

## Airglow emissions : fundamentals of theory and experiment

R Chattopadhyay<sup>1\*</sup> and S K Midya<sup>2,3</sup>

<sup>1</sup>Haripal G.D. Institution, Khamarchandi, Hooghly-712 405, West Bengal, India

<sup>2</sup>Department of Physics, Serampore College, Serampore, Hooghly-712 201, West Bengal, India

<sup>3</sup>Centre for Space Physics, 43 Chalanika, Garia Station Road, Kolkata-700 084, India

E-mail : rchattopadhyay2001@yahoo.com

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**Abstract** : In this article, discovery of airglow and ionosphere has been discussed briefly in the historical and scientific perspectives. Mentioning about all significant atmospheric parameters, different areas of research in airglow and different ionospheric layers of importance have been briefly described. Different types of airglow emissions, related chemical kinetics, different excitation mechanisms of the involved atomic, molecular or ionic species have been discussed giving stress specially to four main airglow emissions. Different layers of ionosphere, their characteristic material content and specific ranges of responses to different kinds of interacting fields *etc.* have also been briefly discussed. The Sun has been described as the main source of all kinds of energetic interactions with the terrestrial ionosphere. Specific solar parameters, that are representatives of various solar activity, have been discussed briefly in relation with the corresponding covariation of various ionospheric parameters involved in the calculations of airglow intensity. Different solar activity periodicities that have been discovered upto date are mentioned. Relations of different airglow emissions with ionospheric activities and specific ionospheric parameters have been briefly described. The important role of ozone in the stratosphere and lower thermosphere in the production of some airglow emissions has been discussed with exemplary works. Different wellknown features of airglow intensity variations such as altitudinal variation, latitudinal variation *etc* have also been mentioned. Different atmospheric models have been briefly described along with their usefulness. Descriptions of different missions and campaigns with which a number of airglow experiment sets are involved, have been presented in a tabular form. Discovery of some new airglow lines, some newly proposed excitation mechanisms and related kinetics, and some remeasured or reevaluated constants and coefficients have been reported too. Effect of different types of solar activity, of different kinds of lunar influences and of various terrestrial atmospheric features, such as, geomagnetic field alignment, geomagnetic storm, lightning, earthquake, dynamical coupling between layers of thermosphere,  $\mathbf{E} \times \mathbf{B}$  drift and ring current *etc* on terrestrial airglow emissions have also been briefly discussed. Some interesting airglow related features which have been discovered in recent past are discussed. Applications of different airglow features have been reported. Lastly, facts and speculation about ionospheric compositions, activities and possible airglow emission features of other inner and outer planets, satellites, comets and meteors have been discussed very briefly.

**Keywords** : Airglow, solar indices, ionospheric activities

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## A report on some specific features of the atmospheric electric potential gradient in Kolkata

S S De <sup>\*1</sup>, B K De <sup>2</sup>, S K Adhikari <sup>1</sup>, S K Sarkar <sup>3</sup>, R Bera <sup>1</sup>, A Guha <sup>1</sup> and P K Mandal <sup>1</sup>

<sup>1</sup> Centre of Advanced Study in Radio Physics and Electronics, University of Calcutta,  
92, A. P. C. Road, Kolkata - 700 009, India

<sup>2</sup> Department of Physics, Tripura University, Agartala, Suriyamaninagar - 799 130, Tripura, India

<sup>3</sup> Department of Physics, University of Calcutta, 92, A. P. C. Road,  
Kolkata - 700 009, India

E-mail : de\_syam\_sundar@yahoo.co.in

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**Abstract** : The results of measurement of surface potential gradient of the atmosphere in Kolkata (latitude: 22°34' N) will be presented. The observed fields at daytime and night time are seen to be higher and show considerable fluctuations from the daily averages of electric field and also a few hours difference in phase with the observations made at different tropical and temperate latitudes. The mean value of the potential gradient averaged for 35 days over a period from February 2004 to January 2005 is around 200 Vm<sup>-1</sup> and the maximum and minimum values are 1.14 times and 0.88 times the mean value, respectively. The results are discussed in terms of the variations of the local factors as well as distribution of thunderstorm activities.

