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RESEARCH ARTICLE

Study of Linear Optical Properties of Acridine-orange Laser Dye

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Abstract

In this research, the linear optical properties and the effect of concentration of the solution on absorption spectra and fluorescence spectra of the acridine_orange dye. It was prepared three concentrations acridine_orange dye dissolved in ethanol (1*10^-3, 1*10^-4, 1*10^-5) M. It was measured spectroscopic properties of the dye solution and for all concentrations (absorption coefficient, refractive index, and fluorescence life-time and quantum yield of florescence level). The results showed that the linear absorption coefficient and linear- refractive index increase with solution concentration increasing and (life-time of fluorescence increases, quantum yield decreases) with solution concentration increasing.

Keywords: *Acridine_orange dye, linear optical properties, laser dye.*

Introduction

Dyes can be emitted in a part of the UV region, and near-infrared through visible light. It is tunable over wide range of wavelengths of incident, according to the type of dye, and because of the wide spectrum covered by the lasers, dye became the lead role an important and growing in different applications [1, 2]. A. Bergmann and others (2001), studying many types of lasers organic dye [3].In the year 1998, (Fredrik and his group) study of electrical and vibrational molecular levels to (C_{60}) practically and theoretically has been observed that there is a convergence in practical results and theory [4].

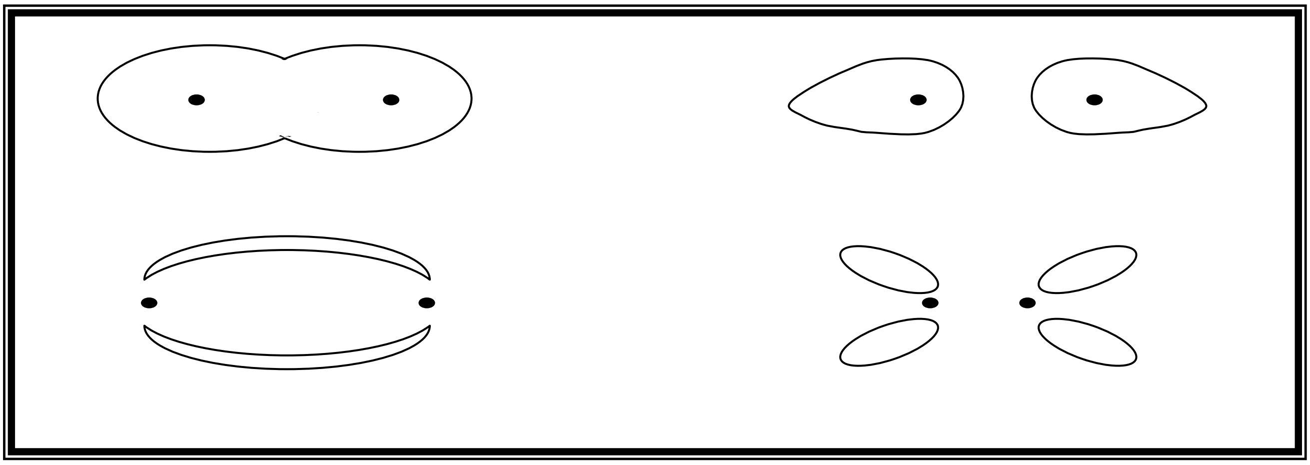
Theoretical Part

Electronically Molecular Energy Levels

Electronic transitions in the case of particles occur in the orbitals of molecule in the visible region and as a result of UV transmission of electrons from the Lower energy levels stable to higher energy levels, such that the electrons are electrons following molecular orbitals: [5]

A. electrons which are the bonds of (σ) and (π) between the organic compound atoms.

B. Nonbonding Electrons which are found in the outer orbitals of atoms, such as oxygen O_2 and N_2 nitrogen... etc. contained organic compound and denoted by the symbol (n).



