A Supersonic Gas Jet Seeded with Tungsten Atoms

J. Lee[1], R. Paudel[2], A. E. Leanhardt[1]

[1]*Department of Physics, University of Michigan, Ann Arbor, MI 48109, USA*
[2]*Department of Physics, Wabash College, Crawfordsville, IN 47933, USA*

We report on progress towards making a continuous tungsten carbide (WC) molecular beam for an electron electric dipole moment (EDM) search. WC has a $^3\Delta_1$ ground state with its two valance electrons in a $\sigma\delta$ molecular orbital configuration[1,2,3]. This molecular structure has been shown to have several unique advantages for an electron EDM search[4].
At present, we have successfully seeded a supersonic gas jet with tungsten atoms. A tungsten filament is resistively heated to over 3000 K in the presence of an argon buffer gas. The resulting W vapor is entrained in a supersonic jet formed by allowing the argon gas to flow through a conical nozzle into vacuum. At low argon pressures, we verify the presence of tungsten in the beam with a quadrupole mass spectrometer [Fig. 1(a)]. At high argon pressures, we directly observe the beam profile by allowing the Ar + W supersonic jet to sputter onto a copper foil placed downstream from a skimmer [Fig. 1(b)].

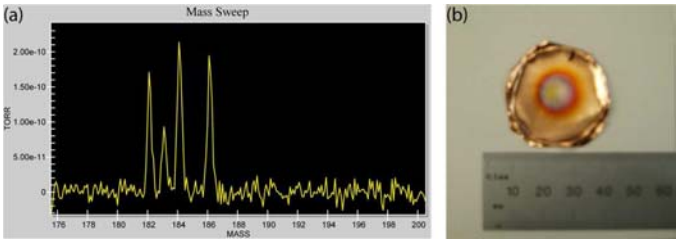

Figure 1: *Tungsten atomic beam diagnostics. (a) Quadrupole mass spectrum of W isotopes evaporated from a filament. (b) Ar + W supersonic beam sputtered onto a copper foil placed* ~ 25 *cm downstream from a* 3 *mm diameter skimmer.*

Future work will focus on optical spectroscopy of metastable argon and tungsten atoms in the jet. Additionally, we plan to add a small fraction of methane to the carrier gas and search for tungsten carbide molecules formed through the reaction $W + CH_4 \rightarrow WC + 2H_2$, which has been observed previously[3].

[1]X. Li, S.S. Liu, W. Chen, and L.-S. Wang, J. Chem. Phys. **111**, 2464 (1999).
[2]K. Balasubramanian, J. Chem. Phys. **112**, 7425 (2000).
[3]S.M. Sickafoose, A.W. Smith, and M.D. Morse, J. Chem. Phys. **116**, 993 (2002).
[4]E.R. Meyer, J.L. Bohn, and M.P. Deskevich, Phys. Rev. A **73**, 062108 (2006).