

shown in Fig. 1 (Curve 4). Commercial samples showed an adultration of groundnut oil to the extent of 39%.

5. Groundnut Oil and Castor Oil

In this system, the velocity variation is 52 m/sec and the adultration of groundnut oil with castor oil can be detected to an accuracy of 2%. The velocity variation with percentage composition of Castor oil (adultrant) is shown in Fig. 1 (Curve 5).

6. Diesel Oil and Kerosene Oil

The graph of velocity variation with percentage composition of Kerosene is shown in Fig. 1 (Curve 6). This system gave a velocity variation of 66 m/sec. Adultration can be detected upto 2%. Commercial samples examined showed large scale adultration of kerosene in diesel oil to an extent of about 25% showing that one-fourth of Diesel is Kerosene oil.

7. Petrol and Kerosene

This system gave large variation of velocity to an extent of 120 m/sec. Due to this large variation, the presence of even small quantities (less than 1%) of Kerosene can be detected. Results are shown in Fig. 1 (Curve 7). Commercial samples obtained from different local petrol bunkers showed adultration of Kerosene in Petrol varying from 10 to 20%.

8. Groundnut Oil and Mineral Oil

This system showed a velocity variation of about 46 m/sec. Adultration of mineral oil upto 2% can be easily detected. Commercial samples showed large scale adultration of mineral oil to an extent of 30%. The results are shown in Fig. 1 (Curve 8).

9. Gingelly Oil and Mineral Oil

The results of this system are shown in Fig. 1 (Curve 9). This system gave a velocity variation of 26 m/sec. In this system accuracy with which the adultrant can be detected is 3% commercial samples showed large scale adultration of mineral oil upto 25%.

It is observed from the systems studied so far, except in the case of groundnut oil as adultrant in gingelly oil, all other systems have shown large variation of velocity, making precise velocity measurement, by ultrasonic interferometer, a powerful tool to study adultration. Interferometer method is known to give an accuracy of 1 in 1000 m/sec and hence adultration can be determined upto an accuracy of 1% in systems which show large variation of velocity (greater than 50 m/sec) between the two constituents. However, in the systems like groundnut oil in gingelly oil, where the velocity variation is very small, the accuracy of this method is very limited and the adultration can be determined only to an accuracy of about 5%. As accuracy of adultration depends on velocity variation, care must be taken in precise determination of velo-

city by this method. The only drawback of this method is that one can not pin down or identify the adultrant. But once the adultrant is known, it is easy to estimate the percentage composition of the adultrant. However to identify the adultrant, further experimentation is necessary.

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A → X BAND SYSTEM OF SrF

THE electronic spectra of the SrF molecule have been investigated by several workers¹⁻⁹. Seven electronic band systems of SrF have been observed in absorption and three of these in emission. Two of the band systems lie in the visible region and the remaining five in the U-V region.

The characteristic feature of the A → X band system of alkaline-earth halides is that the bands form long sequences. Johnson⁴ and Harvey⁹ photographed the A → X band system of SrF on a 21 ft. concave grating spectrograph in the first order. Recently, Domaille *et al.*⁷, used a cw dye laser to excite the B → X system

of SrF and have reported the molecular constants for these two electronic states. According to earlier workers¹⁻³, the electronic states involved in the A → X system are ²Π (upper state) and ²Σ⁺ (lower state). However, the ω_e values for the ground state (X ²Σ⁺) reported by Johnson², Fowler⁴ and Domaille *et al.*⁷, are 498.274, 500.1 and 502.4 cm⁻¹, respectively. This rather large variation has remained unexplained. The present study was undertaken for two purposes: to clarify the discrepancy in the vibrational constants and to record the spectrum on instruments of better resolution and dispersion so that the rotational structure of the more intense bands could be resolved right up to the origin and more accurate rotational constants could be determined.

By recording the emission spectrum of the A → X bands in the second order of a 35 ft. concave grating spectrograph (linear reciprocal dispersion — 0.33 Å/mm) we have succeeded in resolving the rotational structure of the (O, O) band right up to the origin. The rotational study results will be published separately. With more accurate measurements in the present case it was possible to obtain precise vibrational constants and these results are reported in this paper.

