

analysis, it is observed that uranium content in various plant species varies from 0.26 ppm to 15.0 ppm. Plant samples have been divided into three groups, viz., hydrophytes, mesophytes and xerophytes. There is maximum accumulation of uranium in hydrophytes which may be due to their capacity of fixing uranium from water. The uranium content in mesophytes and xerophytes is of the same order though much less than that in hydrophytes.

TABLE II
Uranium content in water

Source of water	Total number of tracks (T)*	Uranium Conc. (ppb)
Laboratory tap water	1.63×10^6	19.2
Manikaran hot springs	1.23×10^6	15.0
Deng hot springs	9.19×10^4	1.1

* Mean of 6 observations.

Nagpal *et al.*⁴ also find same relative order of uranium contents in the three ecological classes of plants, though the U values in the case of individual plants do not agree. The counting statistical errors in our results are less than 5%. However the track count variation in replicates of some plant samples goes upto 35% which is evidence of inhomogeneous distribution of uranium in plants.

The fission track analysis of water samples reveals maximum uranium content in laboratory tap water. This anomaly may be attributed to laboratory contamination such as radioactive dust due to storage of uraninite samples and needs further investigation. Manikaran water contains 15 ppb uranium and Deng water contains only 1.1 ppb. The depletion of uranium in hot water springs is probably due to the increased chemical reactivity of hot waters and the removal of uranium minerals early in the life of hot springs⁷.

Conclusions

1. Fission track technique can prove to be a valuable tool for botanical and hydrogeochemical prospecting of uranium.

2. It can also be used to detect radioactive pollution of our environment in the vicinity of U mining areas.

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MORSE FRANCK-CONDON FACTORS AND *r*-CENTROIDS FOR SOME WERNER BANDS OF H₂ AND D₂

MORSE FRANCK-CONDON factors for the Morse potential and *r*-centroids have been computed for 144 Werner bands of the astrophysically important H₂ and D₂ molecules using new rotational and vibrational constants. The value of $\Delta r \equiv r_{v'+1, v''+1} - r_{v', v''}$ in a sequence is found to remain constant. The Franck-Condon factors derived for the Morse potential may be used in conjunction with experimentally determined band oscillator strengths for five Werner bands (C-X system) of H₂ to derive radiative lifetimes which are inconsistent with the experimental lifetime measurements.

The growing interest of astronomy in the region of vacuum ultra-violet has led many workers to study the spectra of H₂ and D₂ which are in abundance in the interstellar space. Since new rotational and vibrational constants are available for the B²Σ_g⁺ and C¹Π_g states of H₂ and D₂, the study of Franck-Condon factors and related quantities are needed.

Neglecting the variation of electronic transition moment of the molecule with nuclear motion, the relative intensities of the bands of a system of diatomic molecule are largely governed by Franck-Condon factors given by the following expression (Herzberg¹):

$$q_{v'v''} = \left| \int \psi_{v'} \psi_{v''} dr \right|^2$$

where $\psi_{v'}$ and $\psi_{v''}$ are vibrational wave-functions of the upper and lower vibrational levels having quantum numbers *v'* and *v''* respectively. The analytical method of Fraser and Jarman² with *r_e*-shift correction has been employed for the evaluation of Franck-Condon factors of the Werner bands of H₂ and D₂. The experimental molecular parameters for the B²Σ_g⁺, C¹Π_g and X¹Σ_g⁺ states as reported by Herzberg and Howe³,

Bredohl and Herzberg¹ and Dabrowski and Herzberg⁵ have been used for the evaluation of Franck-Condon factors. Further, the approximation that R_e is independent of inter-nuclear separation has been found to be true between 0.6 Å and 1.6 Å by Schmorenzer and Geiger⁶.

where r is the inter-nuclear distance. The quadratic equation and graphical methods of Nicholls and Jarman⁷ have been used to determine the r -centroids of the Werner bands of H_2 and D_2 .

