The International Society for Optical Engineering

OSA Optical Society of America

Joint Session

International Student Conference

Developments in Optics and Communications

University of Latvia

Riga, Latvia

28 –30 April, 2006

Riga has recently become an attractive venue for international events: concerts, the Ice Hockey World Championship, the NATO summit, to name but a few. Science is no exception. This year, student chapters of two world-renowned scientific organizations have joined forces for the international student conference “Developments in Optics and Communications.” DOC-2006 presents a limited number of papers in the field of modern optics applications, which deal with topics as varied as light–matter interactions and visual perception. For some, this conference is a step to their “DOC”-torate. For others, it is a chance to share their broad academic experience. Yet for everybody it is an opportunity to get a new perspective on the research done in optics and communications.

Congratulations on joining science!

On behalf of the organizers,

Aigars Atvars,
President of the Student Chapter,
The Optical Society of America

Latvian Council of Science

TOK project LAMOL
(MTKD-CT-2004-01-014228)

Email to Aigars.Atvars@lu.lv

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SESSION 1

10:00	R.Erts, A.Atvars	*Opening speech*
10:15	**Key speaker (lasers)** A.Ekers	Laser manipulation of molecular levels and its applications
11:00		***Coffee break***
11:20	**Key speaker (vision)** M. Ozolinsh	Feedbacks and Selforganization in Visual Perception: Optical illusions
11:40	A. Nikitina	Optical Illusions and the special effects of the eye
12:00	K. Bagucka, R. Paeglis, I. Lacis	Efficiency of eye movements at different reading speeds
12:20	O. Balcers	The relationship study of photoluminescence outcome and detergent optical brighteners water concentration within the context of convenient anthropogenic load indication in effluent.

POSTER SESSION

12:40	G.Bakradze, V.Skvortsova	Study of transition metal impurities influence on optical and micromechanical properties of MgO
12:43	M. Hobein , A.Gerdes, E. Tiemann	The $a^3\Sigma^+$ state of NaK: High resolution spectroscopy to determine the bound part of the potential
12:46	A. Bulanovs	PLZT EFISH nonlinear multiphase modulator
12:49	D. Lauva, M.Ozolish	Influence of retinal aftereffects and contrast adaptation in perception of Gabor gratings
12:52	S.Makovejs	Raman Amplifiers in Fiber Optical Communication Systems

14:00	A. Podniece, R.Paeglis, I. Lacis	Dynamics of eye movements in recognizing images of natural objects
14:20	S. Fomins, V.Karitāns, G.Ikaunieks, M.Ozolinsh	Saliency based visual attention in the visual search task
14:40	T. Kirova, E.Ekers et. al.	Lifetime determination of degenerate molecular levels in cw regime using the Autler-Townes effect
15:00	M. Auzinsh, K. Blushs, R. Ferber, F. Gahbauer, A. Jarmola, and M. Tamanis	Coherent Excitation and Quadratic Stark Effect in the Cesium Hyperfine Manifold: Level Crossing and Alignment to Orientation Conversion
15:20		***Coffee Break***
15:30	**Invited speaker** E. Baltinsh	Commercialization of Inventions
16:00	***Conference Closing, Excursions***	

Modifications to the program are possible

LASER MANIPULATION OF MOLECULAR LEVELS AND ITS APPLICATIONS

A. Ekers[1], T. Kirova[1], N. N. Bezuglov[2], L. P. Yatsenko[3], R. Garcia-Fernandez[4], K. Bergmann[4]

[1] *Institute of Atomic Physics Spectroscopy, University of Latvia, LV-1586 Riga, LATVIA*
[2] *Fock Institute of Physics, St. Petersburg State University, 198904 St. Petersburg, RUSSIA*
[3] *Institute of Physics of the Academy of Sciences, 03650 Kiev, UKRAINE*
[4] *Deptartment of Physics, University of Kaiserslautern, D-67663 Kaiserslautern, GERMANY*

The Autler-Townes effect was first described some 50 years ago [1], and it was studied extensively later on. It has enabled important applications in atomic physics, like laser cooling [2], transition dipole moment measurement [3], coherent population transfer schemes (STIRAP) [4], etc. However, for molecules only a few high-resolution studies of the Autler-Townes (AT) effect exist [5]. The present contribution presents high resolution studies of the AT effect in molecules, and proposes novel applications of this effect for the determination of lifetimes and branching ratios of highly excited molecular states. A novel technique

The experiments were performed in a Na_2 supersonic beam using the cascade level scheme $X^1\Sigma_g^+ \rightarrow A^1\Sigma_u^+ \rightarrow 5^1\Sigma_g^+$ (or $6^1\Sigma_g^+$) (Fig 1), which represents an open 3-level system. A strong dressing laser couples two of the levels, while a weak probe monitors the modification of these levels by the dressing field. Three configurations can be distinguished: (*i*) a strong dressing field couples the intermediate and upper states, and a weak probe scans across the resonance with the populated lower level; (*ii*) a dressing field couples the lower and intermediate levels, and a probe drives the second transition; (*iii*) strong fields drive both transitions. In case (*i)* the splitting of the dressed levels into AT doublets is observed in the probe excitation spectrum. In the weak probe limit the AT spectrum can be used for the determination of lifetimes of the excited states [6]. This approach appears easier

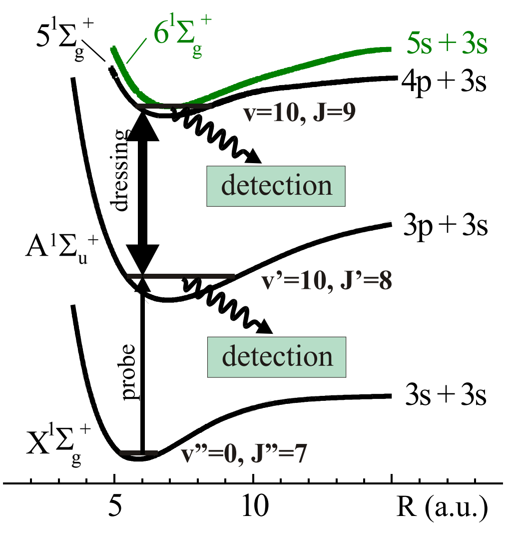


Fig. 1. Cascade scheme in Na_2, case *i*.

than the standard techniques employing time resolved spectroscopy. In the strong probe limit the AT spectrum yields information on the branching ratio of the highly excited states. In case (*ii)* the probe excitation spectrum differs from the doublet structure observed in closed 3-level systems. It changes from a single narrow line at resonance to a broad spectral structure at moderate detuning of the dressing field, and then again to a narrow line at large detuning. This is explained by a dynamic interplay of the AT effect and optical pumping in an open system. Novel application of this effect for laser manipulation of spatial distribution of excited molecules is proposed. Finally, in the case (*iii)* the use of two strong laser pulses in a counterintuitive sequence (second transition before the first) allows one to coherently drive the population flow from the ground state through short-lived highly excited molecular levels with efficiencies close to 100% [7].

Support by the European Social Fund, NATO Grant EAP.RIG.981378, and EU FP6 TOK project LAMOL is acknowledged.

References

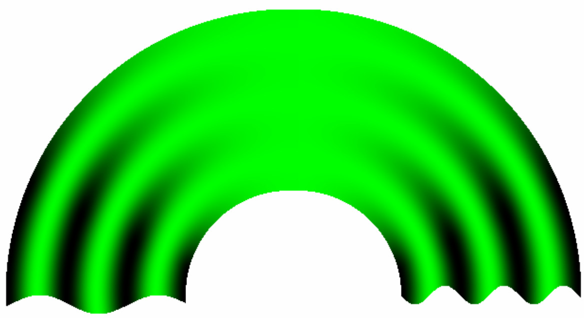
[1] S.H. Autler and C.H. Townes, Phys. Rev. **100**, 703 (1955).
[2] A. Aspect et al., Phys. Rev. Lett. **57**, 1688 (1986).
[3] M. A. Quesada et al., Phys. Rev. A **36**, 4107 (1987).
[4] K. Bergmann, H. Theuer and B.W. Shore, Rev. Mod. Phys **70**, 1003 (1998).
[5] J. Qi et al., Phys. Rev. Lett. **83**, 288 (1999); *ibid* **88**, 173003 (2002).
[6] R. Garcia-Fernandez, A. Ekers, J. Klavins, et al., Phys. Rev. A **71**, 023401 (2005).
[7] R. Garcia-Fernandez, A. Ekers, L. P. Yatsenko, et al., Phys. Rev. Lett. **95**, 043001 (2005).

