rest in a MOT. Trapped molecules are then launched upward to form a fountain in which the eEDM is measured.*

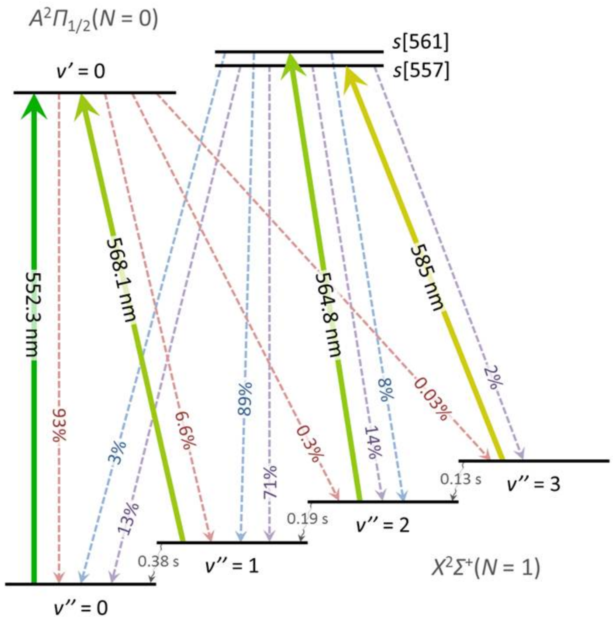

Figure 2: *The molecular transitions we use for laser cooling and the required wavelengths of the cooling lasers. v'' and v' are the vibrational quantum numbers of the ground and excited states respectively. Franck-Condon factors are given as percentages. The linewidth of the $v' = 0$ state is 5.7 MHz.*

References

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[4] M. Tarbutt *et al.*, New J. Phys. **15** 05034 (2013)
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