Observing Instructions

Origin & Evolution of Storms, Clouds, and Hazes on Uranus and Neptune

[Lick/ShARCS-NGS program 2023B-S019]

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Website: http://mtham.ucolick.org/NeptuneUranus/

Science Objective

Determine the frequency, time evolution, and vertical location of storm systems on Uranus and Neptune by obtaining frequent, brief images of these planets.

Recent Press Releases and Publications

- Chavez et al. (2023), Evolution of Neptune at Near-Infrared Wavelengths from 1994 to 2022, Paper Link
- Chavez et al. (2023), Drift Rates of Major Features on Neptune Between 2018 and 2021, Paper Link
- Molter et al. (2019), Neptune's 2017 equatorial storm. Press Release Link; Paper Link
- Wong et al. (2018), Neptune's 2016 dark vortex. Press Release Link; Paper Link
- de Pater et al. (2015), Extreme storm activity on Uranus. Press Release Link; Paper Link

Co-authorship invitation

Modeled after the UCO policy for ToO programs, our co-authorship invitation is as follows:
Multiple activations in 2023A: Observers on duty + program PI
Engineering time: Staff observers on duty

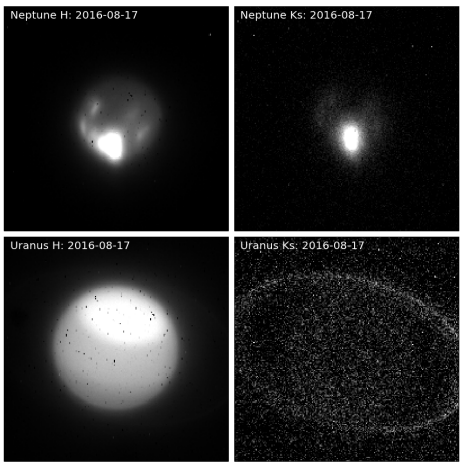

Figure 1: Example Lick/ShARCS observations of the targets

Targets
Uranus
RA: 03:16, DEC: +17:48 (non-sidereal target; coordinates as of 2023-Jul-01)
Apparent magnitude: 5.8
Angular diameter: 3.5”

Neptune
RA: 23:52, DEC: -02:10 (non-sidereal target; coordinates as of 2023-Jul-01)
Apparent magnitude: 7.8
Angular diameter: 2.3”

Ephemerides are available on our program website: `http://mtham.ucolick.org/NeptuneUranus/`

Observing Instructions
1. Before sunset, take flat field frames in H and Ks. Ideally, count levels should be between 10,000 and 20,000 DN. If weather prevents taking sky flats, do dome flats instead (refer to `http://mtham.ucolick.org/techdocs/instruments/sharcs/tips/#flats` for dome flat procedures).

2. Make sure AO operator has ShaneAO in NGS mode and wavefront sensor is on-axis.

*** Steps 3-10 are for Uranus observations, and 11-18 are for Neptune. If you are only observing one target, skip the steps for the target you are not observing ***

3. Acquire Uranus [10min]

4. Have the AO operator lock AO on Uranus in NGS mode (the AO operator will set proper parameters for the ShaneAO system).

5. Put in H filter.

6. Take a 120 sec exposure. Check to be sure there are no saturated or non-linear spots on Uranus (count levels greater than 25,000 DN). If bright spots, take another test exposure of 60 sec and 2 coadds and use that for the rest of H-band imaging.

7. Use the bxy script in ShARCS (more info at `http://mtham.ucolick.org/techdocs/instruments/sharcs/scripts/#bxy`) setting a 4” dither scale.
This will take four 120 sec (or 60 sec x 2 coadds) in a 4”x4” dither pattern. [10min + dithering and readout overhead]

8. Change filter to Ks.

9. Take a 120 sec exposure. Check to be sure there are no saturated or non-linear spots on Uranus with count levels greater than 25,000 DN. If there are very bright storms, take another exposure of 60 sec and 2 coadds and use that for the rest of the Ks-band imaging.

10. Use the bxy script in ShARCS (more info at `http://mtham.ucolick.org/techdocs/instruments/sharcs/scripts/#bxy`) setting a 4” dither scale.
This will take 4 more 120 sec (or 60 sec x 2 coadds) in a 4”x4” dither pattern. [10min + dithering and readout overhead]

11. Acquire Neptune [10min]

12. Lock AO on Neptune in NGS mode (the AO operator will set proper parameters for the ShaneAO system).

13. Put in H filter.

14. Take a 120 sec exposure. Check to be sure there are no hot spots on Neptune (count levels greater than 25,000 DN). If bright spots, take another test exposure of 60 sec and 2 coadds and use that for the rest of H-band imaging.

15. Use the bxy script in ShARCS (more info at `http://mtham.ucolick.org/techdocs/instruments/sharcs/scripts/#bxy`) setting a 4” dither scale.
This will take 4 more 120 sec (or 60 sec x 2 coadds) in a 4”x4” dither pattern. [10min + dithering and readout overhead]

16. Change filter to Ks.

17. Take a 120 sec exposure. Check to be sure there are no hot spots on Uranus with count levels greater than 25,000 DN. If there are very bright storms, take another exposure of 60 sec and 2 coadds and use that exposure time for the rest of the Ks-band imaging.