The property of Δr remaining constant in a sequence is exhibited by the bands of $\Delta v = 0$ sequence for the

Values of Franck Condon factors

System	Mol.	v''	0	1	2	3	4	5
		v'						
C-X	H_2		0.1993	0.2646	0.2070	0.1252	0.0650	0.0305
	D_2		0.0114	0.0369	0.0617	0.0574	0.1009	0.0992
B'-X	H_2	0	0.0800	0.1479	0.3243	0.1389	0.1037	0.0704
	D_2		0.0013	0.0053	0.0119	0.0196	0.0266	0.0310
C-X	H_2		0.3477	0.0320	0.0091	0.0840	0.1209	0.1061
	D_2		0.0674	0.0651	0.1305	0.0851	0.0358	0.0061
B'-X	H_2	1	0.2244	0.0803	0.0432	0.0008	0.0092	0.0263
	D_2		0.0127	0.0196	0.0613	0.0735	0.0724	0.0680
C-X	H_2		0.2696	0.0426	0.1488	0.0477	0.0001	0.0303
	D_2		0.1729	0.1476	0.0381	0.0001	0.0246	0.0516
B'-X	H_2	2	0.2899	0.0193	0.0293	0.0779	0.0649	0.0315
	D_2		0.0532	0.0010	0.1035	0.0719	0.1175	0.0125
C-X	H_2		0.1199	0.2326	0.2240	0.0488	0.1023	0.0452
	D_2		0.2530	0.0384	0.0174	0.0758	0.0619	0.0194
B'-X	H_2	3	0.2241	0.0435	0.1110	0.0357	0.0000	0.0156
	D_2		0.1308	0.1334	0.0555	0.0059	0.0027	0.0170
C-X	H_2		0.0334	0.2314	0.0683	0.1018	0.0000	0.0791
	D_2		0.2353	0.0127	0.1096	0.0373	0.0028	0.0587
B'-X	H_2	4	0.1131	0.0021	0.0321	0.0166	0.0480	0.0068
	D_2		0.2102	0.0701	0.0000	0.0304	0.0505	0.0370
C-X	H_2		0.0060	0.1071	0.0092	0.0033	0.0251	0.0215
	D_2		0.1463	0.1377	0.0571	0.0064	0.0115	0.0237
B'-X	H_2	5	0.0391	0.2250	0.0112	0.1864	0.1101	0.0582
	D_2		0.2330	0.0011	0.0612	0.0742	0.0337	0.0130

The r -centroids ($r_{v',v''}$) of a $v' \rightarrow v''$ transition in a diatomic molecular band system has been defined by Nicholls and Jarman⁷ by the following expression:

$$r_{v',v''} = \frac{\int \psi_{v'} r \psi_{v''} dr}{\int \psi_{v'} \psi_{v''} dr}$$

r -centroid values calculated by quadratic equation method (Jarman *et al.*⁸) which are given below. There is close agreement between the values of r -centroids obtained by graphical and quadratic equation methods.

Values of r-centroids

System	Mol.	v''	0	1	2	3	4	5
		v'						
C-X	H ₂		0.770	0.715	0.659	0.601	0.550	0.445
	D ₂		1.072	1.043	1.018	0.993	0.970	0.945
B'-X	H ₂	0	0.798	0.755	0.712	0.680	0.647	0.618
	D ₂		1.105	1.083	1.055	1.047	1.032	1.017
C-X	H ₂		0.880	0.818	0.762	0.710	0.664	0.620
	D ₂		1.130	1.098	0.068	1.040	1.017	0.995
B'-X	H ₂	1	0.890	0.855	0.810	0.772	0.740	0.713
	D ₂		1.155	1.132	1.110	1.100	1.075	1.060
C-X	H ₂		0.990	0.929	0.865	0.809	0.762	0.720
	D ₂		1.190	1.125	1.099	1.065	1.040	1.025
B'-X	H ₂	2	0.980	0.941	0.890	0.862	0.830	0.801
	D ₂		1.207	1.182	1.160	1.140	1.120	1.105
C-X	H ₂		1.125	1.035	0.970	0.910	0.856	0.810
	D ₂		1.255	1.215	1.180	1.148	1.119	1.090
B'-X	H ₂	3	1.090	1.030	0.990	0.948	0.915	0.888
	D ₂		1.265	1.230	1.210	1.187	1.167	1.151
C-X	H ₂		1.285	1.172	1.080	1.011	0.957	0.910
	D ₂		1.335	1.280	1.238	1.203	1.172	1.142
B'-X	H ₂	4	1.220	1.150	1.090	1.040	1.000	0.974
	D ₂		1.330	1.280	1.265	1.237	1.215	1.197
C-X	H ₂		1.468	1.350	1.215	1.129	1.061	1.000
	D ₂		1.410	1.350	1.307	1.262	1.238	1.197
B'-X	H ₂	5	1.370	1.272	1.200	1.151	1.094	1.058
	D ₂		1.397	1.360	1.327	1.297	1.270	1.247

From the results given above, it has been observed that $\Delta r > 0.01 \text{ \AA}$ showing that the potentials involved in the two systems of both H₂ and D₂ are wide.

