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# NIIHAMA Project: Monitoring Jupiter's $H_3^+$ Auroras

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## Abstract

We are conducting a long-term continuous monitoring of Jupiter's $H_3^+$ auroral flux from an observatory atop Mauna Kea, essential to separate the intrinsic variations and solar-wind driven variations. JAXA contributes an infrared camera while UHH installs and maintains the 90-cm telescope. After completion of all initial tests and adjustments, we will observe Jupietr's aurora for more than a month every apparition.

## 1. Introduction

Jupiter's polar emissions are observed over a broad wavelength range (UV, visible, IR, and X-ray). The infrared auroral emission of thermospheric ion $H_3^+$ has been studied extensively with the ground-based telescopes. The 3.4 $\mu$m emission line of $H_3^+$ stands out in sharp contrast on Jupiter owing to strong absorption by $CH_4$ at 3.4 $\mu$m; reflected sunlight and thermal emissions from deeper atmosphere are efectively masked, leaving high-altitude auroral emissions visible against a very dark Jupiter disk. Therefore, photometry of $H_3^+$ auroral flux at 3.4 $\mu$m provides a powerful tool for the study of the time variability of Jupiter's auroras (and its relation to internal/external phenomena).

While it has been almost 2 decades since the $H_3^+$ auroras were imaged (almost the same amount of time since the first HST/UV images were taken), even a very fundamental question "how Jupiter's auroras respond to the solar-wind variations" remains unsolved. In fact, our 1992 observations (in conjunction with the Ulysses flyby to Jupiter) suggest a positive (but weak) correlation between the 3.4-$\mu$m auroral flux and the solar wind dynamic pressure (Baron et al., 1996), while theoretical models (Cowley and Bunce, 2001) predict the opposite. One of the major reasons for such discrepancy may likely be the lack of long-term continuous observations. This is why we are motivated to carry out the NIIHAMA project.

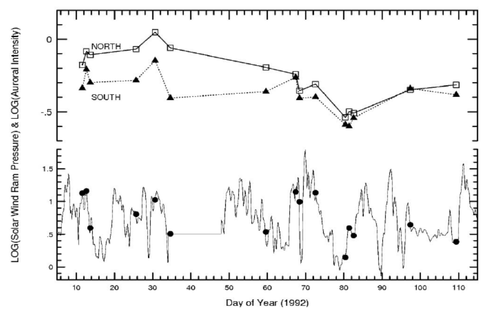


Figure 1: A comparison between $H_3^+$ auroral flux and the solar-wind ram pressure as measured from Ulysses spacecraft (from Baron et al., 1996).

## 2. The NIIHAMA camera

We have developed a simple and compact infrared camera (1024×1024 pixels PtSi array detector plus a special 3.42-$\mu$ narrow-band filter) to enable long-term and continuous monitoring of Jupiter's $H_3^+$ aurora. This camera will be attached to the University of Hawaii at Hilo (UHH)'s 90-cm Hōkū Keʻa telescope atop Mauna Kea. We have named the camera NIIHAMA, an acronym of "**N**ear-**I**nfrared **I**mager on **H**ōkū Keʻ**A** Telescope for **M**onitoring **A**uroras".

Characteristics of the NIIHAMA camera are as follows:

1. The sensor is a platinum silicide (PtSi, 1024×1024 pixels) array detector, identical with the one in Akatsuki/IR2.
2. Two consumer-grade Stirling-cycle coolers are used. One cools the detector, while another cools the cold stage (holding the optics) in the inner shroud.
3. After the entrance pupil, light from the telescope is collimated so that almost parallel beam goes

through the filter (J, H, and K filter set is installed in addition to 3.4-$\mu$m narrow-band filter).

4. On the Hōkū Ke'a telescope, the platescale is 0.6" per pixel (the relay optics reduces the telescope focal length by a factor of $\sim$2).

5. The effective image circle is $\sim$7' in diameter, wide enough to capture in the same frame Galilean satellite(s) as photometric reference.

Although the spatial resolution is limited, the desigin is well suited for continuous measurements of the integrated auroral flux; availability of telescope time far exceeds that from "competition-based" large telescopes.

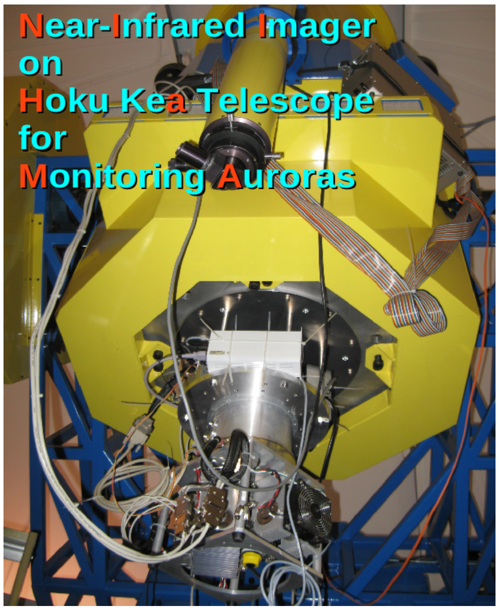


Figure 2: The NIIHAMA camera as attached to the Cassegrain port of the Hōkū Ke'a telescope (during the balancing test in November 2010).

## 3. Observing Plans

The Hōkū Ke'a telescope, as of this writing, is under testing phase with minor problems being solved one by one. After completion of all tests and adjustments, we will attach the NIIHAMA camera and observe Jupietr's aurora for more than a month every apparition. The duration 1 month is so chosen that it is the Sun's rotation period. During such an observing duration, we cover a full rotation of the spiral structure of interplanetary plasma impinging on Jupiter's magnetosphere. Brightning/darkening events of the auroras may be interpreted as responses to the varying solar-wind conditions with little ambiguity.

On each night, we will perform simple standard observation, acquiring 3.4-$\mu$m images, including Jupiter and its satellites in the same frame, every one hour or so. The interval between Jupiter images may be utilized by pointing the telescope to other targets of UHH's interest. The J, H, and K filters will be used for such imagings.

## 4. Concluding remarks

We hope to continue this for years of time as the solar activity is picking up towards its expected maximum in 2013-14. At almost the same timing, JAXA's space telescope, SPRINT-A/EXCEED, will start observing in the EUV region. Jupiter's auroras as well as the inner-magnetosphere plasma are the targets. Therefore, the data from SPRINT-A/EXCEED will complement our IR data, contributing significantly to the understandings of physical processes in this voluminous magnetosphere.

## Acknowledgements

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