

## Characteristics of optical and CNA arcs observed before substorm onset

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We report a substorm event observed at 1930-2130 MLT on 8 March 2005 by the all-sky imager, the 256-element imaging riometer, and the meridional scanning photometer at Poker Flat (PFRR; 65.11N, 147.42W), Alaska. A remarkable feature of this event is the presence of two arcs of cosmic noise absorption (CNA) during the growth phase. The high-latitude CNA arc corresponded to a discrete arc seen in the optical emissions and the low-latitude CNA arc was embedded in the diffuse aurora. The NOAA-17 satellite crossed these arcs within the field of view of the imaging riometer at about thirty minutes before the auroral breakup and measured the corresponding enhancements of precipitating electron flux.

The main observational results are summarized as follows; (1) The electron energy spectra showed the Maxwellian-like distribution with a peak at  $\sim 17$  keV for the high-latitude arc and the power-law distribution for the low-latitude arc. (2) The low-latitude CNA arc was associated with the precipitation at the isotropic boundary. (3) The auroral breakup was initiated at the low-latitude arc. (4) At about ten minutes before the breakup, new optical discrete arc appeared at the location of the low-latitude CNA arc, while the low-latitude CNA arc faded. These results indicate that the latitude at which this substorm was initiated is likely to be close to the isotropic boundary, and that the energy spectra of precipitating electrons at this location changed gradually from ten minutes before the breakup. On the basis of these measurements, we discuss the substorm onset models.