The band oscillator strength ($f_{v'v''}$) combined with the Franck-Condon factors for branching to lower states enables the computation of radiative life-times (Hesser⁹) from

$$\tau = \frac{1.5 q_{v'v''} v_{v'v''} g_1}{(\sum_v q_{vv''} v_{vv''}^3) f_{v'v''} g_2}$$

where g_1 and g_2 are degeneracies of the upper and lower states. Radiative lifetimes for $v = 1-5$ levels of C¹ π_u state of H₂ has been obtained using weighted mean Werner band oscillator strength obtained from Photo-electric absorption measurements by Fabian and Lewis¹⁰. It is evident that the theoretical lifetimes

v'	$f_{v'v''} \times 10^2$	Radiative lifetime in μ seconds	
		Theoretical	Experimental
0	0.6
1	5.92	2.44	0.6
2	6.42	2.18	0.6
3	4.42	1.28	0.6
4	3.17	0.53	..
5	2.24	0.39	..

do not agree with the experimental values. Even RKR Franck-Condon factors of the Werner bands (Spindler¹¹⁻¹³) are not in complete agreement with experimentally determined relative band strengths. Hence we conclude that in spite of the improved molecular parameters available for H_2 and D_2 , the inconsistency in the theoretical and experimental results of radiative lifetimes is due to the fact that the Werner band system is completely perturbed and the new equation cannot be fully applied.

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EXTRACTION PHOTOMETRIC DETERMINATION OF IRON(III) WITH SALICYLALDOXIME

EXTRACTION of iron(III) as salicylaldoximate complex into *n*-butanol was studied at pH 7. The red-orange iron(III) complex is measured at 410 nm. The colour of the organic phase is stable

for several weeks. The system obeyed Beer's law in the range 0–10 $\mu\text{gms/ml}$, with a standard deviation of 0.005. The molar absorptivity, Sandell sensitivity, the composition and stability constant of the extracted species are $3.3 \times 10^3 \text{ moles}^{-1} \text{ cm}^{-1} \text{ litre}$, $0.017 \mu\text{g cm}^{-2}$, 1:1 and 7.4×10^4 respectively. Mn(II), Zn(II), U(VI), Mo(VI) and Cu(II) do not interfere.

The colour reaction between the ferric iron and salicylaldoxime was reported by Ephraim¹ in as early as 1930. Howe and Mellon² employed the colour reaction for the direct photometric determination of iron. However uranium(VI), molybdenum(VI) and copper(II) interfere seriously in the determination³. A survey of literature revealed that no work except the casual mention by Gorbach and Pohl⁴ was reported on the extraction photometry of ferric iron with the oxime. The results of the photometric determination of iron with the oxime, in *n*-butanol are reported in this communication.

The extraction studies carried out in the pH range 1.0 to 9.0 showed that there was no extraction below pH 3 and quantitative extraction occurred in the pH range 6 to 8. pH 7 was selected for the determination of the metal since it is observed that at this pH, the absorbance of the organic phase showed the highest value at 410 nm. The absorbance is constant for several weeks. It is observed that the oxime is to be present in at least 20 fold excess.

Recommended Procedure

5 ml of 5% ammonium acetate (pH adjusted to 7) 1 ml of sodium perchlorate (1 M), 1 ml of oxime solution (10^{-1}M) and different aliquots of the iron(III) solution (10^{-3}M) are taken in a 25 ml separatory funnel. The above sequence of addition is essential for high colour intensity and reproducible results. The volume of the aqueous phase is maintained at 10 ml by adding distilled water. Ten ml of *n*-butanol is then added to the contents of the funnel and shaken well for five minutes. After equilibration, the organic layer is separated, dried over anhydrous sodium sulphate and the absorbance measured against solvent blank. The organic phase obtained in the extraction with the aqueous solution devoid of the metal ion was used as the solvent blank.

The linear plot obtained between the amount of the metal ion and the absorbance showed that iron can be determined by the present method accurately in the range 0–10 $\mu\text{gms/ml}$. The molar absorptivity (ϵ) and the Sandell sensitivity (S) at 410 nm are $3.3 \times 10^3 \text{ mole}^{-1} \text{ cm}^{-1} \text{ litre}$ and $0.017 \mu\text{g cm}^{-2}$ respectively. The standard deviation is 0.005. Manganese(II) (300 fold), zinc(II) (100 fold), uranium(VI) (30 fold), molybdenum(VI) (10 fold)