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Periodic black auroras at the dawn-side dipolarization front during a substorm

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We present characteristic black auroras observed in the dawnside auroral zone during a substorm on February 22, 2009. The auroras consisted of several black beads with a wavelength of about 4 5 km (about 1 degrees) in longitude, which appeared along the equatorward edge of a quiet arc. These periodic structures were observed over three hours of MLT, from Gillam to Sanikiluaq, in Canada; They started approximately 15 minutes after an auroral intensification (substorm onset) occurred at Fort Yukon in Canada. Auroral observations by a meridian scanning photometer at Gillam revealed that the black-beads formed at the equatorward boundary of the proton aurora (Hbeta), which moved poleward as this event unfolded. The black shapes were seen in 558-nm and 471-nm emission lines but not clearly seen in the 630-nm and Hs emissions. These observations indicate that the bead structures are formed by energetic electrons (higher than 1 keV) precipitating from inside of the transition region between dipolar and tail-like field lines after the substorm onset. Indeed, during this event THEMIS A, D and E, located in the plasmasheet, roughly magnetically conjugate to the region where the auroral activity was taking place, observed dipolarizations of magnetic fields propagating dawnward (from the west). After the dipolarization front passed eastward, the black-beads aurora appeared and the black areas gradually expanded north and south. We suggest that this auroral structure was caused by the interchange instability due to confinements of high pressures by flux tubes that have been freshly dipolarized during the preceding substorm.

Keywords: black aurora, substorm, dipolarization, proton aurora, interchange instability