FEEDBACKS AND SELFORGANIZATION IN VISUAL PERCEPTION: OPTICAL ILLUSIONS

M. Ozolinsh
Dept. of Optometry and Vision Science, University of Latvia,
8 Kengaraga Str., Riga
Eemail: ozoma@latnet.lv

Perception and processing of visual information is a tremendous task for humans, and contrary to some other beings like dogs, vision is the dominating information input for decision making. From our previous practice we all know the problems of image processing in computers and different kinds of restrictions to organizing the interchange of visual information with sufficient size and quality. During the past decade, achievements in electronic processing speed and memory density have made possible an unbelievable leap in this area. However that has a cost. Unlike in electronics, where the supply of energy is much easier, and installation of more and more powerful processor cooler fans is possible, the human brain cannot be rebuilt and modified in such a simple way.

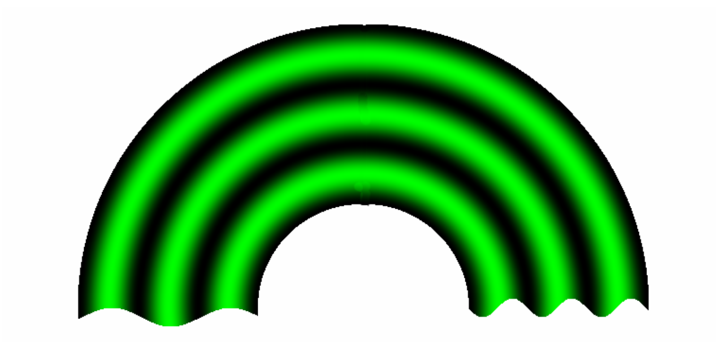
Visual information perception with immediate processing is organized in several steps within the visual pathway in our brains. In the brain, that is not quite correct, however at the same time still 100% correct. The first stage takes place already in our eyes, physically separate from the brain. However, just in our eyes the primary neural information processing takes place. The eyes are connected with the next "elements" of the pathway (optic chiasm, "the commutator," and the lateral geniculate nucleus LGN, "The reception office" of the visual cortex) with only a connection bundle of 10^6 neurons– a one million pin parallel port. The ignition of neural pulses is a "very" slow



Can you recognize the object? Where is light coming from?

process, the maximum rate being around (3-5)x10^2 per sec. As they travel along this neural bundle, pulses lose their intensity, and they are regenerated. Crossmodulation trends to take place via biochemical metabolism processes in the bundle neighbourhood. These energy losses and a limit on the rate of the stochastic neural pulse firing in the eye photoreceptors forces a preprocessing of the image already in the eye retina, *i.e.*, coding of luminance and colour, "compressing" the image, and separating information to be sent faster for more precise processing in order to obtain a high spatial resolution. This preliminary processing should be an economic one, smart to fit the needs of perception and to fit the mechanisms of the further neural processing in the visual cortex. A similar job is done in our everyday life digital camera use. We obtain lot of bits from our camera 5Megapixel CCD or CMOS sensor with 14-16 bit depth for each of the RGB colours. All that is processed on-line in the camera to obtain a uniform 5MP size image with only 8 bit depth per colour. All other information is "lost." However, before being lost, it is used to choose correct the white balance, remove noise, and, depending on your needs and wishes previously loaded in the menu, choose an emphasis either to correctly present faces or landscapes, etc. Depending on the capacity of your memory card, the appropriate data compression level is applied. It happens that the hardest task is to get rid of this friendly offer of companies built in their cameras and to try to export all of the initial information. You should spend a lot of your money to have a camera allowing you to obtain such RAW data.

The image on the retina undergoes similar transformations in the eye neural



And if the object has little another shape?

Based on "Elusive Arch " illusion by Dejan Todorović (University of Belgrade, Serbia).

structures. First, it is adapted to the illumination level and to the contrast of the landscape, allowing it to fit to the best dynamic range of eye receptors, then colour sensitivity corrections depending on the illuminant spectrum (human colour constancy, same as the white balance in your camera) are performed. A part of this task is done already in the eye neural plexiform layers. When information reaches our visual cortex, other kinds of processing takes place. In the final stage, using the previous practice stored in our memory, asks all the time: is that a line, is that a circle, do I recognize where the illumination is coming from, is something moving, do I have the same goggles as all days before. Each of these questions can get an answer. Then, a neuron responsible for that is fired. The flexibility of all that is incredible. An example - after some period of time using progressive lenses in your goggles, which causing distortion of the image, shortly after the beginning to use them, distorted lines become straight ones. However, ways to fire the neuron responsible for something, lets say for movement, are parallel and not only one and unique. That allows to provoke firing of definite cortex neurons watching some specially designed visual stimuli, thus creating various interesting optical illusions.

The report gives an overview of the stages of the human visual pathway from the eye and eye retina neural structures up to the highest visual areas in the cortex, their duties and responsibilities, and demonstrates and gives interpretation of a number of classical and quite new visual illusions.

THE OPTICAL ILLUSIONS AND THE SPECIAL EFFECTS OF THE EYE

Alise Nikitina
Riga State Gymnasium No 1

The ability to see has a very important place in a human's life because through vision we receive the greatest part of our information. The process of vision is very complicated because it involves the collaboration between the eyes and the human brain. External influences affect the process of the vision because the activity of the eye is quite dependent from the external influences.

In this work Prof. Dr. rer. nat. Michael Bach's optical illusion "Lilac Chaser" is analyzed. Furthermore, the structure and the activity of the eye, the spec effects of the eye, the time of the color illusion "Lilac Chaser's" origination, the color optical illusion activity as a function surroundings, and the color blindness effect on this optical illusion are studied.

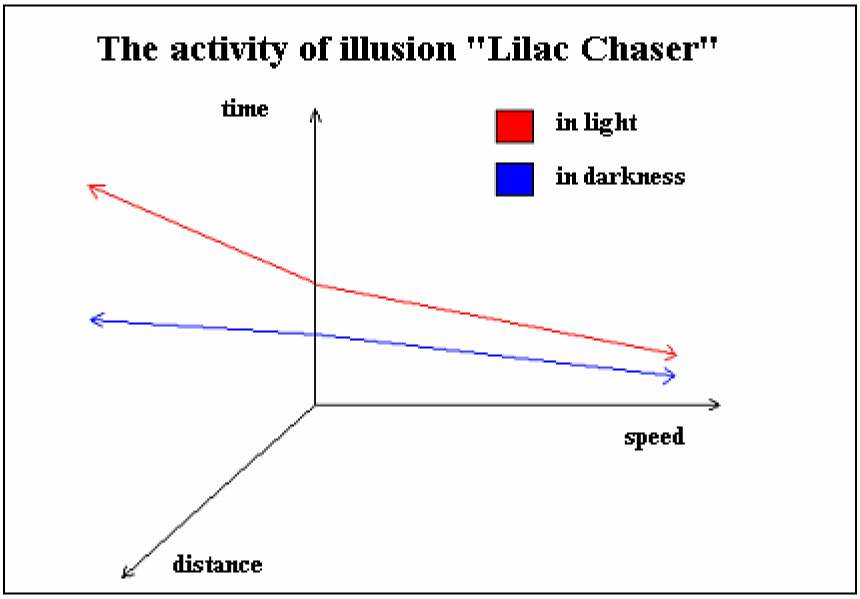


Fig.1.

As a result of the experiments, it is found that the optical illusion "Lilac Chaser's" time of activity was the smallest in darkness, when the subject was relatively close to the monitor, and when the circle of the green color was moving the fastest. This optical illusion was demonstrated also to a color blind subject, who cannot see the difference between red and green.

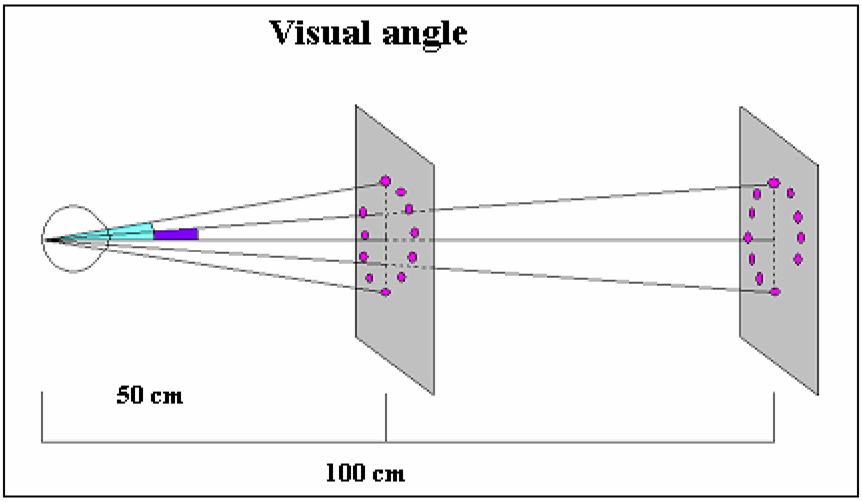


Fig.2.