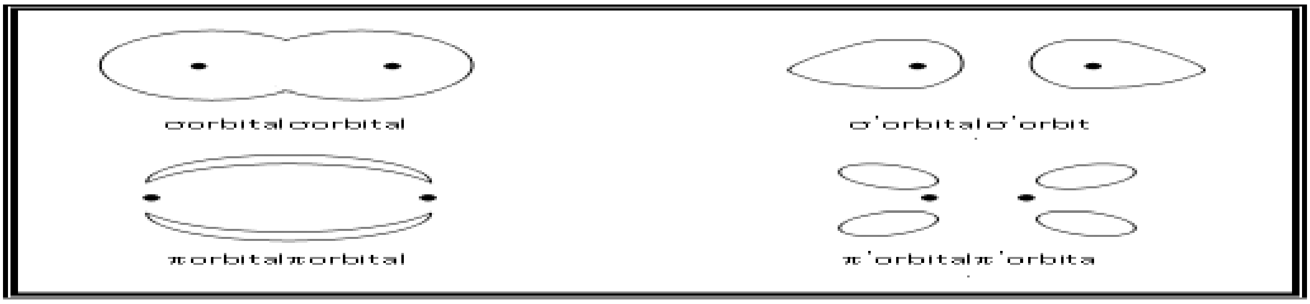


Fig.1: The electronic distribution in molecular orbital's [6]

Experimental Part

Acridine-Orange dye

It has name (3-N, 3-N, 6- N, 6- N-Tetramethylacridine-3, 6-) diamine. It is formula ($C_{17} H_{19} N_3$) and it is Chemical composition: [7, 8]

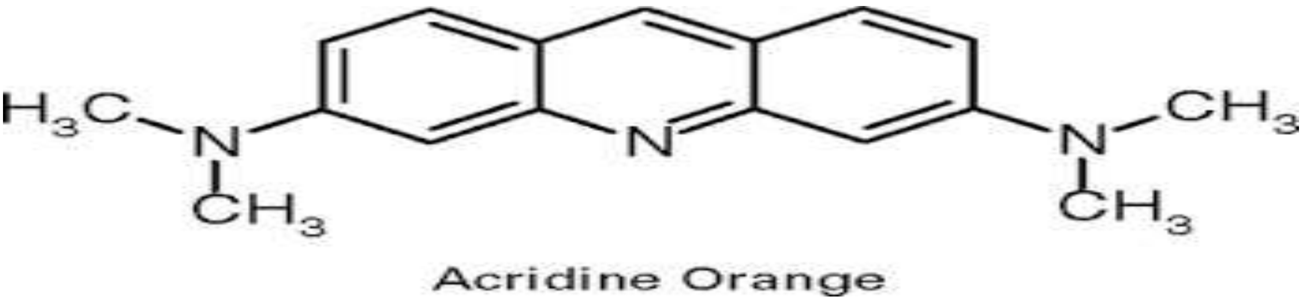


Figure 2: Acridine-Orange Chemical composition [7, 8]

Samples and methods of preparing the composition solution (dye + solvent) using the following equation [9]:

W=) Mw. C .V (/1000 ……………………… (1)

Where:

Mw: The Molecule's weight.

C: concentration of the solution required, V: solution size record

To prepare different concentrations of focus record using the following equation mitigation:[10]

$C_1 . V_1 = C_2 . V_2$……………………………… (2)

Where:

C_1: The first concentration.

V_1: Volume of the first concentration.

C_1: The second concentration.

V_1: Volume of the second concentration.

The Results and Discussion

It was prepared three different concentrations($1{\times}10^{-3}$, $1{\times}10^{-4}$, $1{\times}10^{-5}$) Ml after dissolving dye the acridine-orange in a solvent Ethanol (C_2H_6O), where absorption and fluorescence spectra were measured.

Absorption Spectra

Absorption spectra of samples prepared was measured by using a U.V.-Vis. spectroscopy and it is results shown in the Fig. (3).

