Low Resolution
Spectroscopy
Aurora on Uranus

Jim Fox

Makalii Observatory
Photometry
Photometric Parameters

- Optec SSP-3 solid state photometer
- 0.25m LX-200 telescope
- Blue and Green filters, transformed to Johnson B, V
- Differential photometry, compared to HD 11257
- Precision: 0.002-0.006 mag B and V
- (B-V) mean 0.563, $\sigma$ 0.004, 12 determinations
Spectroscopy
Spectrometry Parameters

- Low Resolution Spectroscopy
- Objective Grating, Star Analyzer SA-100, 100 lines/mm
- 150mm telephoto lens
- Canon D60a, 4.3\(\mu\)m pixels
- Analysis performed using RSpec, Field Tested Systems
- Net effective dispersion: 2.88 Angstroms/pixel
- \(\beta\) Ari used for calibration
  - Spectroscopic binary with A5v primary
  - Approx. same airmass as Uranus
Background

- B, V photometry of Uranus since 2003
- Photometry reported to Association of Lunar and Planetary Observers
  - Remote Planets Section
- Occasional anomalies in (B-V) color
- Sub-Earth latitude range -17° (2003) to +41° (2018)
- More anomalies as north polar region swings toward Earth
- No correlation with longitude in any apparition
- Uranus “shines” by reflecting sunlight and is usually characterized by absorption lines corresponding to methane and ammonia in its atmosphere
## Summary of Measurements

### Uranus Summary

Apparition 2018-2019

<table>
<thead>
<tr>
<th>UT Date</th>
<th>JD</th>
<th>(B-V)</th>
<th>(B-V) Deviation</th>
<th>Sub-Earth Longitude</th>
<th>Spectrum</th>
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<tbody>
<tr>
<td>10/11/2018</td>
<td>402.7146</td>
<td>0.583</td>
<td>+5°</td>
<td>176</td>
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<tr>
<td>10/28/2018</td>
<td>419.666</td>
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<td>11/26/2018</td>
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<td>12/31/2018</td>
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<tr>
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<td>Emission @ 452.8, 527.8 nm</td>
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<tr>
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<td>Emission @ 557.7 nm [O I]?</td>
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</table>

While observations were made, Emission was noted within specified wavelengths and potentially indicative of [O I] activity.
“Normal” Uranus Spectrum
Uranus Emission Lines 4 January 2019
Conclusions

- Aurorae can be detected by either (B-V) color or low resolution spectrography as various atmospheric moieties are ionized.
- Aurorae are relatively short lived, less than 24 hours (see 24, 25, 26 January, 2019 data).
- Aurorae will likely become more frequent and stronger as Uranus’ north pole points more directly toward Sun and Earth over the next decade.
- Insufficient data (so far) to determine if magnetic pole coincides with rotational pole of Uranus.
- Larger instrument may find similar spectral evidence of aurorae on Neptune.