Multispectral Study of Sunlit Aurora Using HiT&MIS: Preliminary Results

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I. Introduction

Background

Sunlit auroral emissions are difficult to observe from the ground due to bright solar background.

A High-resolution spectrograph (~0.012 nm at 630 nm), **HiRISE**[1] (1999, Greenland)[2], has shown that daytime emissions can be extracted from sunlight-contaminated spectra.

Project Overview

Goal: Characterize daytime auroral emissions and morphology differences between day and night, and across seasons

Approach: Continuous, all-season observations of atmospheric emissions

Duration: Jan 2025 - 2026

Location: Swedish Institute of Space Physics (IRF)

Instrument : Ground-based spectral imager -- **HiT&MIS**

II. HiT&MIS

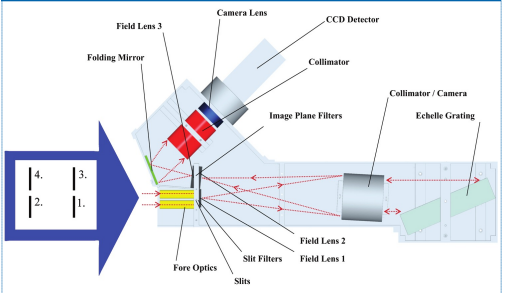
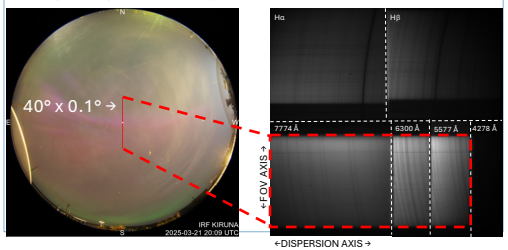


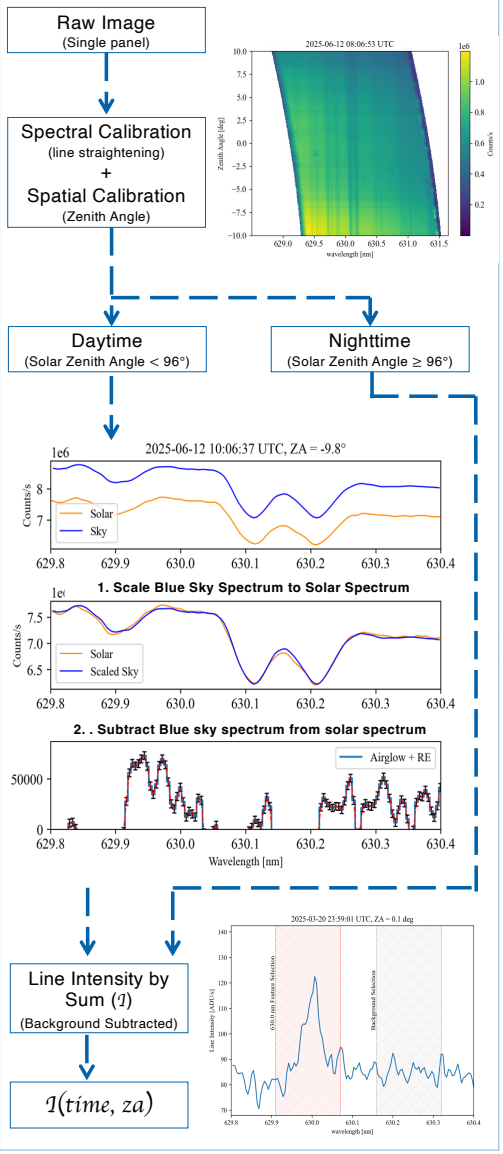
Fig 1 (top): *Schematic of **H**igh **T**hroughput **& M**ultislit **I**maging **S**pectrograph (Descendent of HiRISE).*[3]

Fig 2 (bottom): *Left: HiT&MIS FOV overlaid on all-sky* [4] *image. Right: Raw daytime HiT&MIS frame.*



III. Data Processing Pipeline

Each panel shown in Fig 2 shows an isolated spectra band in the visible range. Each panel is processed thought the pipeline to extract line intensities as functions of time and zenith angle.