**Keywords** : Atmospheric electricity, potential gradient, global electric field, thunderstorm activity

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## Synthesis, characterization and dilatometric studies on N-(*p*-*n*-tri and tetra decyloxybenzylidene)-*p*-toluidine

S Sreehari Sastry\*, K Vijaya Lakshmi, M Ramakrishnancharya, Nanchara Rao, G Sahaya Baskaran  
and C Ramachandra Prabhu<sup>1</sup>

Department of Physics, Acharya Nagarjuna University, Nagarjunanagar 522 510, Andhra Pradesh, India

<sup>1</sup> Faculty of Physics, Department of Applied Sciences, Higher College of Technology,  
P.O. Box -74, Al-Khuwair-133, Muscat, Oman

E-mail: sreehari\_ssastry@yahoo.com

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**Abstract** : Synthesis, characterization and phase transition studies are carried out on two Schiff base liquid crystal materials viz., N-(*p*-*n*-tridecyloxybenzylidene)-*p*-toluidine, 13O.1 and N-(*p*-*n*-tetradecyloxybenzylidene)-*p*-toluidine, 14O.1. The characterization studies (phases and phase transition temperatures) are carried out using polarising microscope equipped with hot stage and differential scanning calorimeter. The phase transition studies are carried out using dilatometric technique. The results infer that these two compounds possess only one monotropic liquid crystalline phase viz., smectic-A. The order of phase transition across isotropic to smectic-A is found to be of first order. The results are discussed in the light of the data available on other nO.m liquid crystal compounds.

**Keywords** : Liquid crystal, synthesis, phase transition, dilatometry, density measurements

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## Ground state properties of ZnX (X = S, Se and Te) semiconductors

A R Jivani\*, H J Trivedi, P N Gajjar and A R Jani

Department of Physics, Sardar Patel University,  
Vallabh Vidyanagar - 388 120, Gujarat, India

E-mail: jivani\_a\_r@yahoo.com

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**Abstract** : The electronic properties viz. total energy, band gap at Jones-zone face and bulk modulus of ZnS, ZnSe and ZnTe semiconductor compounds with zincblende structure are investigated using higher-order perturbation theory, which includes covalent correction term. For describing the electron-ion interaction in these semiconductor compounds, our proposed model potential consisting of linear and quadratic type of interaction within the core and Coulombic interaction outside the core is employed. The computed ratio of the covalent bonding term  $E_{cov}$  to the second order term  $E_2$  comes out to be 6.90% to 13.1% and hence confirms the essentiality of higher-order correction for zincblende-type crystals. We have achieved a good agreement of present findings of total energy, band gap at Jones zone face and bulk modulus with the experimental data and other such available theoretical findings.

**Keywords** : Pseudopotential, semiconductor compounds, total energy, bulk modulus, band gap at X.

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## Mathematical modeling of glow peaks of fluorites relevant to dosimetry and dating

R K Gartia\*, U Ranita and Th Basanta Singh

Luminescence Dating Laboratory, Manipur University,  
Imphal-795 003, Manipur, India

E-mail : rkgartia@yahoo.co.in

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**Abstract** : Mathematical modeling of glow peaks (as many as eleven in the range of 30-600°C) of fluorites (light green) of Indian origin relevant to dosimetry and dating, has been successfully achieved to a high degree of certainty in the frame work of general order kinetics formalism. The criteria to accept the goodness of fit between the experimental glow curve and the numerically generated best fit curve, is judged not from the figure of merit (FOM) as conventionally done but from a rather rigorous criteria *i.e.* the Chi-square ( $\chi^2$ ) test. With this achievement, it has been possible to estimate the lower limit lifetime ( $\tau$ ) of electrons trapped at deep levels of fluorite. The values of  $\tau$  is found to lie in the range of  $10^{16}$  -  $10^{23}$  years at 300°K. Thus, the high temperature glow peaks have potential use in determining the time of mineralisation of the material. In fluorite, these glow peaks occur at 398°C, 439°C, 477°C and 545°C for a moderate heating rate ( $\beta$ ) of  $0.25^\circ\text{Cs}^{-1}$ .

**Keywords** : Thermoluminescence, mineralisation, glow curve deconvolution, lifetime

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## Multiple feedback third order active- $R$ filter with varying tapping ratio $B$

G N Shinde\* and P D Achole

Research Laboratory in Electronics, Yeshwant College,  
Nanded – 431 602, Maharashtra, India

E-mail : shindegn @ yahoo.co.in

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**Abstract** : A third order active- $R$  filter using operational amplifiers (op-amp) and resistors, is designed with multiple feedback and feedforward input signal. It is studied for different values of tapping ratio  $B$ . Center frequency  $F_o$ , circuit merit factor  $Q$  and the positive feedback resistor  $R$  which taps  $R_z$  are kept constant at 60 kHz, 10 and 400  $\Omega$ , respectively. The circuit exhibits low pass, band pass and high pass response at corresponding output points. The gain roll-off in low-pass response is unaffected by varying tapping ratio  $B$ . Band pass response for  $B = 0.5$  shows better gain roll-off and is more symmetric in nature. Bandwidth of the circuit decreases as  $B$  is increased. In high pass response, overshoot increases with increase in  $B$ . The gain roll-off per octave in the transient part is about +14 dB for all values of  $B$  except 0.5, but the gain gets stabilized almost at 0 dB for  $B = 0.5$ .