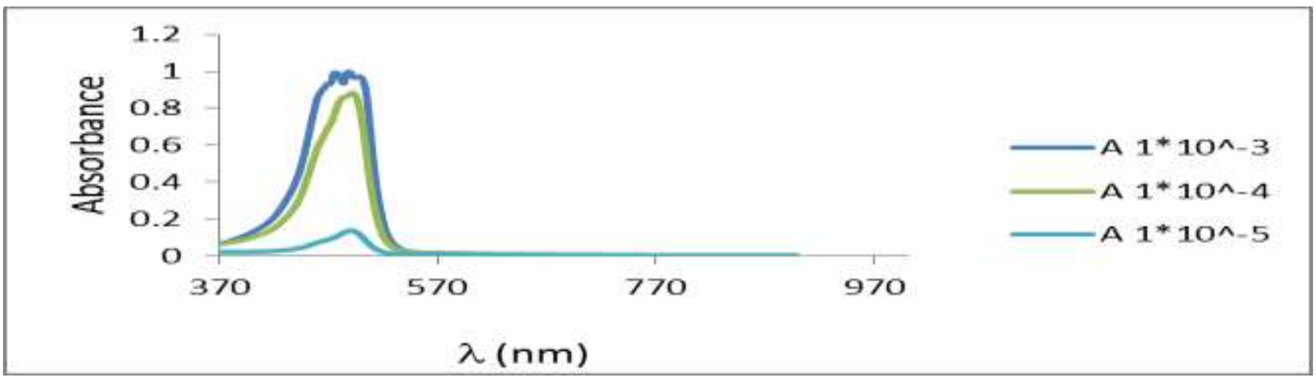


Fig.3: Absorption spectra of the Acridine_orange dye solutions

Table 1: Absorbance of Acridine_orange dye solutions

C (M)	λnm	*Absorbance*
1*10^-3	499	0.97
1*10^-4	493	0.88
1*10^-5	487	0.133

Table (1) showed that concentration decreasing of the dye solution leads to shift toward shorter wavelengths (blue shift)

Spectra of transmission of samples prepared was measured, Fig. (4).