In summary, the research clarified that the color optical illusions often have a connection with the color aftereffect. The time of the origination and expression of the optical illusion is affected by spec effects of the eye, and surroundings affect mainly only the activity of the eye. The subject who cannot see the difference between definite colors also could not see the optical illusion “Lilac Chaser” with these definite colors. The methods of the research of the optical illusions are many and different.

The author thanks *Dr.habil.phys.* professor Maris Ozolinsh, a senior researcher at the Institute of Solid State Physics of the University of Latvia and Mag. Paed. Tamāra Brice, a physics teacher of Riga State Gymnasium No 1, for their help, suggestions, and discussions. I also thank to Prof. Dr. rer. nat. Michael Bach for using his optical illusion “Lilac Chaser” in my experiments.

References:

http://www.michaelbach.de/ot/col_lilacChaser/index.html http://psylux.psych.tu-dresden.de/i1/kaw/diverses%20Material/
www.illusionworks.com/html/color_aftereffect.htm

EFFICIENCY OF EYE MOVEMENTS AT DIFFERENT READING SPEEDS

K. Bagucka, R. Paeglis, I. Lacis
Department of Optometry and Vision Science
University of Latvia, Latvia

Reading, especially fast reading, is a complex integrative task that involves not only precision in eye movements, but also rapid visual-verbal synthesis of information. Many studies use eye movements to investigate the process of reading.

When we read, our eyes don't move smoothly across the page, but rather make jumps from word to word. Periods of relative stillness of the eye are called fixations. We fixate on a word for a period of time, roughly 200-250 ms, and then move to another word. These movements are called saccades and usually take 20-35 ms. The majority of saccades are forward movements from 7-9 letters, but 10-15% of all saccades are regressive or backward movements. Readers do not stop at every word, short words and particularly function words are frequently skipped. There are well-known individual differences in eye movement measures as a function of reading skill: skilled readers make shorter fixations, longer saccades and fewer regressions. Likewise, bilingual readers make shorter fixations, longer saccades and fewer regressions in their dominant language [1].

Most skilled readers do not claim to read all material equally fast, but use the techniques to read at the fastest reasonable rate, considering the difficulty level of the material and the level of comprehension desired. Skilled readers differ from unskilled readers in their use of general world knowledge to comprehend texts [2].

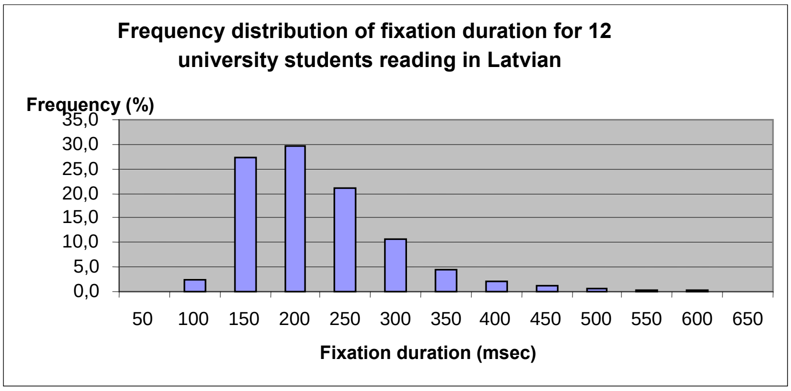
It is interesting to find out how eye movements change as a result of speed-reading training. The average university student reads between 250-300 words per minute, but good reading speed is around 500-700 words per minute. Speed-reading courses do seem to improve reading speed in average readers because we all have a capacity for reading faster than we typically do [3].

The purpose of this study is to compare:

1. the eye movement characteristics of average and skilled readers (fixation duration, saccade length, saccade duration, reading rate, text comprehension) as they read different kinds of texts in different languages

2. the eye movements before and after speed-reading training.

Twelve university students and 5 professional readers volunteered for this research. A professional reader in this research is a person whose occupational duty is to read and review texts. Eye movements were recorded by the eye tracking system *iViewX*. Participants read seven texts (five texts in Latvian, one text in Russian, one text in English respectively) at their normal speed and answered comprehension questions. Analysis of fixations and saccades was performed by ILAB under Matlab [4].



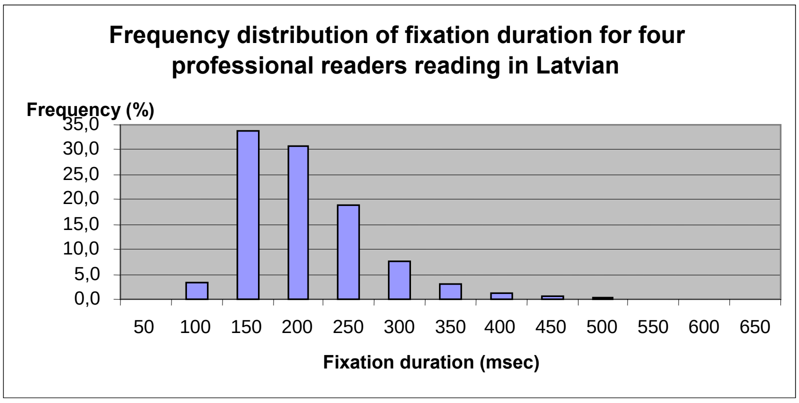


Fig. 1. Fixation duration distributions for professional and average readers

The data lent support to several differences between the general population and professional readers. For a comprehension task the reading rate is smaller and for general population readers it was 248 words per minute (text comprehension 83%), whereas for professional readers 284 words per minute (text comprehension 80%). 'Professionals' can suffice with only 3 or 4 fixations per line (to achieve maximum rate of 416 wpm). They had more short duration fixations (about 150 ms) and few skip-backs (Fig. 1). Thus, their eye movements are more efficient with respect to duration and distribution of fixations. However, some students of exceptional intellectual standing read at a rate and comprehension level comparable to the 'professional' average. Thus, the criterion for an 'average' or 'skilled' reader should include both personal and occupational factors. The research also raises the question as to whether fast reading students are not those who mastered reading well before formal schooling. This may suggest some improvements for schooling strategies in order to improve reading skills of young people.

Research supported by the European Social Fund (R.P.)

References:

1. K. Rayner. Eye movements in reading and information processing: 20 years of research, Psychological Bulletin, Vol. 124, No. 3, 1998, pp. 372-422.

2. K. Rayner, B. Juhasz. Eye movements in reading: Old questions and new directions, European Journal of Cognitive Psychology, No. 16, 2004, pp. 340-352.

3. T. Calef, M. Pieper. Comparisions of eye movements before and after a speed-reading course, Journal of the American Optometric Association, Vol. 70, No. 3, 1999, pp. 171-181.

4. D.R. Gittelman. ILAB: program of postexperimental eye movement analysis, Behavior Research Methods, Instruments & Computers, Vol. 34 (4), 2002, pp. 605-612.

OPTICAL STUDY OF DETERGENT OPTICAL BRIGHTENERS FOR WATER QUALITY CONTROL

O. Balcers
University of Latvia

Introduction. Water quality and anthropogenic loads in many, but not all, cases are related. Some water quality monitoring programms analyze samples for the presence of *Escherichia coli*. These bacteria can come from humans and animals. The human-attributable effluent contains optical brighteners (OBs) from detergents. A convenient and affordable quantitative optical method giving a linear luminescence outcome over several orders of detergent concentrations in aqueous solution is demonstrated. The proposed method uses the common presence of OBs in detergents. Detergent concentration in water can be used as a surrogate indicator of resultant anthropogenic loads in water bodies. The proposed optical method with linear outcome over several ranges of detergent concentrations in water is described.

The field of environmental sensors has been developing driven by the environmental considerations in the Baltic Sea region and the EU. The authors propose the use of optical methods for developing a sensitive, selective, and low cost approach to address research into matter media emmited into water and air. An optical method to detect the human anthropogenic load presence in water bodies by measuring the concentration of minute optical brighteners (OBs) in water due to laundry effluent is demonstrated.

Some water quality monitoring programs analyze samples for the presence of fecal coliform or *E.Coli*. These bacteria can come from both humans and animals. The OBs monitoring helps to clarify if elevated *E. Coli* levels are due to anthropogenic presence.

