Session 2
Auroral Spectroscopy

THE COMPUTER ANALYSIS OF AURORAL GREEN LINE EMISSION VARIATIONS.

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Photomertric time seguences from pulsating aurora are analysed by new method to determine the parameters of two-step green line excitation mechanism. Such mechanism, as know, is described by the set off two differential equations (SDE), depending on two excitation rates quatum yield of $O(^1S)$ atim from precursor and $O(^1S)$ atom. New approach consist in reduction of SDE to linear integral equation(LIE) using sequental identical transformations. The linear multi-parameter regression process is used to determine above named auroral parameters from LIE for real auroral observations. The precision of the LIE method is Better than tradition approash because off using full information of temporal spectra. The work of the LIE computer algorithm will be presented in the report.

EXCITATION OF THE LBH BANDS BY PROTON PRECIPITATIONS

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Production rate of $a^1\Pi_g$ state and absolute photon yield for emission of the LBH system bands are predicted for proton aurora. The calculations were made in three-component (N_2, O_2, O) atmosphere. The contributions of both primary and secondary particles in excitation of the LBH emission were analyzed. Synthetic spectra of the LBH system at different altitudes are demonstrated. Dependence of ratios of the intensities of the N_2 LBH, N_2^+ 1NG, H_β emissions on the characteristic energy of proton flux are discussed.

THE THEORY OF THE ELECTRON-PROTON-HYDROGEN ATOM AURORA: COMPARISON WITH OBSERVATIONS

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Recently, a self-consistent theory for the combined electron-proton-hydrogen atom aurora has been developed. To date, the portions of the model involving just electron transport have been tested against a variety of data with good agreement. Comparisons between the proton-hydrogen atom portion of the model and data are just beginning. In this paper, we review our initial attempts to validate this fully coupled three component auroral model with particular emphasis on the role of the protons and hydrogen atoms.

Specifically, we model three separate auroras and compare with different types of observations. In case 1, we model upgoing electrons observed by the DE-2 satellite as it passes through a region of downgoing protons and electrons. Our second case involves modeling the E region electron density observed by the Chatanika radar during a proton aurora. For our third case, we model the column emission rates observed during a combined aurora by rocket borne photometers . In all three cases, these initial attempts to test the theory versus data are judged to be successful.

SPECTRAL DISTRIBUTION OF ENERGY OF AURORAL EMISSIONS

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Calculations of energy of auroral emissions in various spectral intervals in the region 0.02 to 1.3 mcm have been made on the base of Photometric Semi-Empirical Stationary Airglow Model (PSESAM-1992) created. The above-mentioned spectral region was divided on five intervals. The calculations were made for a central part of the midnight auroral oval for winter solstice and middle solar activity ($F_{10.7}$~150). It was obtained that the energy of auroral emissions in atmospheric column at altitude Z in zenith direction varied approximately to 1.5-2.0 order when Kp-index changed from 0 to9. However, the ratio of the energy yields of the UV-radiation unpenetrating to ground surface (0.02=0.3 mcm) and the radiation which penetrated to one (0.3-0.4 mcm) did not practically depend upon geomagnetic disturbance level. These ratios for different altitudes such as 100 km, 150 km, 200 km and 250 km are about 1.4, 2.0, 3.5 and 4.5, respectively.

MAPING THE EQUATORWARD BORDER OF DIFFUSE AURORA IN 5577 A AND N_2 I POS BAND

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In this paper the analysis of observatorions of the green line 5577Å together with N_2 I Pos band in aurora is presented. The airglow and aurora data base of Calgary observatory, Canada (gemagn. lat. 58 deg.) is used. Every time when Kp exceeds 6+, the south edge of aurora crosses the Calgary`s zenith. A space scaning, 3-narrow-band tilting filter photometer is used for observations. First filter is centred at 5577Å, the second- at $P_1(2)$ of OH(8-3), and the third-at $P_1(5)$. At the time of aurora the emission through the last one-near 7395Å is entierly due to N_2 I Pos, as syntetic spectra, calculated by us show. We map 5577Å and N_2 I Pos band in coordinate system-zenith anglelocal time. The maps belong to the equatorward edge of diffuse aurora. For calculation of energy transformation of particle precipitation we hawe used the simultaneous measurements of DMSP satellite, passing at the same time over Calgary. The coefficient of energy transformation for 5577Å is found to be 7.10^{-4} erg/R and 5.10^{-6} erg/R for N_2 I Pos band in the energy region less than few hundred ev. The optical data show the existence of very narrow band of precipitation of soft particles, equatorward situited, with energy flux less then 10^{-4} erg/cm^{2}s, not detectible by the satellite.

