aim of this experiment is to extract from the 2^3P hfs an improved value of the electric nuclear quadrupole moment of ^{7}Li which is now known to 15% [2, 3].

A traveling wavemeter has been built which measures the wavelength of a laser light source e.g. locked to an atomic transition, by comparison with the wavelength of an iodine stabilized HeNe laser. The wavemeter is placed in a vacuum tank and is equipped with an interference fringe drop-out control electronics which identifies and corrects for missing fringes. This is important for dye lasers which sometimes experience instantaneous instabilities. The interferometer reproduces the wavelength of the HeNe laser beam split into two counterpropagating beams in both counters with 1×10^{-8}.

The absolute wavelength of the $(2^3S_1-2^3P_0)$-transition was measured in $^6\mathrm{Li}^+$ and $^7\mathrm{Li}^+$ (see Table 2). The result for $^7\mathrm{Li}^+$ is in very good agreement with [4]. It thus provides an additional value for the Lamb shift of the $(2^3S_1-2^3P_0)$ line. The wavemeter measurement of the $2^3S_1(F=3/2-F=5/3)$ hfs splitting coincides (see Table 3) with the precise value obtained with laser microwave spectroscopy [5]. Also the isotope shift known from laser scan measurements was well reproduced.

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Observation of Optical Ramsey Fringes in the 10 µm Spectral Region Using a Supersonic Beam of SF_6

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PACS: 42.65, 07.65

Laser excitation of the vibrational energy of molecules in a beam can be conveniently detected with a cryogenic bolometer [1] and a demonstration of this technique in the case of the ν_3 mode of SF_6 excited by CO_2 or N_2O lasers has been recently given [2]. With this equipment the spatial analog of coherent transient effects such as the Rabi oscillations of the transition probability and the adiabatic rapid passage were shown to occur respectively with plane and curved wavefronts [2]. In an attempt to investigate the potential use of this method for very high resolution spectroscopy and optical frequency standards we have made a preliminary experiment to detect the Ramsey fringes associated with saturation spectroscopy in an interaction geometry comprising three or four field zones.

For this experiment we used the $P(4)\ F_1$ and E components of the ν_3 band of SF_6 which can be reached with a waveguide CO_2 laser oscillating on the $P(16)$ CO_2 line at 10.55 µm. To control the frequency of this laser we locked it, with a tunable frequency offset, to a conventional reference laser locked to the $Q(45)\ F_2^7$ SF_6 line. The beam from the waveguide laser was spatially filtered and magnified to have a waist of $w_0 = 6$ mm. In the case of illumination by this single beam the resulting width (FWHM) of the observed line was a combination of transit broadening and residual first-order Doppler effect along the optical axis and amounted to 300 kHz. We used the Rabi oscillation to set the laser beam waist precisely on the molecular beam [2]. Four oscillations of the signal could be observed with successive minima obtained for a total power of ~ 1, 4, 9, and 16 mW (Fig. 1).

To obtain Ramsey fringes, part of the laser beam was intercepted before the interaction region by a screen which transmitted the light only through 1 mm wide slits. Two different geometries were used in these experiments. In the first one, three equidistant standing waves were generated by three equidistant slits of 5 mm separation together with a corner cube placed on the other side of the molecular beam to retroreflect the light back through the slits. In the second geometry, only two of the previous slits were illuminated. An offset between the center of the slits and the center of the corner cube generated two counter-propagating sets of travelling waves with a 5 mm distance between adjacent co-propagating waves of each set. The spacing between the two sets can be arbitrary and was actually 10 mm in this experiment. Highly contrasted fringes have been obtained in both cases and as an example Fig. 2 displays the signal corresponding to the four travelling waves case.

A comparison is made between the observed fringe patterns and theoretical predictions from the perturbative approach [3] or

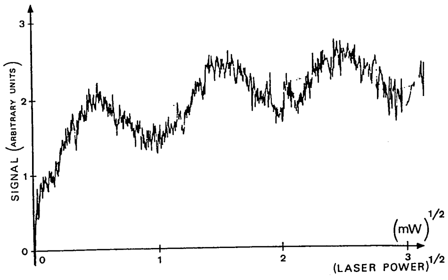

Fig. 1. Rabi oscillations of the bolometer signal as a function of the laser power with the laser locked to the $P(4)\ F_1$ line center

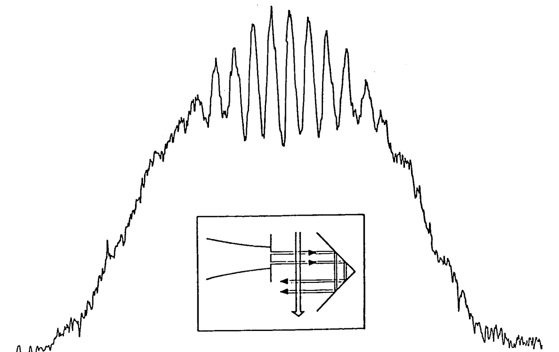

Fig. 2. Ramsey pattern obtained for the $P(4)\ F_1$ SF_6 line with four travelling waves (interaction geometry illustrated by the inset). The horizontal scale is linear in frequency and one fringe period corresponds to 92.5 kHz. The total laser power before the slits was 18 mW. The signal was recorded in a single one minute sweep with a 0.1 second time constant and a 30 Hz modulation frequency of the laser amplitude

from strong field theories using either numerical calculations [4] or the 2×2 matrix method outlined in [5].