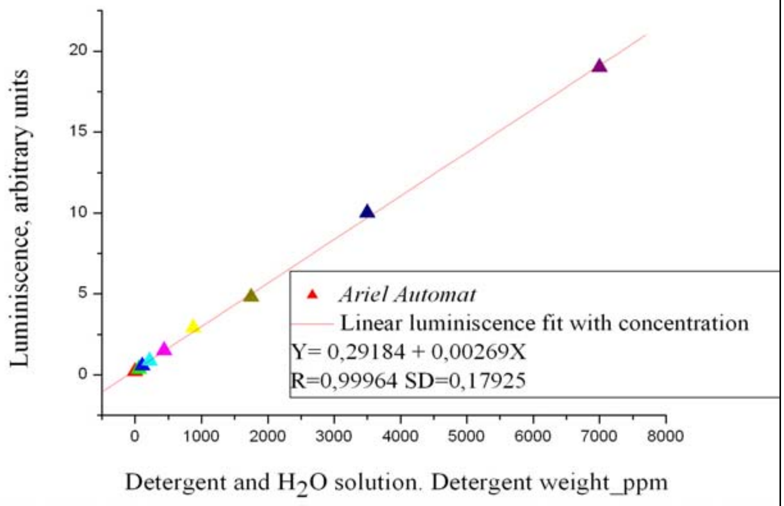
Linear luminiscence optical outcome versus detergent concentration in distilled water. This luminescence, in our opinion, could serve as a conveniently and affordably detectable optical parameter to compare the human impact on the water bodies studied.	

Fig. 1.

OBs are added to detergents in amounts up to 0.2% in order to counter the natural yellowing experienced by fabrics. They absorb light in the UV region and re-emit as visible blue light. The authors have measured the absorption peak form dependance from the detergent water concentration. The peak of absorbtion maximum of our sample shifts from 230nm towards 250nm following a concentration increase from 55ppm to 3500ppm detergent by weight in the distilled water.

The author gratefully acknowledges PhD support of the European Social Fund.

STUDY OF THE INFLUENCE OF TRANSITION METAL IMPURITIES ON THE OPTICAL AND MICROMECHANICAL PROPERTIES OF MgO

G.Bakradze, V.Skvortsova
Institute of Solid State Physics, University of Latvia

MgO is an appropriate object for extensive experimental and theoretical investigations since it has a promising complex of optical, dielectric, and mechanical properties, simple crystal structure, and can serve as a model of a wide band gap oxide crystal. In many applications of MgO single crystals, the presence of impurity ions determines the main physical and mechanical properties of the crystal. Here we present the results of an investigation of the optical and micromechanical properties of magnesium oxide single crystals doped with different concentrations of transition metal ion impurities.

The study of optical properties has shown that the absorption spectrum of MgO consists of two bands at ~ 46000 cm^{-1} and ~ 35000 cm^{-1} respectively. They are associated with the Fe^{3+} charge-transfer transition. In addition to iron bands, two absorption bands referring to chromium ion impurities in octahedral sites are detected. Absorption bands with maxima at ~16400 $cm^{-1}$and ~22500 cm^{-1} correspond to the transitions from the ground state $^4A_{2g}(^4F)$ to the exited states $^4T_{2g}$ and $^4T_{1g}$, respectively.

MgO single crystal fracture toughness and microhardness at different loads were investigated. Using selective chemical etching the dislocation structures and cracks around indentor imprints were studied. It is shown that iron ion impurities increase the brittleness of MgO. The results have revealed a qualitative dependence of optical properties and toughness on the ion impurity concentration.

Based on the obtained results it could be proposed, that the optical and micromechanical properties of MgO single crystals depend not only on the transition ion concentration but also on the relation between different ion concentrations.

THE $a^3\Sigma^+$ STATE Of NaK: HIGH RESOLUTION SPECTROSCOPY TO DETERMINE THE BOUND PART OF THE POTENTIAL

M. Hobein[1,2], A. Gerdes[1], E. Tiemann[1]
[1]Institut für Quantenoptik, University of Hannover,
Welfengarten 1, 30167 Hannover, Germany
[2]Department of Physics and Institute of Atomic Physics and Spectroscopy,
University of Latvia, Rainis Boulevard 19, LV 1586 Riga, Latvia

The lowest triplet state of NaK, $a^3\Sigma^+$, is mostly repulsive with a shallow van der Waals minimum. Dunham coefficients and an IPA potential have already been calculated [1,2]. Measurements to determine the long-range part have been carried out by Ishikawa et al. [2] and the short-range part has been calculated by Ferber et al. by analysing bound-free $c^3\Sigma^+ \rightarrow a^3\Sigma^+$ transitions [3]. However, the describtion of the bound part is based on just a limited datafield of rovibronic levels of the $a^3\Sigma^+$ state and thus calculated and measured values of certain progressions can differ dramatically. Our aim is to expand this datafield by measurements of laser induced fluorescence (LIF) with the technique of Fourier-Transform-Spectroscopy and to fit an IPA potential describing the $a^3\Sigma^+$ state more precisely. Additionally, a simultaneous observation of the $a^3\Sigma^+$ triplet state and the singlet ground state $X^1\Sigma^+$ with asymptote Na(3s) + K(4s) enables us to determine properties of cold collisions of Na + K like scattering length and Feshbach resonance positions.

[1] A.J. Ross, C. Effantin, J.d'Incan, and R.F. Barrow, Mol. Phys. **56**, 903 (1985)

[2] K. Ishikawa, N. Mukai, and M. Tanimura, J. Chem. Phys. **101**, 876 (1994)

[3] R. Ferber, E.A. Pazyuk, A.V. Stolyarov, A. Zaitsevskii, P. Kowalczyk, H. Chen, H. Wang, W.C. Stwalley, J. Chem. Phys. **112**, 5740 (200)

PLZT EFISH NONLINEAR MULTIPHASE MODULATOR

A. Bulanovs
Department of Physics, Daugavpils University,
1 Parades iela., Daugavpils, LV 5401, Latvia
E-mail: bulanov@inbox.lv

The electric field induced second harmonic (EFISH) generation effect in paraelectric lanthanum doped lead zirconate-titanate ceramics (PLZT) has been utilized in a local oscillator device of a nonlinear optical heterodyne interferometer. The application of PLZT X/65/35 plates in a low frequency rotating electric field as the reference sources of EFISH for interferometric analysis of the anisotropy of thin films or surfaces of crystals is proposed.

Our experimental equipment consists of a continuously pumped acousto-optically Q-switched and mode-locked (CW QS ML) 70ps pulse duration YAG:Nd laser (average power 2W, wavelength 1064 nm, 300 ns pulse trains with repetition frequency 1-10 kHz), a Glan polarizer (P) and analyzer (A), a PLZT plate with electrodes having 3-fold or 4-fold symmetry, a laser QS ML

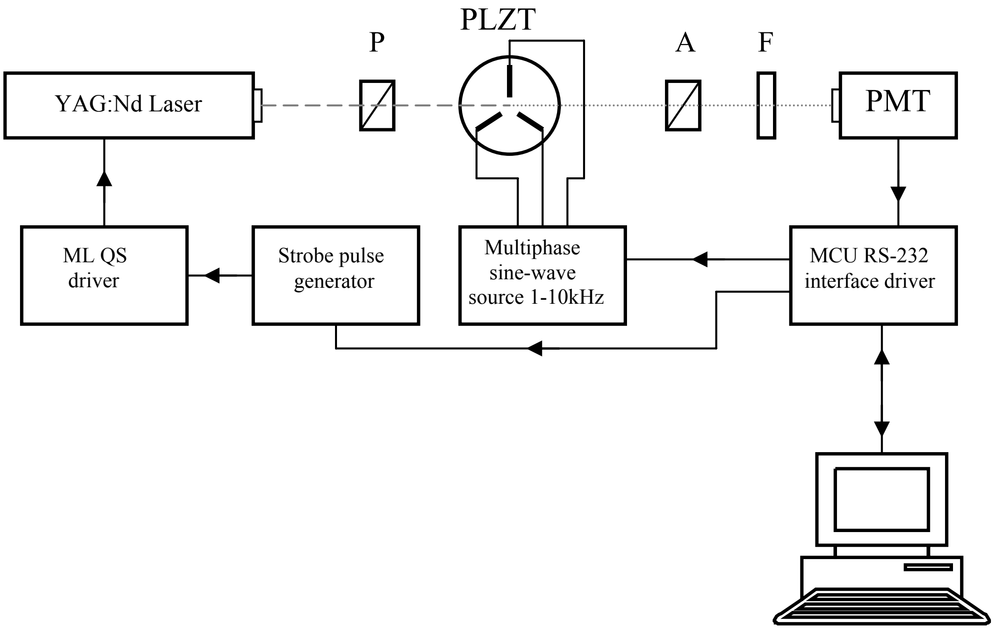


Fig. 1. Experimental set-up for PLZT EFISH cell demonstration.

driver, a sampling (strobe) pulse generator, a multiphase sine-wave source, a second harmonic (SH) filtering package (F) with a wavelength of 532 nm, and a photoregistration tool (PMT). All electronic units (drivers, generators) have been controlled by a microcontroller unit (MCU) and PC software. In order to enhance the

EFISH signal and to position precisely the beam spot in the center of the inter-electrode space, we have slightly focused the fundamental laser beam with a lens having a focal length of 30 cm (not shown in Figure 1.). The sampling (laser starting pulse activating the Q-switch) pulse synchronizable with a high voltage sine wave source (3 or 4 phase) had equidistant 24 delay steps related to one of sinusoids and was controlled with a computer. Mainly we chose an EFISH driver frequency of 6.5 kHz, equal to the laser pulse train's repetition frequency, and output voltages of 1000-2000 V.