Thus, it gives better performance for  $B = 0.5$ . It is easy to design, suitable for monolithic IC implementation and useful for high frequency operation. It also gives better pass band gain.

**Keywords** : Center frequency, feedforward, filter, merit factor, multiple feedback, tapping ratio and third order.

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## The prediction of mass of $Z'$ -boson in an $SO(10)$ -based model

S Sahoo

Department of Physics, National Institute of Technology (Deemed University)  
Durgapur-713 209, West Bengal, India

E-mail: sukadevsahoo@yahoo.com

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**Abstract** :  $Z'$ -bosons are known to naturally exist in well-motivated extensions of the Standard Model. The mass of  $Z'$ -boson is considered in an  $SO(10)$ -based model. We have used the low energy parameters and the estimated value so obtained is accessible to experiments at low energies.

**Keywords** :  $Z$ -boson,  $Z'$ -boson, Higgs boson, grand unified theory

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## Speed and shape of dust acoustic solitary waves in a three-component dusty plasma with vortex-like ion distribution

Prasanta Chatterjee\*<sup>1</sup> and Bholanath Sen<sup>2</sup>

<sup>1</sup> Department of Mathematics, Siksha Bhavana,  
Visva Bharati, Santiniketan-731 235, West Bengal, India

<sup>2</sup> Chhatna Chandidash Vidyapith,  
Chhatna-722 132, Bankura, West Bengal, India

E-mail: prasantachatterjee1@rediffmail.com

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**Abstract** : The existence of dust acoustic solitary waves are investigated on the non-linear, unmagnetized homogeneous three-component dusty plasma whose components are inertial charged dust particles, Boltzmann distributed electrons and vortex like distributed ions. The Sagdeev's pseudopotential technique is employed for this study. Pseudopotential is determined in terms of  $u_d$ , the dust ion speed. It is found that there exists a critical value of  $u_{d1}$ , the value of  $u_d$  at which  $u_d'^2 = 0$  and beyond which the solitary waves cease to exist.

**Keywords** : Dust acoustic solitary waves, speed, shape, pseudopotential technique

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## Earth-ionosphere wave guide model for Rugby – Visakhapatnam path consistent with VLF phase variation measurements

D N Madhusudhana Rao<sup>1</sup>, M Indira Devi<sup>1\*</sup>, T Arunamani<sup>1</sup> and Ibrahim Khan<sup>2</sup>

<sup>1</sup>Department of Physics, Andhra University, Visakhapatnam –530 003, Andhra Pradesh, India

<sup>2</sup>Department of Instrumentation Technology, Andhra University College of Engineering,  
Visakhapatnam - 530 003, Andhra Pradesh, India

E-mail: indiramalladi@yahoo.com

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**Abstract** : The phase variation measurements of 16 kHz VLF transmissions from Rugby (England) made at Visakhapatnam (India) for over one year have been used as the basis to find the model for the Earth – ionosphere wave guide for the transmission path that reconciles with experimental measurements. The computations have been carried out assuming a perfectly conducting Earth and three different lower ionospheric conductivity models, namely, sharply bounded with infinite conductivity, sharply bounded with finite conductivity and a diffuse boundary with exponentially varying conductivity. It is found that the exponential model gives a diurnal phase shift or day to night shift in the height of reflection much less than what is obtained from measurements. But a sharply bounded ionosphere with finite conductivity is found to reproduce not only the diurnal height change but also the seasonal variation in it, seen in experimental data.

**Keywords** : Radio wave propagation, ionosphere, D-region, VLF phase variations.

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## Scattering of positron by hydrogen-like ion

P K Verma, M K Sinha

University Department of Physics, B.R. Ambedkar Bihar University,  
Muzaffarpur-842 001, Bihar, India

and

D N Roy

Department of Physics, Patna University, Patna-800 005, Bihar, India

E-mail : labhkishorji@yahoo.co.in

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**Abstract** : Scattering of positron by hydrogen-like ion  $\text{He}^+$  has been theoretically analysed by employing distorted-wave method. Total cross section and differential cross sections for  $1s$ - $2s$  excitation of  $\text{He}^+$  by positron-impact, have been evaluated in intermediate and high energy ranges. Differential cross sections have been calculated with polarization potential and without polarization potential to observe the impact of polarization potential on differential cross section. Phase shifts for  $e^+ - \text{He}^+$  elastic scattering have been calculated. Results have been compared with available theoretical results.

**Keywords** : Scattering of positron, hydrogen-like ion, distorted wave method, phase shift.

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