Impact of Laser on Fine Structure by Using Object Oriented Programming

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Abstract:
This research investigates the Impact of Laser on Fine Structure by Using Object Oriented Programming. A and electric quadrupole coupling constant B. For relative frequency reference and linearization of LIF recorded data a temperature stabilized half meter long Fabry-Perot etalon with free spectral range of 149.724MHz for red region and 149.6MHz for blue and green region was used. A commercial Burleigh wave meter was employed with an accuracy of 0.01A for precise reading of the excitation wavelength. Fourier transform spectra of Lanthanum was also generated in the optical region of 3500 to 8800A in the graphical form while the data was received in digitalized form by a group in Riga (R. Ferber, A. Jarmola, M. Tamanis, Department of Physics, University of Latvia, Raina Bulvaris, Riga), The same was converted in the graphical form at TU Graz before starting the experimental work. In the FT spectra of La I and La II many Lines were unclassified. In case of La I lines some of the involved levels were also unknown and moreover the hyperfine constants of most of the levels were not known before. In case of La II, the A and B constant of most of the levels in the investigated region were already published via other optical regions. At first main emphasis was given to the measurement of hyperfine constants of already known energy levels and those levels were also investigated which were yet unknown. Through a detailed exploration, more than 155 lines of La I and La II were excited in the aforementioned optical regime of laser dyes during this work. Approximately one half of the lines investigated in this study by means of laser exciation were previously unknown La I lines found on the basis of highly resolved Fourier transform (FT) spectra, having a resolution of 0.03 cm^{-1}. The analysis of spectral lines extracted from already recoreded FT spectra using computer programs (Filter and Classification programs) was carried out. Four new levels of La I were discovered and confirmed by the second laser excitation

Introduction: Structures of integrated circuits and semiconductor devices require operation of the laser at the shortest wavelength possible. Also, by matching the wavelength of a laser to the peak absorption of a specific material, the top layer of a multilayer structure can be removed selectively without damage to the layers underneath.

- All Nd : glass lasers employed in inertial confinement fusion experiments are operated at the third harmonic, i.e., 352 nm, because the shorter wavelength is more optimum for pellet compression compared to the fundamental output. Med-ical applications require solid-state lasers operating in a specific spectral range for control of the absorption depth of the radiation in the skin, tissue, or blood vessels. Frequency agility is required from lasers employed in instruments used for absorption measurements, spectroscopy, sensing devices, analytical chemistry, etc. A fixed or tunable laser in conjunction with harmonic generators and/or an optical parametric oscillator is usually employed to meet these requirements.

TABLE 2.2. Physical and optical properties of Nd : YAG.

Chemical formula	Nd : $Y_3Al_5O_{12}$
Weight % Nd	0.725
Atomic % Nd	1.0
Nd atoms/cm^3	1.38×10^{20}
Melting point	1970 °C
Knoop hardness	1215
Density	4.56 g/cm^3
Rupture stress	$1.3–2.6 \times 10^6$ kg/cm^2
Modulus of elasticity	3×10^6 kg/cm^2
Thermal expansion coefficient	
[100] orientation	8.2×10^{-6} °C^{-1}, 0–250 °C
[110] orientation	7.7×10^{-6} °C^{-1}, 0–250 °C
[111] orientation	7.8×10^{-6} °C^{-1}, 0–250 °C
Linewidth	120 GHz
Stimulated emission cross section	
$R_2 - Y_3$	$\sigma = 6.5 \times 10^{-19}$ cm^2
$^4F_{3/2} - ^4I_{11/2}$	$\sigma = 2.8 \times 10^{-19}$ cm^2
Fluorescence lifetime	230 μs
Photon energy at 1.06 μm	$h\nu = 1.86 \times 10^{-19}$ J
Index of refraction	1.82 (at 1.0 μm)

