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Auroral observations at the Mario Zucchelli Base (Antarctica). Morphological features

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Abstract. Auroral displays are the visible manifestation of the solar wind-magnetosphere-ionosphere interaction at the high latitude polar regions. The study of this phenomenon is very relevant for both the investigation of the magnetosphere-ionosphere coupling and the comprehension of the overall magnetospheric dynamics during the so-called magnetic substorms. Here, we present some preliminary results on the morphological features of the auroral emission as observed at the *Mario Zucchelli* station in Antarctica during a recent winter campaign. In particular, we are going to show how the morphology of the auroral emission changes with the wavelength (630.0 nm, 557.7 nm and 427.8 nm).

Key words. Magnetospheric Physics: Auroral phenomena – Magnetospheric Physics: Magnetosphere/ionosphere interactions – Mathematical Geophysics: Fractals and multi-fractals

1. Introduction

Since the early studies on the magnetospheric dynamics the auroral observations have played a fundamental role in the investigation of the magnetosphere-ionosphere coupling during the magnetic substorms. These events are indeed the results of a chain of subsequent phenomena related with the energy releases and topological changes that occur in the near-Earth magnetospheric tail regions (the geomagnetic tail plasma sheet).

In the last decade, an increasing interest has been posed on the auroral activity as a proxy of the occurrence of complexity in the magnetospheric dynamics (Lui et al. 2000; Consolini 2002; Uritsky et al. 2002). These studies showed the existence of scale-invariant distribution function for several parameters connected to the auroral emission, supporting the idea that the magnetospheric dynamics could be that of a system near *forced and/or self-organised criticality* (Chang 1999). Furthermore, in a recent paper, Kozelov et al. (2004) extended the previous analysis on scale-

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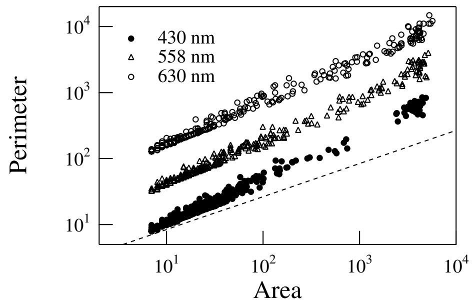

Fig. 1. Plot of perimeter versus area for the auroral structures extracted form the 3 different wavelength datasets. Data relative to 558 nm and 630 nm structures are respectively scaled by a factor 4 and 16 for convenience. The dashed line refers to the expected scaling for simple non-fractal objects.

invariance to ground-based observations of auroral phenomena, confirming the previous results.

In this note we present some preliminary results on the morphology of auroral emissions observed at the Italian Mario Zucchelli Station in Antarctica (TNB).

2. Data and results

The auroral observations considered in this note refer to an event observed on April, 03, 2001 by the all-sky camera (ASC) system mounted at the *AURORA* observatory of TNB-Antarctica when the TNB station was crossing the midnight-dawn sector. In detail, the auroral images are 16 bit digital images of 512×512 pixels relative to auroral emission at 3 different wavelengths (430.00 nm, 550.0 nm and 630.0 nm), which are characteristic of the auroral spectrum and refer to atomic oxygen O and molecular nitrogen N_2^+ (1NG) optical transitions.

To extract information on the morphology of auroral emission we applied a simple segmentation technique based on a threshold method. The chosen intensity threshold was equal to the mean value plus one standard deviation. For each extracted structure we evaluated the area and the perimeter.

It is well known that in the case of simple 2D object embedded the perimeter scales with area as a power law with an exponent α equal to $1/2$, however this relationship is no longer valid in the case of fractal objects (Mandelbrot 1982) where the perimeter is expected to increase faster than the square root of the area.

In Figure 1 we show the scaling of the perimeter of the extracted structures as a function of the area for the observations at the different wavelengths. In all the cases the perimeter increases with area faster than that is expected for simple non-fractal objects. In detail, the scaling exponent α results to be $\alpha = 0.69$, 0.66 and 0.63 for 430 nm, 558 nm and 630 nm structures, respectively. This result supports the idea that emitting structures are fractal objects showing an increasing complexity with decreasing wavelength.

3. Conclusions

The preliminary study of the morphology of the auroral structures revealed that these structures are fractal objects and that the emission due to the primary electrons (430 nm) seems to be characterised by a more filamentary character. This is an interesting result that needs to be confirmed using a larger dataset, and discussed in connection with the occurrence of turbulence (Kozelov and Rypdal 2007).

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