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Observation of High Contrast, Ultranarrow Optical Ramsey Fringes in Saturated Absorption Utilizing Four Interaction Zones of Travelling Waves

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PACS: 42.65, 07.65

The attainable linewidth in high resolution laser spectroscopy is ultimately determined by the finite interaction time of the absorbing atoms or molecules with the exciting field. By applying Ramsey's method of separated oscillating fields this transittime broadening can be reduced substantially as well in linear [1] and saturated [2] absorption as in dopplerfree two-photon transitions [3].

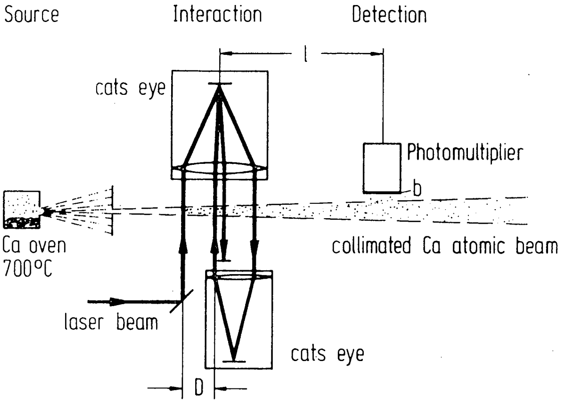

Fig. 1. Experimental setup for detection of Ramsey-fringes in saturated absorption

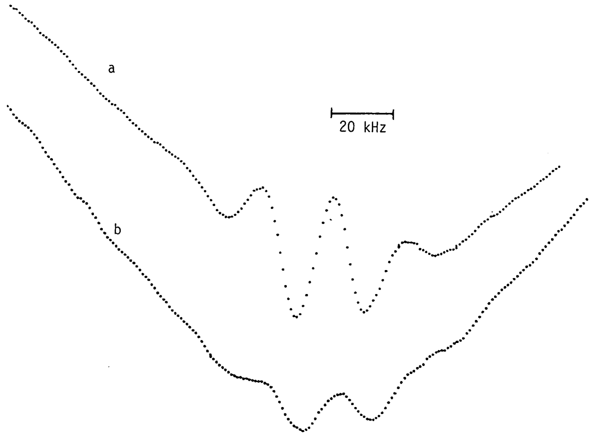

Fig. 2. Observed Ramsey Fringes. Curve *a*: Taken with two pairs of travelling waves (see Fig. 1). Curve *b*: Taken with the conventional setup of three standing waves

Ramsey fringes in saturated absorption – reported till now – were observed by utilizing either three equally spaced standing waves [4, 5], two pairs of standing waves [4], or sequentially a travelling wave, a standing wave, and a counterpropagating travelling wave [6].

We have observed for the first time optical Ramsey fringes by means of travelling waves, only. As a suitable transition we have chosen the $({}^3P_1 - {}^1S_0)$ intercombination line of ^{40}Ca in view of its narrow natural linewidth and its properties as a potential optical frequency standard [7].

In our experiment a collimated Ca atomic beam passes sequentially through two pairs each of equally spaced travelling waves with parallel but counterpropagating rays (Fig. 1). Automatic phase alignment was achieved by means of cat's eye retroreflectors [4]. The excited atoms are detected about one decay length downstream by monitoring the resonance fluorescence [8]. As was shown by Bergquist et al. [4] and in detail by Bordé [9], optical Ramsey fringes in saturated absorption arise from the following four sequential interaction processes: generation of coherence, generation of upper state population, generation of coherence, and generation of lower/upper state population. With our excitation configuration utilizing four running waves, these frou processes are clearly separated and no competition between the generation of coherence and the generation of state population can occur, resulting in a higher interference contrast of the Ramsey fringes.

Curve *a* in Fig. 2 shows a Ramsey pattern taken at a separation between two copropagating rays of $D = 1.75$ cm. This curve represents a superposition of two Ramsey resonances generated by the two recoil components of the saturated absorption. Curve *b* shows the corresponding feature observed with the conventional Ramsey setup utilizing three standing waves for the interaction. Note the increased fringe contrast of curve *a*. Each curve represents 40 sweeps at 60 ms per channel. A high resolution dye ring laser spectrometer was used. The frequency stabilization concept was similar to that described in [10]. The spectral width of the dye laser was 10 kHz to 20 kHz. The narrowest fringe width we have observed till now is 10 kHz at FWHM corresponding to a field separation of $2D = 5.4$ cm. Further experimental profiles – for example the $\Delta m = \pm 1$ crossover transition providing only one recoil component – will be investigated and compared to the theory of Bordé [9].

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