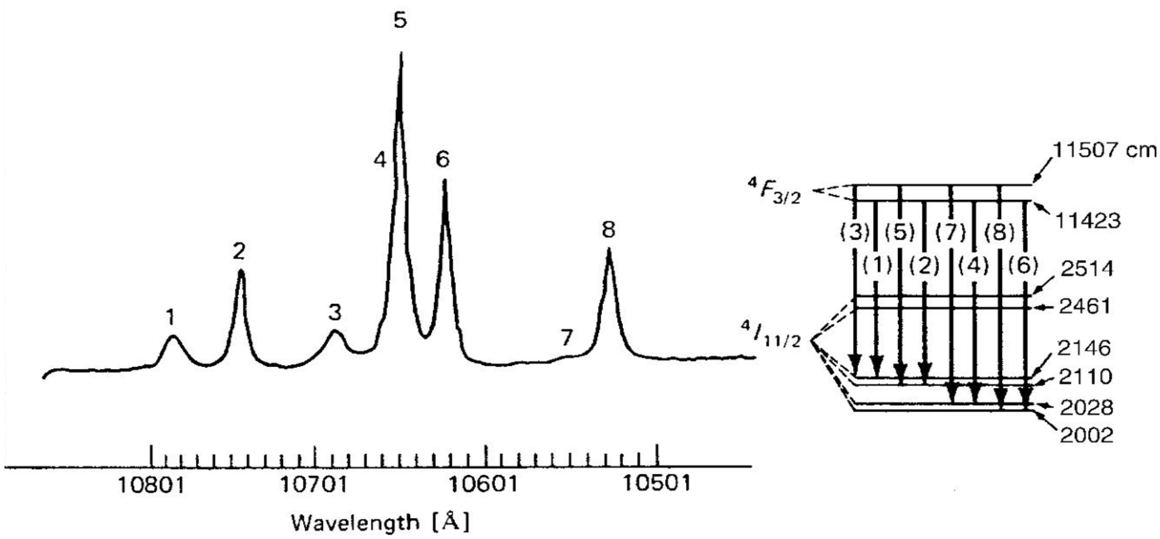

TABLE 2.4. Physical and optical properties of Nd-doped glasses.

Glass Type Spectroscopic properties	Q–246 Silicate (Kigre)	Q–88 Phosphate (Kigre)	LHG–5 Phosphate (Hoya)	LHG–8 Phosphate (Hoya)	LG–670 Silicate (Schott)	LG–760 Phosphate (Schott)
Peak wavelength [nm]	1062	1054	1054	1054	1061	1054
Cross section [×10^{20} cm^{2}]	2.9	4.0	4.1	4.2	2.7	4.3
Fluorescence lifetime [μs]	340	330	290	315	330	330
Linewidth FWHM [nm]	27.7	21.9	18.6	20.1	27.8	19.5
Density [gm/cm^{3}]	2.55	2.71	2.68	2.83	2.54	2.60
Index of refraction [Nd]	1.568	1.545	1.539	1.528	1.561	1.503
Nonlinear coefficient [10^{16} cm^{2}/W]	3.74	2.98	3.48	3.10	3.78	2.90
$d\,n/d\,t$ (20 –40 C [10^{6}/ C]	2.9	−0.5	8.6	−5.3	2.9	−6.8
Thermal coefficient of optical path (20 –40 C) [10^{6}/ C]	+8.0	+2.7	+4.6	+0.6	8.0	—
Transformation point [C]	518	367	455	485	468	—
Thermal expansion coefficient (20 –40 [10^{7}/ C]	90	104	86	127	92.6	138
Thermal conductivity [W/m C]	1.30	0.84	1.19	—	1.35	0.67
Specific heat [J/g C]	0.93	0.81	0.71	0.75	0.92	0.57
Knoop hardness	600	418	497	321	497	—
Young's modulus [kg/mm^{2}]	8570	7123	6910	5109	6249	—
Poisson's ratio	0.24	0.24	0.237	0.258	0.24	0.27

Impact of Object Oriented Programming on Equation based Modeling

section σ (ν),

$$B_{21} = \frac{c}{h\nu g(\nu)} \sigma(\nu), \qquad (1.49)$$

where $c = c_0/n_0$ is the speed of light in the medium. The energy density per unit frequency (ν) is expressed in terms of the lineshape factor $g(\nu)$, the energy $h\nu$, and the photon density φ [photons/cm^3] by

Transfer process		Multimode	Single mode
Diode slope efficiency	η_P	0.50	0.50
Transfer efficiency	η_t	0.95	0.95
Absorption efficiency	η_a	0.90	0.90
Stokes shift	η_S	0.76	0.76
Quantum efficiency	η_Q	0.95	0.95
Coupling efficiency	η_C	0.90	0.90
Beam overlap efficiency	η_B	0.90	0.38
Electrical slope efficiency	σ_S	0.25	0.10

Second, the emission lines of ions in glasses are inherently broader than in crys-tals. A wider line increases the laser threshold value of amplification. Neverthe-less, this broadening has an advantage. A broader line offers the possibility of obtaining and amplifying shorter light pulses and, in addition, it permits the stor-age of larger amounts of energy in the amplifying medium for the same linear am-plification coefficient. Thus, glass and crystalline lasers complement each other. For continuous or very high repetition-rate operation, crystalline materials pro-vide higher gain and greater thermal conductivity. Glasses are more suitable for high-energy pulsed operation because of their large size, flexibility in their phys-ical parameters, and the broadened fluorescent line.