18. Use the bxy script in ShARCS (more info at `http://mtham.ucolick.org/techdocs/instruments/sharcs/scripts/#bxy`) setting a 4" dither scale.
This will take 4 more 120 sec (or 60 sec x 2 coadds) in a 4"x4" dither pattern. [10min + dithering and readout overhead]

19. At end of night, take Darks with the exposure times used for Uranus and Neptune imaging, as well as the H and Ks flat field frames.

20. E-mail Erin Redwing (`eredwing@berkeley.edu`) and copy the support astronomers (`sa@ucolick.org`) indicating that data were taken. Please include a summary of the Uranus, Neptune, flat field, and dark frames numbers, weather conditions, seeing estimate, and observer names in the e-mail, or in a text file saved to the directory with the data. The on-duty support astronomer will make the data available via the on-line data archive. [60 min total for Uranus+Neptune]

Notes:
(1) Standard star and sky observations are not needed, as absolute photometry is not required, and a sky frame can be constructed from a median-average of the dithered image.
(2) Program may be run on consecutive nights, or twice within the same night separated by at least 6 hours, which will give coverage of different hemispheres (rotation period for both planets is $\sim$16 hours)

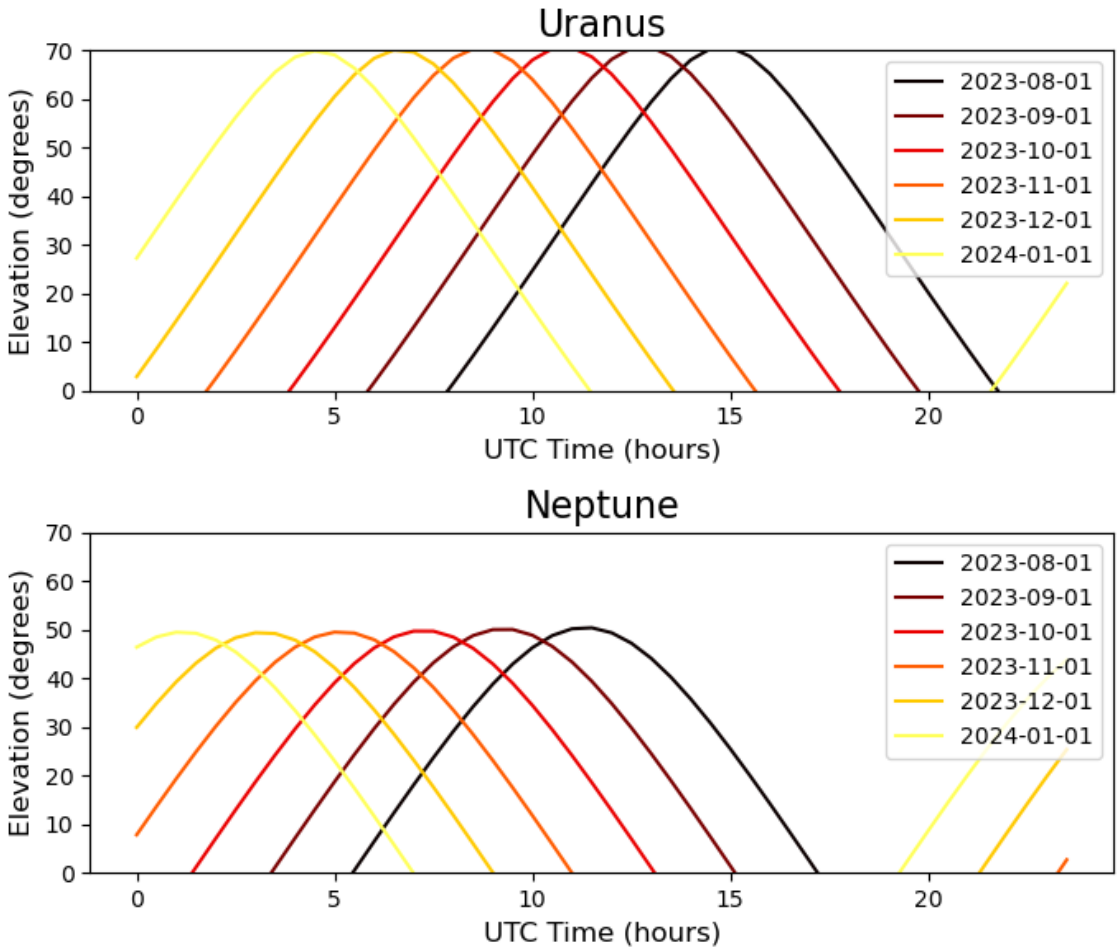

Figure 2: Approximate elevations of Uranus and Neptune on different dates throughout the semester.

Approx time intervals when targets are up and it is nighttime at Lick (half-hour resolution):

Uranus
2023-08-01: 08:00 - 21:00 UT
2023-09-01: 06:00 - 19:30 UT
2023-10-01: 04:00 - 17:30 UT
2023-11-01: 02:00 - 15:30 UT
2023-12-01: 00:00 - 14:00 UT
2024-01-01: 21:00 - 12:00 UT

Neptune
2023-08-01: 05:30 - 17:00 UT
2023-09-01: 04:00 - 15:00 UT
2023-10-01: 01:30 - 13:00 UT
2023-11-01: 00:00 - 10:30 UT
2023-12-01: 21:30 - 09:00 UT
2024-01-01: 19:30 - 07:00 UT