The emission spectrum of the A → X band system of SrF molecule was excited in a D.C. copper arc. The lower electrode was charged with spectral grade SrF₂ supplied by B.D.H. (London). The slit-width employed was 20 μ and iron arc lines were used as standards for measuring the band heads. The measurements are accurate to ± 0.05 cm⁻¹.

The bands are double-headed and are degraded towards shorter wavelength side. Only two sequences Δv = 0 and +1 have been observed in both sub-systems, ²Π_{3/2} → ²Σ⁺ and ²Π_{1/2} → ²Σ⁺. The Δv = +1 sequence forms head of the heads at 6394.87 Å and 6283.2 Å for Q₁₂ and Q₂ heads, whereas P₁₂ and P₂ heads do not form the head of the heads due to sharp decrease in intensity. In a similar way Δv = 0 sequence does not form the head of the heads.

The vibrational constants for the upper and lower states of the two sub-systems have been evaluated by using a least square fit. The band heads of the ²Π_{1/2} → ²Σ⁺ and ²Π_{3/2} → ²Σ⁺ transitions are represented by the following two equations, respectively:

$$\begin{aligned} \nu(v', v'') &= 15069.087 + 506.001 (v' + \frac{1}{2}) \\ &- 2.2638 (v' + \frac{1}{2})^2 + 0.008908 (v' + \frac{1}{2})^3 \\ &- 0.000107 (v' + \frac{1}{2})^4 - [498.175 (v'' + \frac{1}{2}) \\ &- 2.1409 (v'' + \frac{1}{2})^2 + 0.001268 (v'' + \frac{1}{2})^3 \\ &+ 0.000155 \times (v'' + \frac{1}{2})^4] \end{aligned} \quad (1)$$

$$\begin{aligned} \nu(v', v'') &= 15348.260 + 505.687 (v' + \frac{1}{2}) \\ &- 2.2238 (v' + \frac{1}{2})^2 + 0.002214 (v' + \frac{1}{2})^3 \\ &+ 0.000047 (v' + \frac{1}{2})^4 - [497.732 \\ &\times (v'' + \frac{1}{2}) - 2.1538 (v'' + \frac{1}{2})^2 \\ &+ 0.000527 (v'' + \frac{1}{2})^3 + 0.000113 \\ &\times (v'' + \frac{1}{2})^4]. \end{aligned} \quad (2)$$

These two equations reproduce the observed bands in the two sub-systems to within ± 0.2 cm⁻¹. It is seen from equations (1) and (2) that there is a slight difference of 0.44 cm⁻¹ between the ground state constants obtained from the two sub-systems. This is due to head-origin separations in various bands⁶. The vibrational constants are given in Table I. The reported ground state constants are the mean values of those derived for the two sub-systems.

TABLE I
Molecular constants of the A → X system of SrF

Con- stants	Upper State		Ground State
	A ² Π _{3/2} (cm ⁻¹)	A ² Π _{1/2} (cm ⁻¹)	X ² Σ ⁺ (cm ⁻¹)
ν _e	15348.260	15069.087	0
ω _e	505.687	506.001	497.953
ω _e x _e	2.2238	2.2638	2.1473
ω _e y _e	0.002214	0.008908	0.000898
ω _e z _e	0.000047	-0.000107	0.000134

Taking the B_v' values determined from the laser data⁸ and B_v'' values from microwave optical double resonance measurements⁹, we can calculate the head-origin separations for the Q heads of the (1, 0) and (1, 1) bands by the following relation:

$$\nu_Q - \nu_0 = \frac{1}{4} \left[B_0'' + \frac{B_0''^2}{(B_0'' - B_0')} \right] \quad (3)$$

From this one can determine the positions of the origin of the (1, 0) and (1, 1) bands. It is easy then to determine ω_e''. The value of ω_e'' thus calculated, from the band origins is 503.16 cm⁻¹ which compares favourably with the value 502.4 cm⁻¹ reported by Domaille *et al.*⁷.

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