

FREQUENCIES OF cw FIR LASER LINES FROM
OPTICALLY PUMPED CH₂F₂

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The frequencies of 48 optically pumped cw FIR CH₂F₂ laser lines have been measured relative to stabilized CO₂ lasers. Uncertainties are estimated to be about 5 parts in 10⁷.

Key words: Difluoromethane, FIR frequency synthesis, laser frequency measurement, optically pumped FIR laser, stabilized CO₂ lasers, CH₂F₂.

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In this note, we report frequency measurements on the 48 previously reported (1-4) cw FIR laser lines from CH_2F_2 which were optically pumped by lines in the normal $9\ \mu\text{m}$ band of CO_2 .

The FIR radiation was generated in a 1 m Fabry-Perot cavity as described previously (4). The FIR frequencies, known approximately from wavelength measurements, were synthesized by two stabilized CO_2 lasers and an X-band klystron and mixed with the FIR radiation in a W-Ni point-contact-diode (5). The frequency of each CH_2F_2 laser line was set midway between the extinction point on the gain curve as determined by watching the beat note on a spectrum analyzer as the FIR cavity length was scanned. The width of the gain curve as determined in this manner varied from 3 to 26 MHz and the S/N ratio of the beat signal ranged from 10 to 40 db.

The measured frequencies for the CH_2F_2 FIR laser lines, identified by wavelengths and CO_2 pump lines, are given in Table I. The fractional frequency uncertainty of $\pm 5 \times 10^{-7}$ is an estimate of the reproducibility of the FIR laser frequencies in an optically pumped Fabry-Perot or waveguide cavity (6). No corrections have been applied for pressure, power, Stark, or other types of frequency shifts. Vacuum wavenumbers were calculated from the measured frequencies with $c = 299\,792\,458$ m/s (7). The CH_2F_2 pressure at which each frequency measurement was done corresponded to the maximum output power for that FIR line. Pressure measurements were made with a capacitance manometer.

CH_2F_2 is the most efficient optically pumped FIR laser molecule to date (4). Its many strong lines are certain to be useful in laser spectroscopy and other FIR applications. Precise knowledge of the frequencies of these laser lines will enhance their value in these applications.

Table I. Summary of the CH₂F₂ frequency measurements.

CH ₂ F ₂ Laser Line λ(μm)	Measured Frequency (MHz) (Uncertainty: $\frac{\Delta\nu}{\nu} = \pm 5 \times 10^{-7}$) ^a	Vacuum Wavenumber (cm ⁻¹) ^b	CH ₂ F ₂ Pressure Pa(mTorr) ^c	CO ₂ Pump Line (9.4 μm Band)
95.6	3 137 510.6	104.656 087	37(280)	R(12)
105.5	2 841 142.9	94.770 326	39(290)	P(16)
109.3	2 742 946.0	91.494 831	17(130)	P(24)
117.7	2 546 495.0	84.941 929	28(210)	R(20)
122.4655	2 447 974.6	81.655 645	17(130)	P(8)
122.4658	2 447 968.5	81.655 439	31(230)	R(22)'
134.0	2 237 296.4	74.631 512	31(230)	P(22)
135.3	2 216 263.5	73.926 593	17(130)	P(24)
158.5	1 891 274.3	63.086 120	15(110)	P(10)'
159.0	1 885 959.3	62.908 831	11(85)	P(20)
166.6	1 799 139.3	60.012 827	28(210)	R(20)
166.7	1 798 647.0	59.996 406	27(200)	R(22)'
184.3	1 626 602.6	54.257 623	13(100)	R(32)
191.8	1 562 655.9	52.124 591	27(200)	P(22)
193.9	1 546 083.4	51.571 792	9(70)	R(22)''
194.4	1 541 764.7	51.427 733	12(90)	R(12)
202.5	1 480 712.9	49.391 266	9(70)	R(6)
214.6	1 397 118.6	46.602 859	9(70)	R(34)
227.7	1 316 860.5	43.925 737	16(120)	P(18)
230.1	1 302 845.8	43.458 258	9(70)	R(42)
235.7	1 272 171.4	42.435 071	13(100)	R(32)
236.59	1 267 131.0	42.266 939	13(100)	R(6)
236.60	1 267 081.5	42.265 288	13(100)	R(6)
256.0	1 170 941.0	39.058 387	21(160)	P(24)
261.7	1 145 430.1	38.207 437	12(90)	P(38)
270.0	1 110 319.9	37.036 287	9(65)	R(22)''
272.3	1 100 806.7	36.718 958	10(75)	P(10)'
287.7	1 042 150.4	34.762 394	12(90)	R(34)
289.5	1 035 552.7	34.542 319	10(75)	P(4)
293.9	1 020 044.0	34.025 006	11(80)	P(20)
298.2	1 005 303.3	33.533 310	13(100)	R(36)'
326.4	918 417.0	30.635 092	11(80)	R(14)
355.1	844 185.9	28.159 009	16(120)	P(8)

382.0	784 806.0	26.178 312	13(100)	R(36)"
382.6	783 486.0	26.134 280	13(100)	P(10)"
394.7	759 543.3	25.335 638	10(75)	P(6)
418.3	716 743.3	23.907 982	11(80)	R(12)
435.0	689 255.1	22.991 074	9(65)	R(6)
464.4	645 530.9	21.532 594	9(70)	P(6)
503.1	595 941.7	19.878 475	5(40)	R(6)
511.4	586 167.4	19.552 438	9(70)	R(28)
541.0	554 159.0	18.484 755	9(65)	R(42)
567.5	528 239.2	17.620 164	9(70)	R(28)
588.0	509 827.2	17.006 005	8(60)	R(46)
642.6	466 530.5	15.561 783	7(50)	R(44)
657.2	456 139.1	15.215 162	9(70)	P(10)"
724.9	413 552.3	13.794 620	10(75)	P(4)
1 448.1	207 025.3	6.905 619	7(50)	R(44)

' and " indicate different CO₂ laser frequency offsets.

^aEstimated uncertainty in the reproducibility of the FIR laser frequency.

^bCalculated from the measured frequency with $c = 299\,792\,458$ m/s (7).

^cPressure at which each frequency was measured as determined by a capacitance manometer calibrated in Torr (1 Torr = 133.3 Pa).

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