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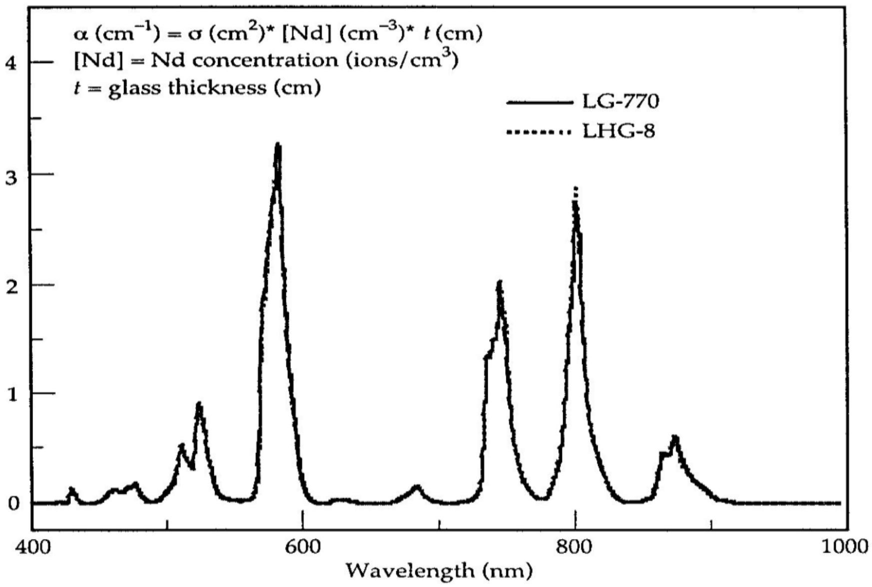

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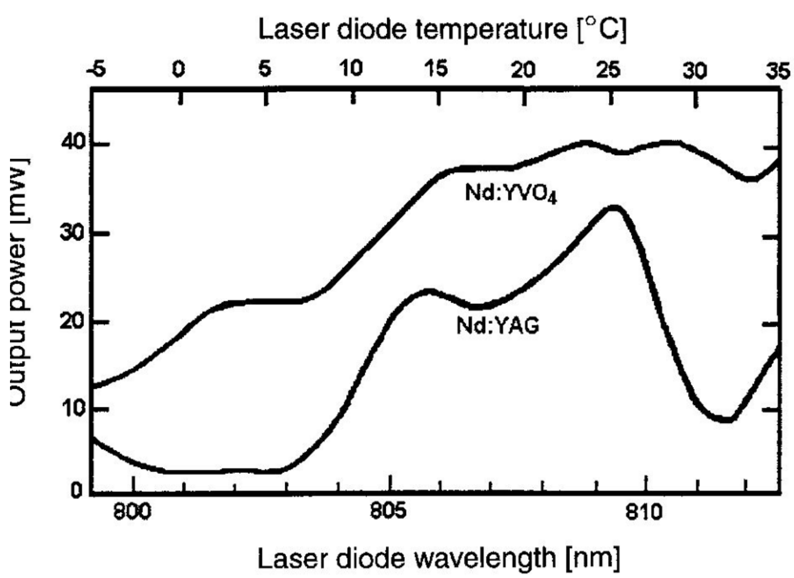
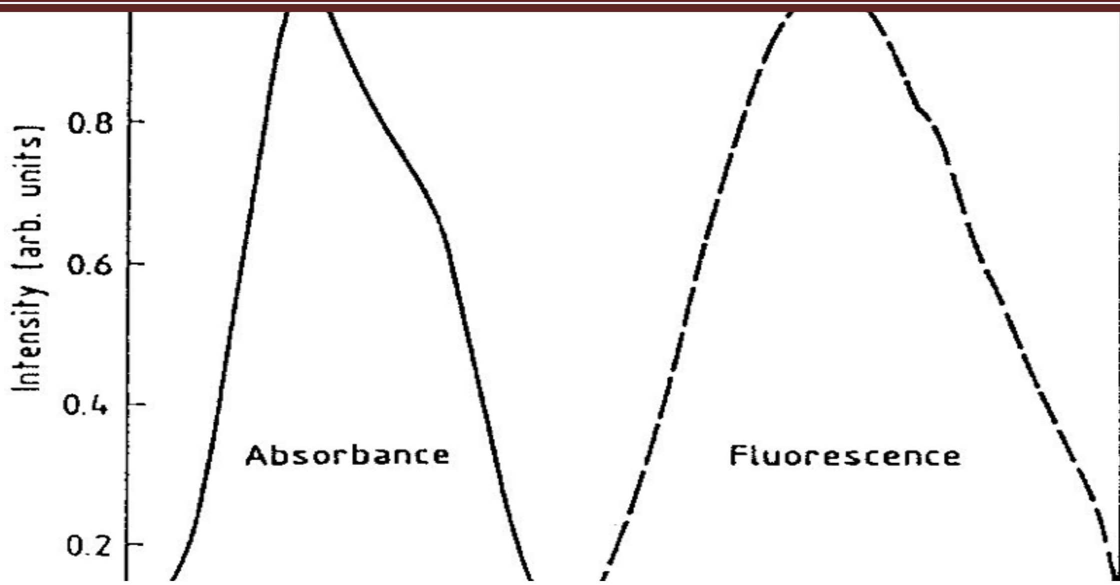


