Multispectral analysis of the discrete aurora

Observations of the aurora-borealis have long been used to infer information about the causative magnetospheric particle source as well as the composition and temperature of the atmospheric gases with which they interact. Such measurements are a critical complement to direct in-situ measurements over auroral arcs by rockets and satellites. Because in-situ measurements traverse arcs in a matter of seconds, they can only provide a one-dimensional snapshot of a parameter. In contrast, ground-based measurements can sense the spatial, spectral, and temporal variability of the aurora during its development, providing insight into how the particle acceleration process develops and how the upper atmosphere responds.

Multispectral imaging has long been used in terrestrial remote sensing to isolate and identify distant targets. In a multispectral imager, spatial, spectral, and temporal information are acquired simultaneously. Only recently has the full multispectral paradigm been applied to problems of auroral physics.

The above image is a composite of three spectral images recorded by the spectral camera at Sondrestrom, Greenland. The auroral arc is near the horizon, and the separation of the three spectral emissions along the magnetic field line is clearly seen. In the upper left figure, the altitude profile of the emissions has been estimated. The N$_2$ emissions (blue peak and lower green peak) peak at ~120km as expected. What is unexpected is the ~100km separation between the O 630nm and O$^+$ 732nm emissions. The data suggest a peak in O$^+$ production near 400km.

Elevation scans by the Sondrestrom ISR through this arc (shown at right) confirming that ionization occurs in narrow field-aligned pillars extending through F-region altitudes in this event.