# IGRINS-2 SV Observation Evaluation Form 1 form per science case

## Title: Probing the Atmosphere Compositions of a Hot Jupiter on An Eccentric Orbit

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## Description of the primary goals and the main findings

We plan to observe high S/N (SNR~100-300) IGRINS-2 H and K spectra of a Hot Jupiter, HAT-P-2 b around a F8V star K =7.6 during its secondary eclipse. The exoplanet HAT-P-2 b is on an eccentric orbit (e=0.5) with a 5.6 day period and is known to have large offset (~1000K) in its day and night equilibrium temperatures. Our goal is to detect emission from volatile species such as H2O and CO in its atmosphere. We plan to use cross-correlation techniques to investigate the eclipse data.

We obtained a total of 39 mins of on-target exposure under IQ20/CC50 condition, constituting 13 AB/BA pairs in H and K band during the pre-eclipse. The observed spectra correspond to the orbital phase of ~ 0.29 – 0.31 and at an airmass <1.1 during the entire observation. The observation has to be terminated prematurely due to a software crashing issue. Nonetheless, each AB/BA pair spectra has an SNR per resolution element of ~300.

We used plp-igrins2-dev pipeline provided by KASI team for the flatfielding, performing sky calibration and extracting 1D spectra. We then used a custom reduction software developed by Megan Mansfield to correct for barycentric velocity shift during the observation (Mansfield et al. 2024). We modeled a simple hot-jupiter atmosphere using petitRADTRANS 3 (Mollière et al 2019). We simply assumed a H/He dominated atmosphere and used stellar and planet parameters for the model. We then performed cross-correlation analyses between the model spectra and the normalized IGRINS2 spectra. We have a tentative detection at 1.8 sigma significance for CO. This showcases IGRINS-2's capability of obtaining high SNR spectra under an extremely short amount of exposure time for exoplanet atmosphere science.

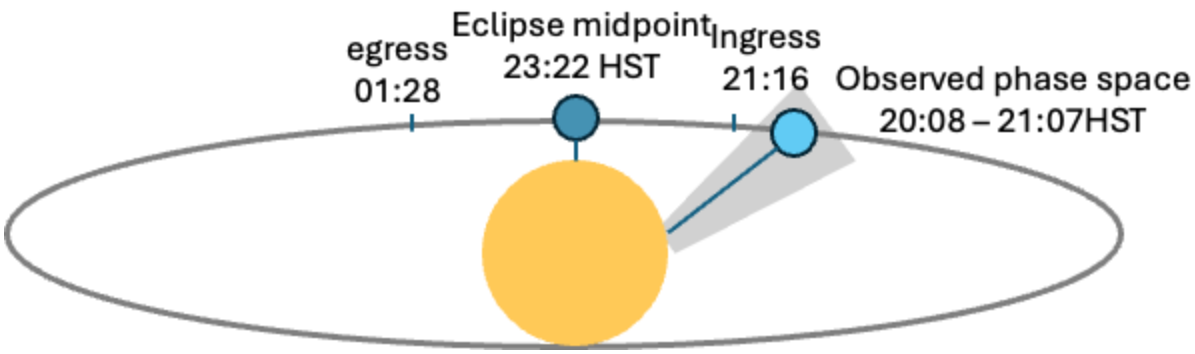


Fig 1. A diagram showing the pre-eclipse observation of HAT-P-2 b.

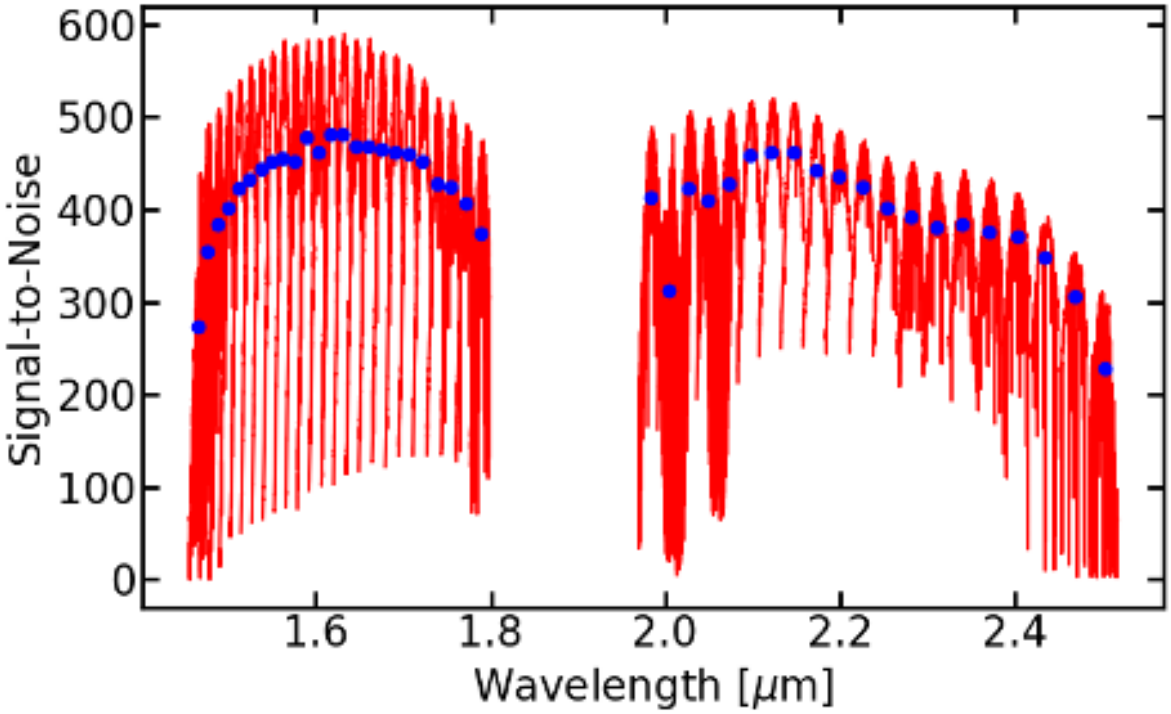


Fig 2. A SNR plot for all orders in the H and K band, showcasing the high SNR in each AB pair of spectra. The plot is made with an adapted version of IGRINS-Transit developed by Dr. Megan Mansfield (Mansfield et al. 2024).

## Additional comments on IGRINS-2 performance:

Results of any other IGRINS-2 capability tested and comparison with other instruments

N/A

## Suggestions for improvements:

First of all, thank you to all who've contributed to developing data reduction tools and involved in the commissioning and SV processes. I have a suggestion for recipe making during the data reduction process. Currently by default, all spectra for the same target are grouped under one group. The only way to put AB/BA pairs into separate groups for time-series observations is to manually input the group numbers for the temporary recipe file. I would greatly appreciate it if there is an option to give different group numbers to AB/BA pairs of the same target.

## Any additional comments about IGRINS-2 SV

Thank you for letting me be part of the SV team and I learned a lot!

Reference:

Mansfield et al., 2024, AJ, 168, 14W
Mollière et al., 2019, A&A, 627A, 67M