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Cryogenic Buffer Gas Cooling of Tungsten Carbide

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"The existence of a permanent electric dipole moment of the electron (eEDM) would violate time-reversal symmetry and suggest new physics beyond the Standard Model.
Recently, polar molecules have been widely used in eEDM research because they generate strong internal effective electric fields and can offer quantum states that help suppress systematic errors.
In particular, beam-based experiments such as ACME use polar molecules in high-flux molecular beams to probe the eEDM with high precision[1].

With such an approach in mind, we are exploring alternative molecular candidates that may further enhance sensitivity. One promising candidate is tungsten carbide (WC). In eEDM measurements, sensitivity improves with the strength of the internal effective electric field, the interaction time, and the number of detected molecules. WC offers a favorable combination of these factors.
Compared to ThO, which utilizes a metastable excited state, WC can be used in its ground state, enabling longer interaction times and improved statistical sensitivity[2]. Moreover, WC is non-radioactive, making it easier and safer to handle in experiments.

We are currently developing a cryogenic buffer gas beam source to produce WC. In this technique, molecules are generated via laser ablation and then cooled through collisions with a cryogenic rare gas, such as helium. Furthermore, achieving longer interaction times requires decelerating heavy polar molecules. To this end, we are exploring the use of centrifuge deceleration.

In this presentation, we report our progress in developing a cold WC beam, including the design of the source and detection method."

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