We have proved that a PLZT EFISH modulator is suitable for interferometric analysis and mapping of SH anisotropy of the surfaces of the crystals under test. Multiphase sinusoidal modulation up to the kHz range and subsequent Fourier analysis or lock-in detection of NLO interferometer output is necessary to extract the information about nonlinear susceptibilities of matter under investigation. In summary, the presented EFISH device has no moving parts, has small dimensions (EFISH cell diameter 1-2 cm) and is suitable for nonlinear optical diagnostics of ferroelectrics and related materials, including mapping of physical fields and scanning optical microscopy.

INFLUENCE OF RETINAL AFTEREFFECTS AND CONTRAST ADAPTATION IN PERCEPTION OF GABOR GRATINGS

D. Lauva, M. Ozolinsh

Department of Optometry and Vision Science, University of Latvia

Eemail: didzis.lauva@inbox.lv

Contrast adaptation is a little known complex process which occurs in all visual pathways that start in the retina and end in the higher cortex levels. Mostly it uses the primary and secondary visual cortex [1]; it also is closely related to aftereffects on the retina. Findings on the neuronal level have been done using fMRI technology [2], but less is known about psycho physiological experiments.

To study the contrast adaptation we used Gabor patches as stimuli in all our experiments because they join with the background without making borders.

Our experiments are divided in two parts. During the first, adaptation time, a

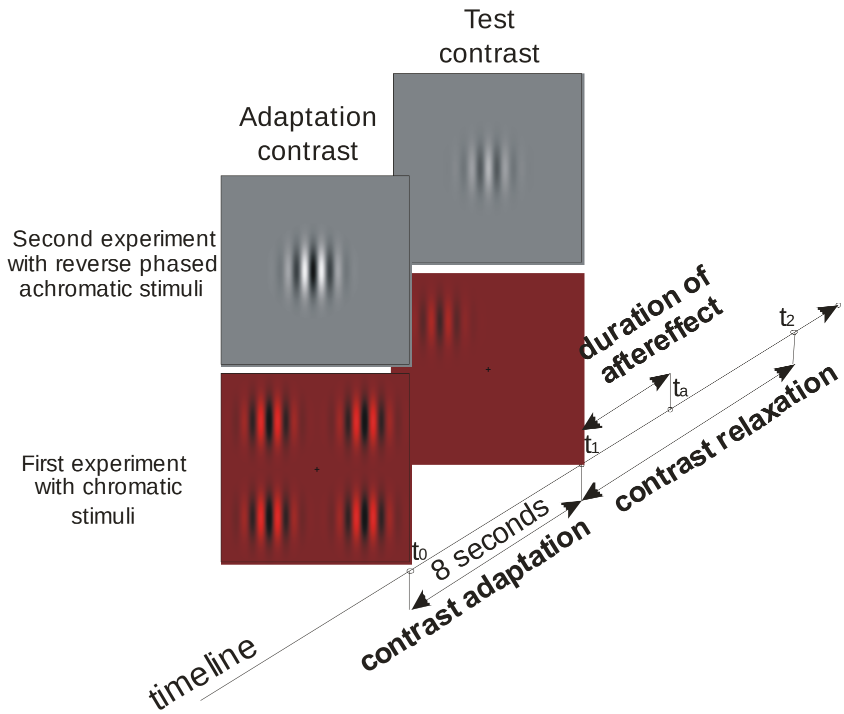


Fig. 1. Visual stimuli paradigm for contrast adaptation experiment. In both experiments we measure contrast relaxation time t2–t1, and in second experiment we measure duration of aftereffect ta-t1.

subject adapts to a high contrast stimulus. After the adaptation time the adaptation stimulus is changed to a lower contrast test stimulus. A term "contrast distinction", i.e., the difference between adaptation stimulus contrast value and relaxation stimulus contrast value is used as a parameter to characterize the experimental conditions. The subject's task is to fix the time at which the subject loses the sense of afterimages or at which the contrast sensitivity relaxes sufficiently to permit the subject to perceive the lower contrast test stimulus (Fig.1).

Firstly we determine if it makes a difference to affect different cone types in the periphery (Fig 2). The test stimulus had the same orientation and was spatially in phase with the adaptation stimulus. The retinal aftereffect is related to contrast adaptation, so we create a model that shows how

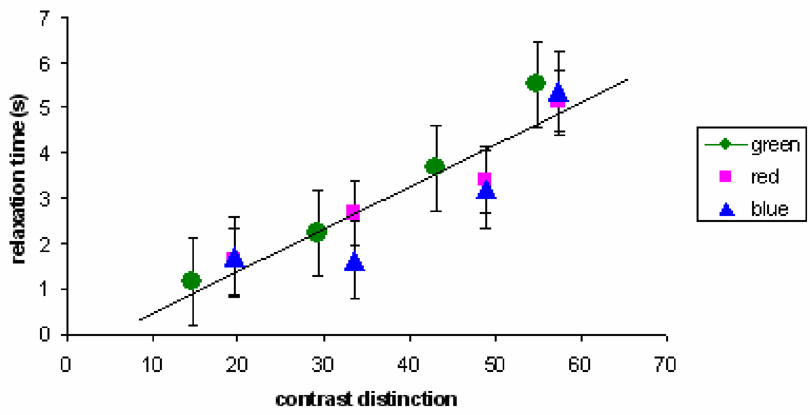


Fig 2: This graphic shows how relaxation time depends on contrast distinction using red, green and blue stimuli.

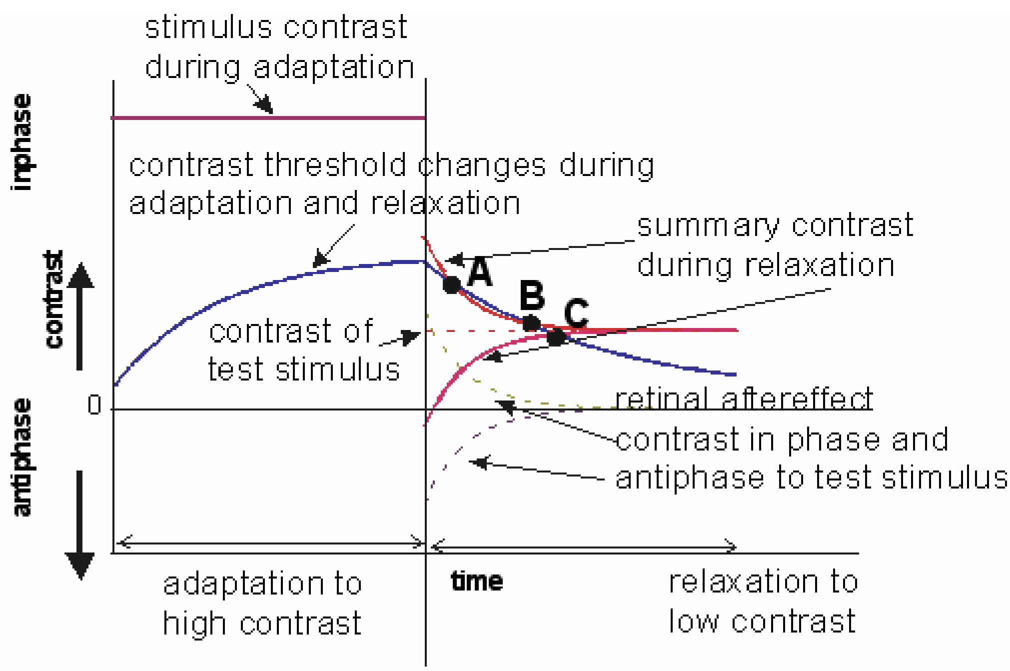


Fig. 3. Retinal aftereffects always appear in antiphase (reverse phased) to the adaptation stimulus. A – disappearance of aftereffect, B and C – appearance of reverse phased and in phased test stimuli..

the aftereffect impacts contrast adaptation and perception (Fig. 3). Here we used also a reverse phased achromatic test stimulus in central area of retina. In the latter case, when test stimuli are reverse phased, aftereffects and test stimuli add together, thus they amplify each other, and vice versa if aftereffects are reverse phased to test stimuli.

Analyzing the results we have suggested that the aftereffect depends only on adaptation stimuli, not on the test stimuli, thus the aftereffect disappearance time does not change significantly in our experiments with constant adaptation stimulus contrast.

