ZEEMAN SPECTROSCOPY OF LASER-ABLATED VO IN A MAGNETIC TRAPPING FIELD AT SUBKELVIN TEMPERATURES

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Thermalization of laser-ablated atoms (such as Eu or Cr) with a cryogenically cooled He buffer gas has recently been established as an effective technique for loading traps.[a] Here we report preliminary results obtained by applying this technique to a molecule, VO. The work introduces a new approach to measuring high-resolution spectra (due to the low, cryogenic temperatures) of unstable species (prepared by laser ablation).

The VO($^4\Sigma^-$) molecules are produced by YAG pulses (20 mJ, 7 ns, 532 nm) impinging on a compacted and thermally processed sample of V_2O_3 placed in a cryogenic cell ($<$1 K) surrounded by a quadrupole magnetic trapping field; the cell is in thermal contact with a dilution refrigerator. Once produced, the VO diffuses through the ^{3}He buffer gas and undergoes collisional relaxation, both translationally and internally. The VO molecules are detected within the $C^4\Sigma^-$-$X^4\Sigma^-$ band at 571 nm either by laser absorption or laser-induced fluorescence spectroscopy. The field free spectra were used to determine both the translational and rotational temperatures; these were found to be the same, equal to about 1 K. The spectra were measured at each frequency of the probe laser as a function of time (time profiles). From the spectra taken at different delay times we conclude that the thermalization with the buffer gas occurs within 20 ms after the ablation pulse. The rate at which the VO molecules disappear from the cell is an order of magnitude faster than for the atoms. Among the plausible loss mechanisms seem to be chemical reactions of the VO molecules with other molecules in the trap or sticking of the VO to the "dust." This is consistent with the observation that with the trapping field on, the decay rate of VO remains the same. The inhomogeneous magnetic broadening was largely reduced to the underlying magnetic shift by using a CCD camera to image the spatial distribution of the VO molecules. Considerable information about the g factors and hyperfine relaxation can be gathered from this type of spatially resolved Zeeman spectroscopy.

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[a] J. Kim *et al.*, Phys. Rev. Lett. 78, 3665 (1997).