

ON THE STUDY OF ABSORPTION AND FLUORESCENCE SPECTRA OF SOME AROMATIC HYDROCARBONS IN SOLUTION

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ABSTRACT. Effects of the variations of wave-lengths of the exciting radiation on the fluorescence of some aromatic hydrocarbons have been studied. It has been found in all cases that the long wave-length limit of the exciting radiation is the longest wave-length of the absorption band of the material.

INTRODUCTION

There is up to the present time no satisfactory theory for fluorescence in solutions. According to Perrin (1918) emission of fluorescence by organic substances was due to flashes of exploded molecules. But the experimental results of Wood (1922) and Pringsheim (1922) were not capable of explanation by Perrin's hypothesis. Pringsheim suggests that molecules being excited by absorption of light energy may revert into the normal state with the emission of fluorescence. Hence fluorescence is defined as the reverse of light absorption, where absorbed light energy is re-emitted without causing any change in the structure of the absorbing system. Thus fluorescence and absorption are inter-related phenomena. If so, it is quite natural for one to ask—how are they related? Is there for each absorption band a corresponding fluorescence band or are all the fluorescence bands chained into one? Is it possible to isolate any fluorescence band from the remaining? What is the long wave-length limit of the exciting radiation for each substance? Is there any change of intensity of fluorescent light as we pass from one absorption band to another through non-absorbing interval? In order to understand the true mechanism of fluorescence and to find out the relation between absorption and fluorescence, particularly the influence of frequency of incident radiation the present work was undertaken and the paper describes the result so far obtained. Simple aromatic hydrocarbons are taken because they dissolve in organic liquids as neutral molecules.

They yield the same fluorescence bands in vapour, in solution and in the pure crystal, except for the small shifts of the bands, depending on the neighbours of the fluorescing molecules. The absorption as well as fluorescence spectra of some aromatic compounds have been studied by a number of workers particularly by Seshan (1936), Pringsheim (1939) and Sambursky and Wolfshn (I, 1940; II, 1942).

For studying fluorescence, usually ultra-violet radiations from a mercury arc are used for exciting light waves and fluorescence is observed by ordinary complimentary filters method. By this method we cannot study the properties

of an individual band and we do not get any information mentioned above. As the Hg arc emits only a few lines in its spectrum, only a few definite wave-lengths can be obtained from it, and so a continuous variation of wave-length is not possible. To avoid that difficulty we have used monochromatic light isolated by means of a slit from the spectrum of white light as our source.

EXPERIMENTS

The source of light is a coiled-coil gas filled lamp. Light is condensed by a condenser on to the slit of the spectrograph which is focussed properly. The spectrum is received on a screen with a movable slit. From the spectrum with the help of the movable slit, we take out any monochromatic beam as exciting radiation. The solution under examination is taken in a cell. The incident and the fluorescent rays are again condensed on the slit of another spectrograph. Time of exposure was the same all through. As the intensity of the incident beam depends on the current, through the lamp, it was carefully kept constant.

RESULTS

Anthracene, Naphthacene, Phenanthrene and Perylene were dissolved in alcohol and the solution was taken in a cell. By moving the slit radiations of different wave-lengths were allowed to be incident on the solution. Thus we pass from one wave absorption band to the other through non-absorbing interval. The results are summarised below :

(1) The positions and the number of fluorescence bands remain unchanged with the change of exciting radiation.

(2) The longest absorption band of each substance is its longest critical wave for exciting fluorescence. Light-wave longer than the longest absorption band of the substance cannot excite fluorescence.

(3) As the exciting radiation is changed from one absorption band to another through non-absorbing interval, the total intensity of fluorescence bands is also changed. Absorption band wave as incident radiation produces the maximum intensity of fluorescence.

Results are tabulated below :—

TABLE I

	Absorption bands in A	Fluorescence bands in A	Critical Exciting radiation in A
Anthracene	3750, 3550, 3380 & 3220	4500, 4240, 4000 & 3790	3750
Perylene	4250, 4000, 3790 & 3590	5000, 4700 & 4480	4250
Naphthacene	4680, 4380 & 4140	5460, 5080 & 4750	4680
Phenanthrene	3750, 3690, 3550 & 3460	4490, 4250, 4030 & 3850	3750

TABLE II

Solute	Solvent	Refractive Index	Longest absorption wave-length in A. U.	Critical exciting wave-length in A.U.
Naphthacene	acetone	1.359	4660	4660
	alcohol	1.362	4670	4670
	CCl ₄	1.465	4780	4780
	Solid solution in Anthracene.		4910	4910

In Table I are given the longer limit of wave-length for excitation of these substances in alcoholic solutions and also the positions of fluorescence and absorption spectra.

Table II gives the positions of the longer wave-length limit of absorption and of excitation of fluorescence of Naphthacene. This substance was studied in detail in solution. The absorption and fluorescence spectra of this substance were studied in different solvents and also the different critical exciting wave-lengths for them were determined.

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