When the test stimulus contrast is increases, as one can see from the graph (Fig. 4), the time of the appearance of the test stimulus decreases toward the afterimage disappearance time when the test stimulus contrast increases, and it suggests that there is some higher test stimulus contrast level when subject has continuous perception of Gabor stimuli due to overlapping of afterimage and test image perception.

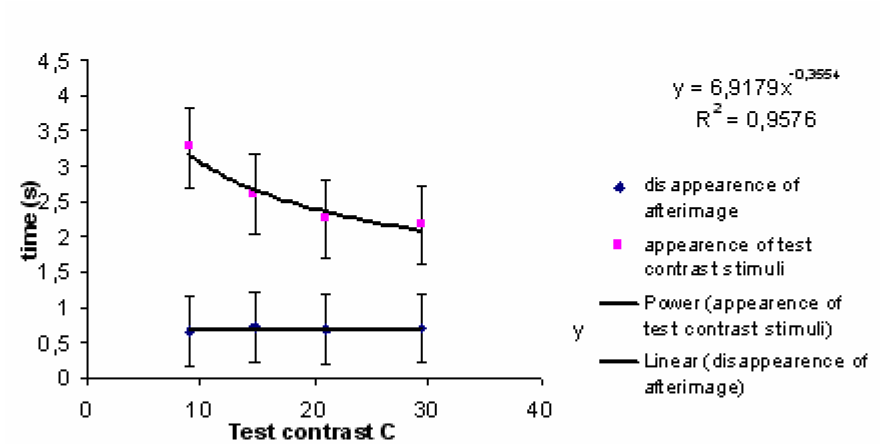


Fig. 4. Time when afterimage disappears (upper curve) and test stimuli appears (lower curve). Measured at four different test stimuli contrasts.

References:

1) Thomas Stephan Heinrich, Michael Bach, *Contrast Adaptation in Human Retina and Cortex.* Investigative Ophthalmology & Visual Science, October 2001, Vol. 42, No. 11, page 2721–2727.

2) Gardner JL, Sun P, Waggoner RA, Ueno K, Tanaka K, Cheng K., *Contrast adaptation and representation in human early visual cortex.* Neuron, August 2005, Vol. 47, page 607–620.

RAMAN AMPLIFIERS IN FIBER OPTICAL COMMUNICATION SYSTEMS

S. Makovejs, *IEEE/LEOS, OSA, SPIE, Student Member*
Riga Technical University, Telecommunications Institute
Address: 12, Azenes str., LV – 1048, Riga, Latvia
E-mail: s_mak@inbox.lv Phone: +3718615444

Internet traffic has drastically increased over the past several years, which in its turn has lead to the necessity of upgrading optical system components that stands for information transmission. It was understood that it makes no sense to use optical fiber for transmission of a single signal, so new technology, called Wavelength Division Multiplexing (WDM), was proposed. WDM technology is currently used in most long – haul transmission lines and assumes that a fiber is used for transmission of many channels. Since these channels occupy rather broad spectrum range, the problem of amplifying this bandwidth arises. Electrical amplifiers have become obsolete, since they are completely unpractical in this case, because one electrical amplifier would be needed for each channel, as well as signal conversion from one form to another. Raman amplification grants an alternative way to amplify signal optically, that is, one Raman amplifier can be used to amplify all channels simultaneously. It must be said that there are also other technologies of optical amplification, like EDFA and SOA, but they will not be covered here.

In my work different configurations of Raman amplifiers are examined and appropriate conclusions are drawn. Also, to the author's best knowledge, little research has been done, concerning the necessity of taking into account different parameters during design, respectively, in which cases do we have to include appropriate parameters and in which cases they can be neglected. My work gives is an attempt to clarify these questions and research in this area is to be continued in the future.

In a nutshell, the results show that it is not the best choice to neglect pump depletion (as it is often proposed) in the pump and signal propagation equations. Comparing with solving with numerical methods it was found that the error is quite big. At the same time, if we want to design WDM system with Raman amplification we must take into account different other aspects (like, amplified spontaneous emission, double Rayleigh scattering and others). The simulation of such system could take much computational time, so it might be much wiser to design a simple scheme first. If eye diagram, optical signal – to – noise ratio and BER are unsatisfactory in this case, it would be senseless to design more complex system.

Also, configurations of different number of pumping waves are compared. It has been corroborated that the more pumping waves are taken (with thoroughly adjusted wavelengths and powers), the flatter gain is obtained.

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DYNAMICS OF EYE MOVEMENTS IN RECOGNIZING IMAGES OF NATURAL OBJECTS

A. Podniece, R. Paeglis, I. Lacis
Department of Optometry and Vision Science,
University of Latvia, Riga, Latvia

We can perceive objects around us in about 150 ms and make some perceptual hypotheses about what we have seen. Some more time is needed for a motor response. Eye movements are among the fastest voluntary movements, therefore we want to explore which eye movement parameters are critical fast response to an image, and which of them change depending on how complicated the image is. With a complicated image we mean a photograph of an animated or unanimated object.

In a series of experiments we use an innovative solution to explore dynamics of eye movements in object recognition. We have developed an experimental scheme in which visual stimuli are shown 8 to 16 degrees off the line of sight. They appear after randomized periods for 300ms. We asked 10 people (age 20-30) with varying levels of knowledge about biology and about nature to shift their sight after an image is flashed. Volunteers in this experiment were encouraged to look to the side of the photo if it was an animal (mammal, insect, reptile, bird) or look away if it is another object or scene (natural landscape, cars, architecture, food, flowers). We registered eye movements with *iViewX* eye tracking system (infrared reflection). The analysis was performed with a Matlab solution ILAB (Fig.1) and *MS Excel*.

The results confirm that it is possible to train a person to use a saccade (look to) or and anti-saccade (look away) to classify objects. This is a faster way to react to an object than a button press or release which has been used extensively in vision research. In this way, we have verified that a human observer can recognize and classify animals and other objects in periphery faster than in 500ms.

All observers fall into two groups: those who recognize images correctly in more than 90%, reaction time about 450-500 ms, and persons who err frequently but start initial response in about 200-300ms.The latter can make up to 3 correcting eye movements within 500-700ms. Hence, in a single recognition event several actions are programmed. We also observed that some saccades are stopped before reaching a target (a correct or incorrect response) and another movement is launched. This casts a further doubt on the ballistic nature of saccades.

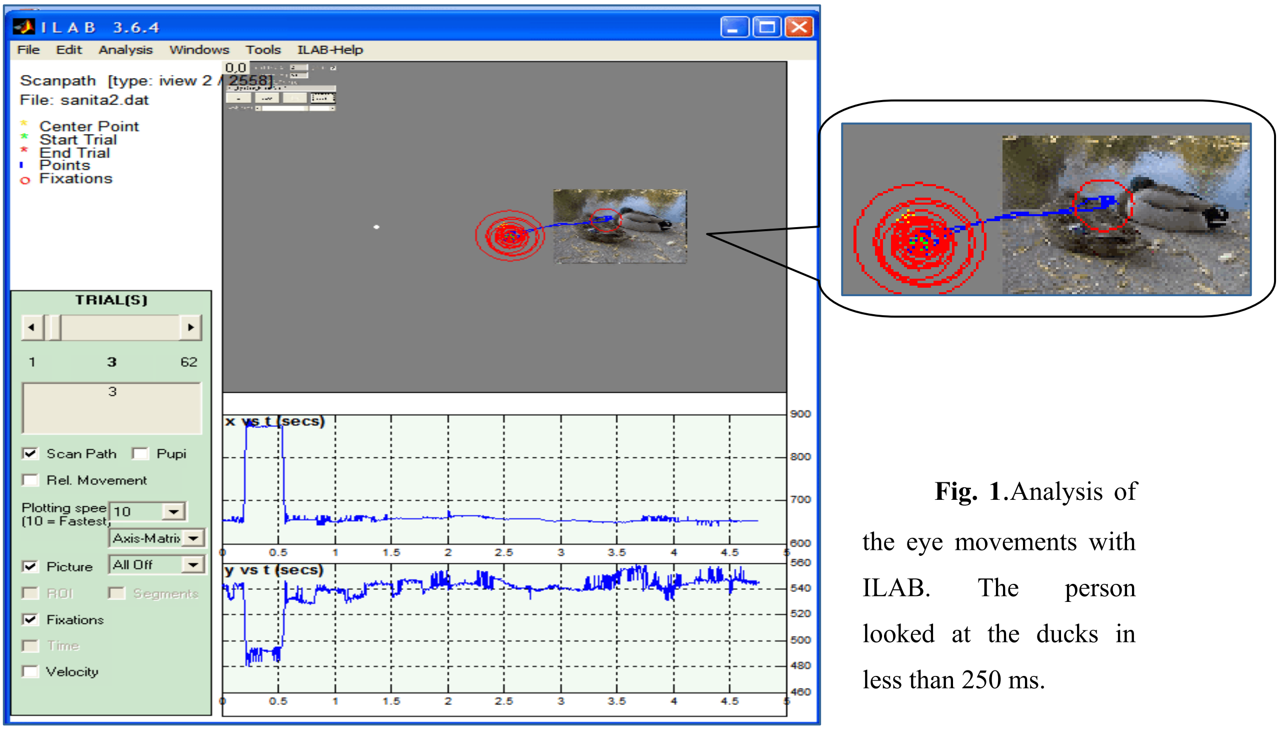

Fig. 1. Analysis of the eye movements with ILAB. The person looked at the ducks in less than 250 ms.