- Ti:Sapphire

  Since laser action was first reported, the Ti : Al_2O_3 laser has been the subject of extensive investigations and today it is the most widely used tunable solid-state laser. The Ti : sapphire laser combines a broad tuning range of about 400 nm with a relatively large gain cross section that is half of Nd : YAG at the peak of its tuning range. The energy level structure of the Ti^{3+} ion is unique among transition-metal laser ions in that there are no *d* state energy levels above the upper laser level. The simple energy-level structure ($3d^1$ configuration) eliminates the possibility of excited-state absorption of the laser radiation, an effect which has limited the tuning range and reduced the efficiency of other transition-metal-doped lasers.



Conclusions:

The results shows that the thermal equilibrium lower energy states of ions or atoms are more heavily populated than higher energy states according to Boltzmann's statistics. In order for stimulated emission rather than absorption to occur, the population between two energy states has to be inverted, such that the higher energy level is more heavily populated compared to the lower level. Energy to achieve this population inversion is supplied by a pump source. In a three-level laser the ground state of the electronic transition is also the lower laser level. At thermal equilibrium the majority of ions are in this level. Thus, at least half of the ions at the ground level must be transferred to the upper laser level before laser action is possible.

References:

[1] A. J. Schokker, Associate Professor, Civil and Environmental Engineering, The Pennsylvania State University. Personal Communication. Aug. 2004.

[2] B. M. Luccioni, R. D. Ambrosini, and R. F. Danesi, "Analysis of Building Collapse Under Blast Loads," Engineering Structures, Vol. 26, 2004, pp. 63–71.

[3] AUTODYN, "Interactive Non-Linear Dynamic Analysis Software, Version 4.2, User's Manual," Century Dynamics Inc., 2001.

[4] G. Mazor, O. Igra, G. Ben-Dor, M. Mond, and H. Reichenbach, "Head-On Collision of Normal Waves with a Rubber-Supported Wall," Philosophical Transactions:
Physical Sciences and Engineering, Vol. 338, No. 1650, 1992.

[5] W. Bleakney, D. R. White, and W. C. Griffith, "Measurements of Diffraction of Shock Waves and Resulting Loading on Structures," Journal of Applied Mechanics, Vol. 17, Dec. 1950, pp. 439–445.

[6] J. K. Wright, Shock Tubes, John Wiley & Sons Inc., 1961.

[7] O. Igra, X. Wu, J. Falcovitz, T. Meguro, K. Takayama, and W. Heilig, "Experimental and Theoretical Study of Shock Wave Propagation Through Double-Bend Ducts," Journal of Fluid Mechanics, Vol. 437, 2001, pp. 255–282.

[8] O. Igra, J. Falcovitz, H. Reichenbach, and W. Heilig, "Experimental and Numerical Study of the Interaction between a Planar Shock Wave and a Square Cavity," Journal of Fluid Mechanics, Vol. 313, 1996, pp. 105–130.

[9] P. Neuwald, H. Klein, and H. Reichenbach, "Unsteady Flows Inside Structures - High Speed Visualization as a Tool for Numerical Modeling and Code Validation," SPIE, Vol. 2869, 1996, pp. 798–806.

[10] H. Reichenbach and P. Neuwald, "Indoor Detonations - Visualization and Pressure Measurements in Small-Scale Models," SPIE, Vol. 4183, 2000, pp. 92–104.

[11] D. C. Pack, "The Reflection and Transmission of Shock Waves I: The Reflection of a Detonation Wave at a Boundary," Philosophical Magazine, Vol. 2, No. 14, 1956, pp. 182–188. 122

[12] D. C. Pack, “The Reflection and Transmission of Shock Waves II: The Effect of Shock Waves on an Elastic Target of Finite Thickness,” Philosophical Magazine, Vol. 2, No. 14, 1956, pp. 182–188.

[13] G. Taylor, “The Formation of a Blast Wave by a Very Intense Explosion. I. Theoretical Discussion,” Proceedings of the Royal Society of London. Series A, Vol. 201, No. 1065, 1950, pp. 159–174.