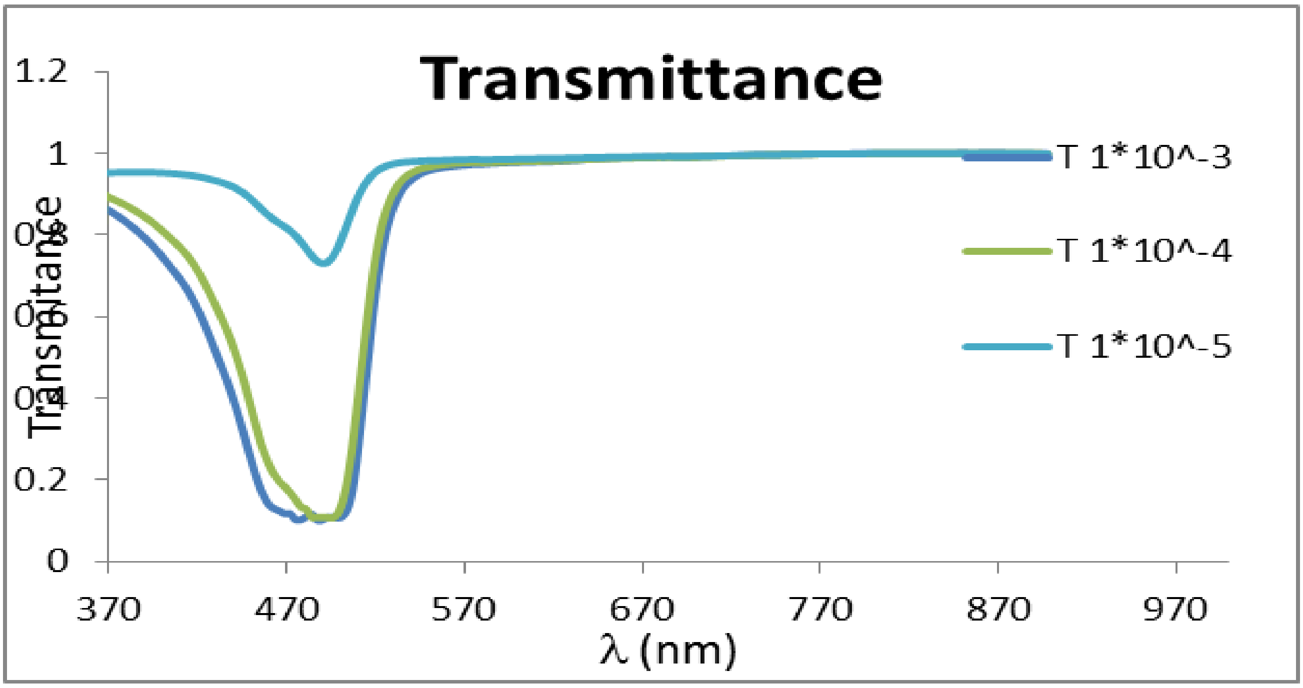


Fig.4: Transmission spectra of acridine_orange dye solutions

Table 2: Transmittance of acridine_orange dye solutions

C (M)	*λnm*	*Transmittance*
1*10^-3	499	0.1
1*10^-4	493	0.106
1*10^-5	487	0.73

From absorbance and transmittance values, and using the equations (3, 4, 5) [12, 13], linear absorption coefficients (α_o), linear refractive index (n_o) and extinction coefficients (K) were calculated, Table (3).

$$\alpha_o = 2.303\ A / d \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

$$K = \frac{\alpha_0 \lambda}{4\pi} \quad \ldots\ldots\ldots\ldots\ldots(4)$$

$$n_o = \left[\frac{4R}{(R-1)^2} - K^2\right]^{1/2} - \frac{R+1}{R-1} \quad \ldots\ldots\ldots\ldots(5)$$

Table 3: Linear absorption coefficient (α_o), linear refractive index (n_o) and extinction coefficients (K) of Acridine-orange dye dissolved in Ethanol at different concentrations

C (Ml)	α_o (cm^{-1})	*K x 10^{-6}*	n_o
1×10^{-3}	2.237	8.874	_
1×10^{-4}	2.030	7.968	1.773
1×10^{-5}	0.306	1.186	2.01

From the table (3), linear optical coefficients ($\alpha_o cm^{-1}$, K) increased with increasing concentration, while the refractive index decreased with increasing concentration

Fluorescence Spectra

Fluorescence spectra of samples prepared was measured by using a fluorescence spectrometer and it is results shown in Fig. (5).