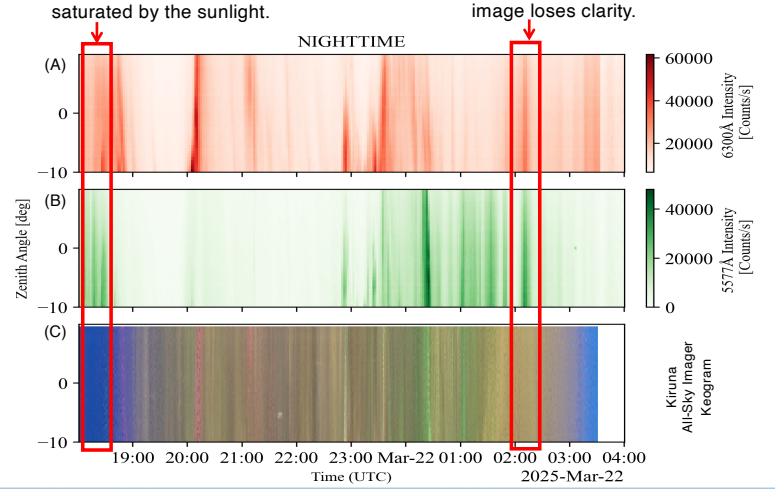
IV. Results

Fig 3*: (A) and (B) are keograms of the red-line (630.0 nm) and green-line (557.7 nm) emissions (airglow + aurora) as measured by HiT&MIS. (C) shows a corresponding keogram from the Kiruna All-Sky Camera.*[4]

Real Auroral Signal, Sharp spikes in the HiT&MIS keograms align with auroral features in the all-sky imager keogram, confirming that HiT&MIS is detecting true auroral emissions.

Twilight advantage, HiT&MIS captures auroral emissions during twilight hours when the all-sky imager remains saturated by the sunlight.

Maintains Contrast, HiT&MIS clearly captures emissions under light cloud cover, while the all-sky image loses clarity.



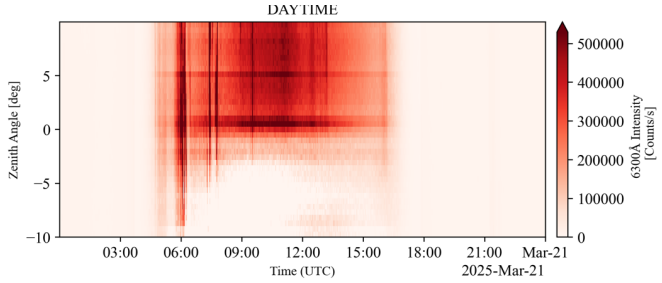


Fig 4: *keogram of red-line (630.0 nm) for a full 24 hours in march.*

Daytime Emissions, the keogram shows a clear contrast between day and night, showing a preliminary detection of real daytime atmospheric emissions.

Needs Further Processing, the daytime emission signal is affected by background artifacts and requires better processing to extract a clean and reliable result.

V. Next Steps

Continue to develop a robust data processing pipeline applicable to all HiT&MIS spectral lines.

Photometric Calibration (Counts/s → Rayleigh)

Create finer segments of the solar background and fit each segment individually improve accuracy of blue spectrum scaling.

Derive Characteristic Energy (Eo) and Total Energy Flux (Qo) of the precipitating particles for the whole dataset.

VI. References

1. Pallamraju, D., Baumgardner, J. and Chakrabarti, S. (2002) 'HIRISE: A ground-based high-resolution imaging spectrograph using echelle grating for measuring daytime airglow/auroral emissions', *Journal of Atmospheric and Solar-Terrestrial Physics*, 64(12–14), pp. 1581–1587. doi:10.1016/s1364-6826(02)00095-0.

2. Pallamraju, D., J. Baumgardner, S. Chakrabarti, and T. R. Pedersen (2001), Simultaneous ground based observations of an auroral arc in daytime/twilighttime O I 630.0 nm emission and by incoherent scatter radar, *J. Geophys. Res.*, 106(A4), 5543–5549, doi:10.1029/2000JA000244.

3. Chakrabarti, S., Jokiaho, O.-P., Baumgardner, J. L., Cook, T. A., Martel, J., & Galand, M. 2012, Optical Engineering, 51, 1

4. Toyomasu, S., et al. "Low cost webcast system of real-time all-sky auroral images and MPEG archiving in Kiruna." *Proceedings of 33rd Annual European Meeting on Atmospheric Studies by Optical Methods, Kiruna.* Vol. 292.