

# Intense molecular beams to test fundamental physics

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Advances in the production and cooling of molecules have given an impetus to the search for the electric dipole moment (EDM) of the electron in the past decade (see Table 1). This has enabled the testing of beyond the Standard Model (BSM) theories upto an energy scale of 1 TeV [1]. Future experiments hold potential to test BSM theories at even higher energy scales.

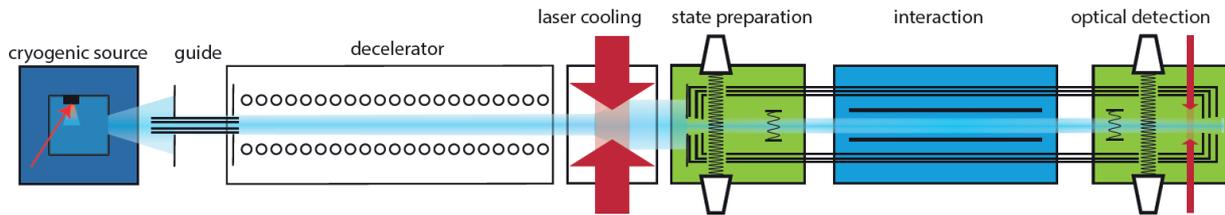


Fig. 1: Planned setup for the electron EDM search using a BaF molecular beam

Our group is starting an experiment [2] to measure the electric dipole moment (EDM) of the electron using a cold, slow and intense barium fluoride molecular beam, the experimental layout is depicted in Fig. 1. We plan to Stark decelerate and laser cool the cryogenic barium fluoride molecular beam. The molecule will be prepared in a superposition of two hyperfine states and be made to interact with an electric field inside the interaction zone. The two hyperfine states develop a phase difference which is directly proportional to the electron EDM.

Table 1: eEDM experiments; currently with the best upper bounds on the electron EDM

Molecule	eEDM upper bound (in e-cm)
ThO (Harvard/Yale University)	$8.7 \times 10^{-29}$ [1]
HfF <sup>+</sup> (JILA)	$1.3 \times 10^{-28}$ [3]
YbF (Imperial College)	$1.05 \times 10^{-28}$ [4]

I will present the work done on the first part of the experiment, which is the beam production. To start with, we are developing a cryogenic and supersonic molecular beam source. The beam from a cryogenic source is slower and denser compared to the beam from a supersonic source. The cryogenic source is under construction and will be coupled to the decelerator according to the planned setup. The supersonic source will be used to perform spectroscopy on barium fluoride molecules and to explore the best possible rotational states for laser cooling. We built a supersonic source which is a combination of pulsed even lavie valve [5] with laser ablation. I will present the optimization results on strontium fluoride molecules from this source.

To sum up, I will present the motivation for eEDM searches, details of our planned experiment and my own work in the construction and optimization of the supersonic source.

## References

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- [5] U. Even. *Pulsed Supersonic beams from high pressure source: Simulation results and Experimental Measurements*. Advances in Chemistry, vol. 2014 (2014), pp. 1-11

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