EXCITATION MECHANISMS FOR THE PRODUCTION OF O(^{1}S) IN AURORA

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The excitation mechanisms of 5577Å auroral green line are studied using data from in situ rocket measurements by [1,2]. Distinctive feature of our study is the simultaneous modelling of the green line luminosity profiles and the luminosity ones of VK-bands and 1NG bands of N_2 and N_2^+. For satisfactory agreement between modeled luminosity profiles and observed ones we derive a value for the rate constant in quenching reaction O(^{1}S) + O equal to $1x10^{-16}$ exp(-380/T). It is shown that the energy-dependent behavior of the column intensity ratio I(5577Å)/I(4278Å) is strongly varied with season and cannot be a good instrument for deducing initial electron flux parameters.

1. W.E.Sharp, M.H.Rees, A.I.Stewart.(1979) *J.Geophys.Res.* V.84, p.1977.
2. A.J.Deans, G.G.Shepherd. (1979) *Planet.Space Sci.* V.26, p.318.

SOME RESULTS ON e^--p-H TRANSPORT IN THE ATMOSPHERE.

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Some results for Monte-Carlo transport model of auroral electron and proton-hydrogen atom precipitations are presented. An influence on the main transport characteristics of the dipolar geomagnetic field were consider in detail by "collision-by-collision" degradation scheme. For electron and proton fluxes it was found that: (1) the model gives a good agreement with the laboratory transport measurements of the energy deposition distributions, ranges, albedo, lateral spreading and "effective eV per electron-ion pair"; (2) the shape of the altitude energy deposition distribution depends on dipolar geomagnetic field insignificantly, but albedo is changed very strongly; (3) the main feature of the electron flux spectra in the whole energy and pitch-angle ranges, including "break" of the flux curve near 20-30 eV, are described by our model sufficiently good; (4) the lateral spreading of the proton fluxes has a very complex dependence on initial energy and altitude; (5) the energy-dependent behaviour of the "eV per electron-ion pair" for electron and proton fluxes has a similar shape and is nearly constant (~35 eV) as initial energy of particle increases.

CALCULATION OF H_β EMISSION IN AURORA. COMPARISON WITH OBSERVATIONS.

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H_β emission in aurora is calculated by simplified model based on results of precise Monte-Carlo simulation of proton-H atom transport in the atmosphere. Comparisons with rocket measurements [1] and simultaneous satellite and groundbased observations [2] were made. It was found that both altitude profile of emission rate and spatial distribution of column emission rate observed from the ground agree well with values calculated by measured downgoing proton flux.

1. F.Soraas et al. (1974) *J.Geophys.Res.* V.79, P.1851.

2. T.Ono et al. (1987) *Geophys.Res.Let.* V.14, P.660.

SIMPLIFIED ALGORITHM FOR PRECISE CALCULATION OF SPATIAL DISTRIBUTIONS IN COMBINED ELECTRON-PROTON-HYDROGEN ATOM AURORA.

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Simplified algorithm was built for calculation of spatial distributions of energy deposition, ionization and emission rates in the zone of combined electron-proton precipitation. The data of low-altitude satellites may be used as initial parameters of downgoing streams. The algorithm is based on results of precise Monte-Carlo simulation of electron and proton precipitations and gives the ability to avoid long-time transport calculations for modeling of various auroral phenomena. The algorithm takes into account following effects: (1) mirroring of electrons and protons, (2) altitude and energy dependence of spreading for proton-H atom fluxes, (3) influence of the atmosphere density and composition profiles. The error of the algorithm at the altitudes 100-200 km doesn't exceed 10% in comparison with precise Monte-Carlo method.

CALCULATIONS AND OBSERVATIONS OF PROTON PRECIPITATION IN THE DAYSIDE AURORA

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A simple procedure to evaluate the Balmer excitation rates of Hα and Hβ produce the corresponding volume emission rates vs. height, using semi-imperical range relations of proton in air is used. The calculations are carried out with identified ion-energy particle spectra of the dayside aurora obtained by low altitude satellites. It is found that the calculated emission intensities of Hα and Hβ are observable for ground-based optical detection. Measurements of the dayside aurora at Longyearbyen, Svalbard, are discussed in relation to these calculations. Furthermore, it is observed pulsed proton events on the dayside, which for decreasing time between each event shows increase in the emission intensity and a fluctuating behavior in the primary initial proton energy. Each pulsed proton event was associated with an enhancement in green 5577Å emission, and some correspondent to poleward-moving auroral forms.