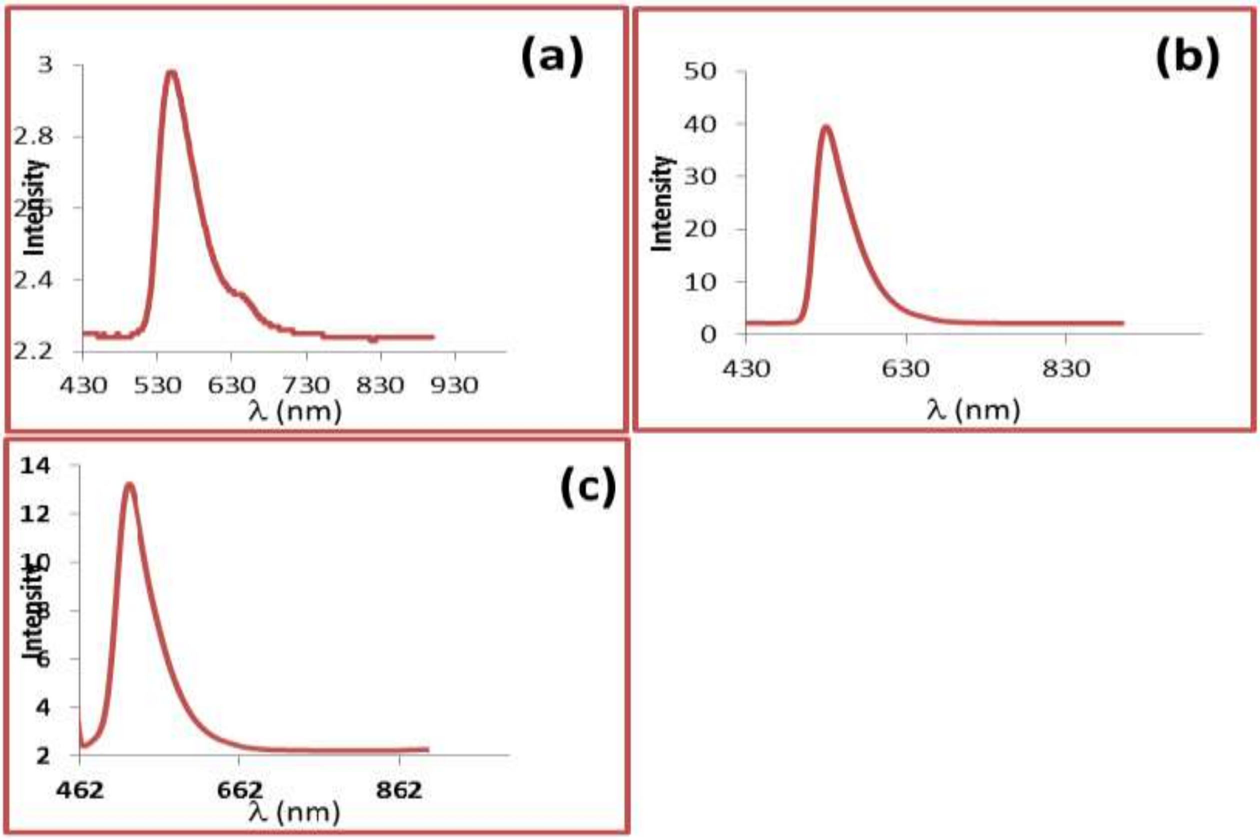


Fig.5: Fluorescence spectra of the Acridine_orange dye at different concentrations: [(a) 1x10^{-3}, (b) 1× 10^{-4}, (c) 1×10^{-5}] Ml

Table 4: Fluorescence intensity of Acridine_orange dye dissolved in Ethanol at different concentrations

C (M)	λnm	Fluorescence intensity
1*10^-3	548	2.98
1*10^-4	532	39.24
1*10^-5	520	13.15

The spectra of fluorescence showed a wavelength shift to the greater wavelength with greater concentration (Red shift) [14], this shows the significant effect of the solution concentration on the order of energy transitions in molecular orbitals. The spectra of fluorescence showed that the concentration (10^{-4}) is the highest intensity. This indicates the significant effect of high concentration and low concentration on the fluorescence intensity of two concentrations (10^{-3}, 10^{-5}) respectively. By using the results of fluorescence, the lifetime of fluorescence level(τ_f) and quantum Yield(Q_f) account possible from relations (6,7) after measuring the area under the curve of absorption and fluorescence spectra by using (GEUP 6) program, Table(4).

$$\tau_F = \frac{a \times \tau_{fRB}}{a_{RB}} \quad \ldots\ldots\ldots\ldots\ldots\ldots(6)$$

τ_{fRB} Is the lifetime of fluorescence level record for a compound which (rhodamine B) and worth (3.230ns) when the concentration (10^{-4}) M and a_{RB} is the area under the curve fluorescence of (rhodamine B) and its value (117.6) cm^{-1}.

It can also be quantum Yield (Q_f) account to find the ratio of the fluorescence spectrum area to the absorption spectrum area [15].

$$\phi_F = \frac{\int F('\nu)d'\nu}{\int \varepsilon('\nu)d'\nu} \qquad (7)$$

$\int F('\nu)d'\nu$: Fluorescence-spectrum area.

$\int \varepsilon('\nu)d'\nu$: Absorption spectrum area.

Table 5: Life-time of fluorescence level quantum-Yield (Q_f) of Acridine_orange solution at a different concentrations.

C (M)	τ_f (ns)x10^{-3}	Q_f
1×10^{-3}	9.36	0.12
1×10^{-4}	5.36	0.38
1×10^{-5}	0.106	0.95

The above results showed the effect of the concentration on the fluorescence life-time (τ_f) of the fluorescence and its quantum-Yield (Q_f), where the fluorescence life-time (τ_f) decreases with the decrease in concentration while the quantum-Yield decreases with the concentration decreasing.

Conclusions

- Through practical results showing increased absorption intensity with concentrations so as to increase the number of molecules .The higher intensity obtained (0.9676) when the concentration (1x10^{-3}) Ml.
- The change wavelength is (blue shift) with decrease concentration, and this shows the effect of solution concentration on the order of the electrical orbits in a molecule of a kind ($n\rightarrow\pi^*$).
- Since the linear optical properties linked to the of spectrum, we noted the effect of concentration on the absorption coefficient and reflective index.
- Through fluorescence spectra possible to identify the effect of concentration on the life-time and quantum-Yield of them

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