A second point of relevance is the connection between image features and the direction of the first saccade. In the case of an animal, the first saccade is preferentially guided to the animal's face or another typical part of the body (like a leg for quadrupeds) and lands there even after image has disappeared.

We find no support for the hypothesis that the response to classify an image depends on the observer's profession or education. Instead, it depends on the image complexity.

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References:

1. R. VanRullen, Ch. Koch, P. Perona. Rapid natural scene categorization in the near absence of attention, *PNAS* – **Vol. 99,** 2002, pp. 9596-9601.

2. I. van der Linde, U. Rajashekar, L.K. Cormack, A.C. Bovik. A study of human recognition rates for foveola-sized image patches selected from initial and final fixations on calibrated natural images, University of Texas at Austin(USA), 2005.

3. G.A. Rousslet, S.J. Thorpe, M. Fabre-Thorpe. Processing of one, two our four natural scenes in humāns:the limits of paralelism, *Vision Research*-**Vol-44**, 2004, pp. 877-894.

4. K.K. Evans, A. Treisman. Perception of Objects in Natural Scenes: Is It Really Attention Free? , *Journal of Experimental Psychology*-**Vol.31(6)**, 2005, pp 1476-1492.

5 .D.R. Gittelman. ILAB:A program for postexperimental eye movement analysis, *Behavior Research Methods, Instruments,& Computers*- **Vol.34(4)**, 2002, pp. 605-612.

SALIENCY BASED VISUAL ATTENTION AND THE VISUAL SEARCH TASK

S. Fomins, V. Karitāns, G. Ikaunieks, M. Ozolinš
University of Latvia Department of Optometry and Vision Science

Key words: *eye tracking, scene perception, attention, bottom-up processing, saliency*

Vision is an active process in which the viewer seeks out task-relevant visual information. A complete theory of vision and visual cognition requires an understanding of how ongoing visual and cognitive processes control the orientation of the eyes in real time, and in turn, how vision and cognition are affected by gaze direction over time. Attention plays a central role in visual and cognitive processing, and because eye movements are an overt behavioral manifestation of the allocation of attention in a scene, eye movements serve as a window into the operations of the attention system.

Two general classes of selection mechanisms control the allocation of attention. First, *bottom-up* selection involves fast, and often compulsory, stimulus-driven mechanisms. That is to say, those particular parts of the visual input are selected based on the properties of that input. For example, movement in the peripheral visual field, such as a shooting star, or a unique feature, such as a single red apple among green apples, will automatically attract attention. Such salient stimulus features capture attention in visual search tasks (Yantis and Jonides, 1984) and influence the guidance of eye movements in free-viewing of natural scenes (Parkhurst *et al.*, 2002). On the other hand, *top-down* selection, is a slower, goal-directed mechanism in which the observer's expectations or intentions

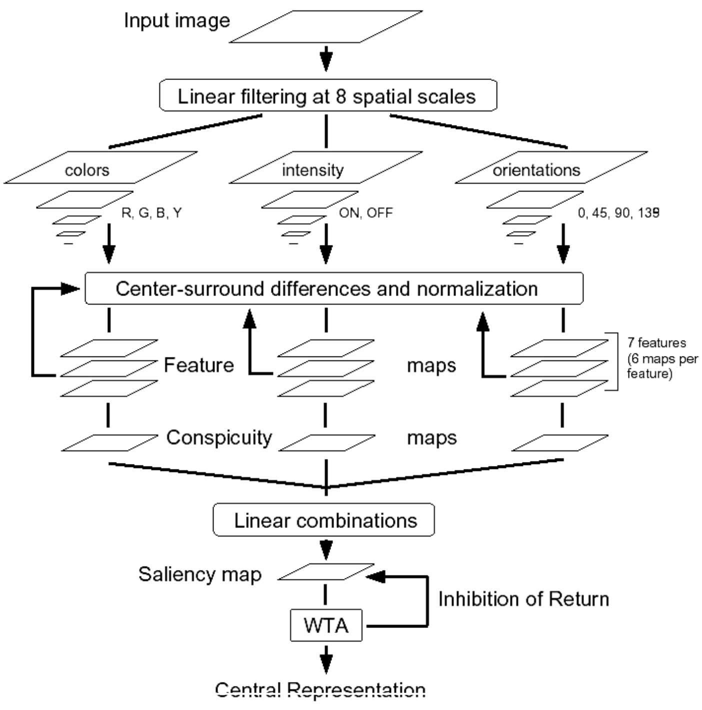

Fig. 1. Saliency based model of attention [1].

influence the allocation of attention. For example, task demand can influence the viewing behaviour.

The model of saliency based visual attention for analysis of scenes was proposed by Itti, Koch, and Niebur (1998) (***fig.1***). The model is based on the extraction of the early visual features of images in order to provide bottom-up input to the saliency map. Processing includes the centre-surround mechanisms simulating the photoreceptor cells' receptive fields in the retina. This approach is motivated by the biological computational models of vision. The model was able to reproduce human performance for a number of pop-out tasks. Although the result does not necessarily indicate similarity between human eye fixations and the model's attentional trajectories, it indicates that the model, like humans, is attracted to "informative" image locations [3,4].

In our experiment 'C' letter optotype stimuli on the white screen background were exposed to an observer with the task to find a diagonally oriented gap letter between vertically oriented distractors of the same size and color (***fig.2***). Presented stimuli consisted of the sum of the clear stimulus and the blurred contribution *B*. Blurring was applied through digital filtering with a Gaussian. For each set of blur *B* and the Gaussian (dispersion/sigma), the Michelson contrast ratio of the luminance modulation along the gap region was chosen as a measure of the blur depth.

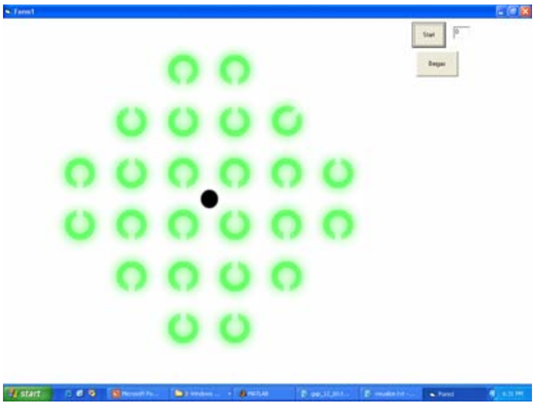

Fig. 2. 'C' letter stimuli. Task is to find the diagonally oriented.

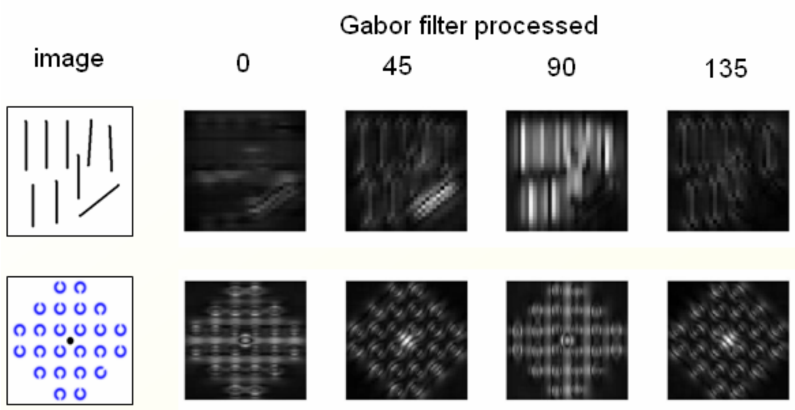

Fig. 3. Orientation maps of line and C letter images.

The sizes of stimuli subtended angles of 0.37, 0.75 and 1.5 degrees. Blue and green stimuli were presented to three observers and thirty trials were run for the each of the search sets.

The stimuli search time and search object notification distance, were analyzed. Two distinct searching behaviors were realized/ascertained. For the low contrast and highly blurred sets the search behavior can be characterized by small step saccades mostly to the neighboring distractor. A lot of backwards steps were made to compare the current stimulus with a previous one. With the high contrast sets more typical for blue stimuli, large rapid saccadic movements along the task field were dominant.

