# Collisional Effects on Calcium Spectroscopy in Hollow Cathode Discharges

R.L. Cavasso-Filho, A. Mirage[1], F.C. Cruz, A. Scalabrin, and D. Pereira

*Instituto de Física Gleb Wataghin, UNICAMP*
*CP 6165, Campinas, SP, 13083-970*
*Tel 055 19 7885406, Fax 055 19 7885427*
*E-mail: cavasso@ifi.unicamp.br, Website: http://www.ifi.unicamp.br/~flavio*
[1] *Instituto de Pesquisas Energéticas e Nucleares- CNEN*
*São Paulo, SP, 05499*

Calcium is an attractive element for high-resolution and precision spectroscopy. A strong dipole-allowed 1S0-1P1 transition, at 423 nm, can be used for laser cooling and trapping of this element. The 1S0-3P1 intercombination transition at 657 nm, with a Q of $10^{12}$, is very suitable for the development of a compact and transportable optical frequency standard, which could use thermal or cold atoms. In addition, this narrow optical transition has been used for atomic interferometry and precision measurements. In this work, we investigate the use of homemade Calcium hollow cathode lamps as auxiliary tools in laser cooling and trapping experiments, and for general use in high resolution and precision spectroscopy. The population of basically all excited levels by the discharge and the hollow cathode configuration are suitable for spectroscopy with several sub-Doppler techniques. In addition, optogalvanic detection provides a high sensitivity technique to probe weak transitions. Fluorescence spectra taken in our lamp, which uses Argon as buffer gas, from 400 to 800 nm have shown that Calcium is very efficiently produced by sputtering in the discharge. We have obtained optogalvanic spectra of Calcium transitions at 423 (cooling), 610, 612, 616, 645, 657 (clock) and 672 nm with Doppler and sub-Doppler resolution, using a standard saturation spectroscopy setup. In particular, the spectra with optogalvanic detection show good agreement with absorption spectra for the 423 nm resonant transition. Doppler linewidths on the order of 1.8 GHz were obtained. However the sub-Doppler spectra have a considerable amount of collisional broadening (from 500 MHz to 1 GHz) and are particularly affected by velocity changing collisions, which contribute with a Doppler pedestal to the homogeneous profile. For the resonant transition, we have recorded simultaneous spectra using the lamp and a Calcium atomic beam. For this, a laser beam at 423 nm was sent transversal to the atomic beam and the fluorescence at 423 nm was detected, giving first-order Doppler free as well as collision unaffected spectra. From this we have measured the collisional shift in the discharge for the Calcium resonant transition. An analysis of the collisional effects in all the spectra will be presented at the conference. Despite the advantage of the high sensitivity obtainable with optogalvanic detection, the measured spectral broadening and shifts, due to collisions in an electric discharge environment, put limits to the use of hollow cathode discharges for high resolution and precision spectroscopy.