EPSC Abstracts
Vol. 5, EPSC2010-337, 2010
European Planetary Science Congress 2010

Properties of AKR source from two point measurements

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Abstract

The radiation pattern has been determined on the basis of the comparative analysis of auroral kilometric radiation (AKR) received in the space-diversity mode by two satellites, INTERBALL-2 and POLAR. The radiation propagates in a cone with an opening angle ~ ±25°and the axis aligned with the local magnetic field. The results confirm the theoretical estimates that the source boundaries play a significant role in the generation of the auroral kilometric radiation and in the formation of the radiation pattern.

1. Introduction

Auroral kilometric radiation (AKR) is an electromagnetic emission which is generated in regions located at auroral latitudes and propagates away from Earth. Wu and Lee (1979) proposes the cyclotron maser instability development of the auroral regions of the magnetosphere with a low plasma density (ω_P/ω_B <<1, in the Calvert cavity) as a mechanism of AKR generation. This mechanism describes well most of observed AKR properties, in particular, the dependence of the AKR intensity on the geomagnetic activity, AKR polarization, typical frequencies et etc. According to the proposed mechanism, the radiation flux should be maximal in the direction outward from the Earth at angles of 60°-80° with respect to the local magnetic field.

The problem of the generation of AKR in a spatially bounded region and influence of cavity boundaries on the AKR spectra was considered by P.Louarn and D. Le Queau (1996) and T. Burinskaya and J.L.Rouch (2007). The general dispersion relation for waves which propagates at an arbitrary angle to the magnetic field being was derived by T.Burinskaya for a source region with transverse size exceeding the wavelength of emission. Projection of wave vector on the magnetic field direction is sufficiently large which ensures enough time of wave propagation inside the source and, correspondingly, a significant increase of its intensity. The cone-opening angle is mostly governed by the source size.

2. Results of measurements

We used the results of observations of the AKR in two experiments, POLRAD on the INTERBALL-2 satellite and PWI on the POLAR satellite to experimentally test the effect of the boundaries of the generation region. The position of the source field line and the radiation-pattern boundaries is determined with observed spectra of AKR. The analysis is done for the time interval of simultaneous measurements by two satellites when the INTERBALL-2 satellite was located equatorward an extended polar auroral arc at altitudes ~15000–18900 km from the ground and the Polar satellite was poleward this arc at altitudes ~45000–47000 km. Both satellites move in such a way that they were located for a long time on the same geomagnetic meridian. This makes it possible to consider the two-dimensional problem, and thereby, to simplify experimental data processing.

Since the AKR is generated at frequencies close to the local electron gyrofrequency, the observed frequency band corresponds to AKR generation altitudes of 2500-7000 km, i.e., below the satellite altitudes . Both satellites detected similar variations in the AKR intensity and spectra, which implies that the same AKR source was observed. However, a stable difference is also observed. Namely, the lower AKR frequency amounts to 170 kHz according to the INTERBALL- 2 data, while it is equal to 260 kHz according to the data acquired by POLAR.

Using the difference in the AKR spectra detected by two satellites, we calculated the radiation pattern of the AKR source. The radiation pattern was calculated under the following assumptions: (i) the radiation pattern is symmetric with respect to the local magnetic field in the polar and equatorial directions and (ii) the radiation pattern widths at the frequencies 170 and 260 kHz are equal. The conditions that the frequencies 170 and 260 kHz are the lower frequencies of the AKR spectra received by INTERBALL-2 and POLAR satellites, respectively, allowed us to calculate the source latitude and the maximum width of the radiation pattern [4] . We

present the results of calculations for several spectra of the stationary AKR source.

3. Conclusion

The calculations described above provide the following conclusions for the studied stationary AKR source extended over the longitude: (i) the AKR radiation pattern is directed along the magnetic field in the source and (ii) the full width of the radiation pattern of the stationary AKR source amounts to ~±25°

Acknowledgements

Authors are grateful to D.A. Gurnett and his team for PWI data. We also grateful to G. Parks and his team for UVI data.

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