The performance of the saliency model's first stage was compared for line distractor stimuli and experimental stimuli. It was noticed that the first stage is insensitive to the C letter orientation (***fig.3***). Further improvements are to be made to detect the orientation of the gap taking into account models of receptive field of retina.

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1. Laurent Itti, Christof Koch, and Ernst Niebur. *A Model of Saliency-Based Visual Attention for Rapid Scene Analysis*. IEEE Transactions on pattern analysis and machine intelligence, Vol. 20, No. 11, November 1998. Laurent Itti, Christof Koch, and Ernst Niebur.

2. Derrick Parkhurst , Klinton Law, Ernst Niebur. *Modelling the role of salience in the allocation of overt visual attention.*
Vision Research 42 (2002) 107–123

3. Wolfgang Einhauser and Peter Konig. *Does luminance-contrast contribute to a saliency map for overt visual attention?* European journal of neuroscience, Vol.17, pp, 1089-1097, 2003.

4. Michael L. Mack, Monica S. Castelhano, John M. Henderson & Aude Oliva. *What the Visual System "Sees": The relationship between fixation positions and image properties during a search task in real-world scenes.* OPAM(*Outdoor Photography Association of Michigan*) Annual Workshop, Vancouver.

LIFETIME DETERMINATION OF DEGENERATE MOLECULAR LEVELS IN CW REGIME USING THE AUTLER-TOWNES EFFECT

T. Kirova[1], A. Ekers[1], R. Garcia-Fernandez[2], M. Auzinsh[1], K. Blush[1], N. N. Bezuglov[3], L. P.Yatsenko[4], K. Bergmann[2], O. Dulieu[5], and M. Aymar[5]

[1] Institute of Atomic Physics and Spectroscopy, University of Latvia, Riga, Latvia
[2] Department of Physics, University of Kaiserslautern, Kaiserslautern, Germany
[3] Fock Institute of Physics, St. Petersburg State University, St. Petersburg, Russia
[4] Institute of Physics, Ukrainian Academy of Sciences, Kiev, Ukraine
[5]Laboratoire Aimé Cotton, CNRS, Campus d'Orsay,Orsay Cedex, France

Most schemes of laser manipulation of quantum states rely on the use of strong field effects in light-matter interactions, which can be interpreted in terms of the Autler-Townes (AT) effect [1]. The AT effect is observed as a splitting of spectral lines in the excitation spectrum due to "dressing" of the molecular energy levels by a strong laser field. The AT effect itself has a potential for development of novel applications, like the recently demonstrated technique for lifetime and branching ratio measurements of highly excited molecular states using cw laser fields [2]. The method is demonstrated on example of the $5^1\Sigma^+{}_g$ (v=10, J=9) state in Na_2.

The experiment was performed in a supersonic molecular beam of Na_2 crossed by two parallel co-propagating laser beams. The probe laser excites the $X^1\Sigma^+{}_g$ (v"=0, J"=7) to $A^1\Sigma^+{}_u$ (v'=10, J'=8) molecular transition, whereas the strong field couples the excited state $A^1\Sigma^+{}_u$ (v'=10, J'=8) to the final $5^1\Sigma^+{}_g$ (v=10, J=9) state. The fluorescence signal from both the excited and final states was detected as a function of the probe field detuning for different detunings of the strong field. The excitation spectra exhibit the typical AT doublet pattern with the separation between the AT components equal to $\sqrt{\Omega_S^2 + \Delta_S^2}$, where Ω_S and Δ_S represent the coupling field Rabi frequency and detuning respectively. The ratio of the two AT peak intensities is shown to depend on the strong field detuning and on the lifetimes of the intermediate and upper levels.

Analysis based on the dressed-states approach [3] shows that when the probe field is sufficiently weak and in the case of non-degenerate levels and negligible inhomogeneous broadening, this ratio is a simple function of the lifetime of the final level and can therefore serve as a tool for its direct measurement. Under real experimental conditions molecular levels exhibit magnetic sub-level degeneracy, and profiles of spectral lines are subject to Doppler broadening. Simulations based on the density matrix equations of motion were performed and gave the best fit to the experimental data with a value of 40ns for the lifetime of the $5^1\Sigma^+_g$ (v=10, J=9) state in Na_2. This value is in good agreement with the theoretical estimates based on *ab initio* calculations.

References

[1] S. H. Autler and C. H. Townes, Phys. Rev. **100**, 703 (1955)

[2] R. Garcia-Fernandez, A.Ekers, J. Klavins et al., Phys. Rev. A, **71**, 023401 (2005)

[3] C. Cohen-Tannoudji and S.Reynaud, J. Phys. B, **10**, 345 (1977)

COHERENT EXCITATION AND QUADRATIC STARK EFFECT IN THE CESIUM HYPERFINE MANIFOLD: LEVEL CROSSING AND ALIGNMENT TO ORIENTATION CONVERSION

M. Auzinsh, K. Blushs, R. Ferber, F. Gahbauer, A. Jarmola, M. Tamanis
University of Latvia, Department of Physics and Mathematics, Rainis Blvd. 19, Riga LV-1586, Latvia

Level crossing spectroscopy and alignment to orientation conversion in the hyperfine manifold of cesium will be described and discussed. Level crossing spectroscopy in an external electric field was used to investigate the tensor polarizabilities α_2 of the $nD_{3/2}$ and $nD_{5/2}$ states of cesium with n=7,9, and 10. Using a precisely measured value of α_2 for the case of n=10, new measurements of α_2 for n=7 and 9 were made and compared with previous measurements in the literature [1]. In the case of the $nD_{5/2}$ states, level crossing spectroscopy could provide information about the hyperfine constant *A*.

Alignment to orientation conversion was caused by an electric field in the $7D_{3/2}$ and $9D_{3/2}$ states of cesium without the need for magnetic fields or collisions [2]. Initial alignment was caused by linearly polarized exciting radiation. The appearance of orientation was confirmed by the observation of circularly polarized fluorescence light.

The experiments were performed with cesium vapor in a glass cell at room temperature. Electric fields up to 2000 V/cm were produced by Stark electrodes inside the cell. Two step laser excitation with diode and dye lasers was used. Experimental signals were compared with a detailed theoretical model.

[1] M. Auzinsh, K. Blushs, R. Ferber, F. Gahbauer, A. Jarmola, and M. Tamanis, Opt. Comm. (to be published).

[2] M. Auzinsh, K. Blush, R. Ferber, F. Gahbauer, A. Jarmola, M. Tamanis, arXiv.org, physics/0603194

Invited lecture

COMMERCIALIZATION OF INVENTIONS

E.Baltins
Connect Latvija
Elmars_b@connectlatvia.lv,
www.connectlatvia.lv

Connect has a success history of bringing together science and business institutions worldwide. Connect Latvia has already launched several high-tech spin-offs and opened the gate of international markets to several Latvian science-based enterprises.

In today's market economy, growing importance is assigned to the development of knowledge based businesses. This fact is emphasized by government representatives, business leaders, and professionals at all levels. The economical development is driven by technological and innovation capacity. In this process skills to transfer the ideas and inventions into commercially viable applications play a very important role.

There is a lot of industrial equipment available on the market for many different applications in all kinds of industries, including those that have been developing rapidly in recent years – biotechnology, nanotechnology, and others. This shows the increased level of usage of human brainpower nowadays. These facts support the trend that during the next 20 years there will be ever more and more needs for new and revolutionary solutions in all industries.

There are at least three critical resources that can make a strong basis for successful entrance into the future of the commercialization of inventions:
research and development – building up world-class capacity in basic and applied research in the region. Businesses and even industries are changing faster than ever, thus creating more opportunities for new applications than ever. Research is as critical to the renewal of existing industries as to the building of new ones
networks – social interaction in the e-information society plays a very important role in accelerating technology commercialization efforts. Lately, networks in fast running and changing business environments have been recognized as necessary for keeping

individuals and organizations at the leading edge. Special skills to act in the network driven world (rather than in the hierarchical world of old fashioned organizations) are required for those willing to succeed when faced with challenging obstacles and innovations. Business has no borders anymore in this world, and that makes networks an unambiguous resource in sustaining leadership

human resources – the market is saturated as never before and it becomes harder to get into the market with a new product. Therefore special skills and continuously updated knowledge of individuals and companies are crucial in the process of commercialization of inventions. This is where professionals in running commercialization processes and entrepreneurs must be in place to bring the good inventions and ideas from universities and research institutes to the marketplace.

In conclusion, it must be clarified that commercialization of the new inventions by university researchers and inventors is not a charity, but a business, where researchers, entrepreneurs, investors and marketing or commercialization experts each has an important and rational role.