

## [247.02] Classification of Asteroid 9983 Rickfienberg

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### Prior Work and the Current Study

- 9983 Rickfienberg previously observed by Carthage in 2011
  - Rapid rotation makes characterization by filtered photometry difficult
  - Poor data quality during 2011 opposition led to uncertainty in characterization
- Period determined in 2011 by Odden at Phillips Academy Observatory and Rick Fienberg at his home observatory: 5.29 hrs.
- New observations made at 2013 opposition to determine composition
  - Utilized WIYN 0.9m at f7.5 using S2KB Camera
    - 0.6 arcsec/pixel, 20 arcmin x 20 arcmin field
  - High-cadence B-V-R-I images obtained over three nights
  - Opposition in 2013 nearly 2 magnitudes fainter than 2011 opposition
    - Utilized 240 sec exposures on 9983
  - Calibration fields included Landolt standards as well as four asteroids of known compositions:
    - 453 Tea (S-type)
    - 1343 Nicole (C-type)
    - 259 Alethia (X-type)
    - 2508 Alupka (V-type)

### Observational and Analysis Considerations

- Hazy conditions during one night compromised some of the data
- Comparison asteroids selected to span range of composition types and be well-placed at comparable air masses to 9983.
- Selection of comparison stars for photometry had to be carefully handled to avoid saturated stars and, in the case of 453 Tea, the R exposures of the asteroid itself
- Exposures timed to keep asteroids of interest away from field stars
  - Rapid motion of several targets required careful attention to field positioning
- MCO Canopus utilized for photometry
  - Careful selection of comparison stars
  - Quality control on comparison star catalog magnitudes
- Time phasing of four-color photometry requires interpolation between exposures to determine color magnitudes
  - Rapid rotation makes simple magnitude subtraction inaccurate
- Linear, moving three-point quadratic, and logarithmic (flux) fits were all tried to interpolate brightness between measured points

**Abstract**  
Four-color filtered CCD photometry was obtained on 9983 Rickfienberg during its 2013 opposition. High-tempo exposures were taken with the S2KB camera on the 0.9m WIYN telescope at Kitt Peak National Observatory over three nights, covering several rotations of the object. In addition, observations were obtained of a field containing 4 Landolt standard stars, and four other asteroids of known composition: 259 Alethia (X type), 453 Tea (S type), 1343 Nicole (C Type) and 2508 Alupka (V type). These data were obtained to confirm that color indices measured for 9983 Rickfienberg could be confirmed and errors bounded. Asteroid 9983 Rickfienberg exhibited color indices of B-V=0.868, V-R=0.568, and R-I of 0.335, consistent with an S-type characterization. No variation in composition was seen over the period of each rotation within the measurement uncertainties. This work was conducted by undergraduate students from Carthage College, and analysis was performed by students at Phillips Academy. Support was received from the Wisconsin Space Grant Consortium, a Small Research Grant from the American Astronomical Society, and the Israel Family Foundation.

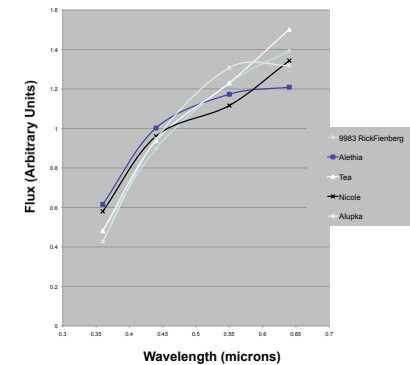
### Results

- Best values obtained for 9983 Rickfienberg color magnitudes are:

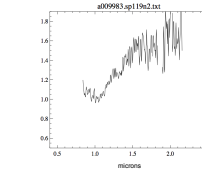
$$B-V = 0.868, V-R = 0.568, R-I = 0.335$$

- Spectral flux comparing 9983 Rickfienberg to comparison asteroids consistent with S-type
- Landolt standards showed minimal correction necessary [Of the order of hundredths of a magnitude]

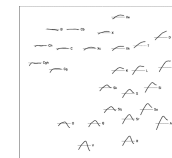
### Flux-Normalized Spectra inferred from Four Color Photometry



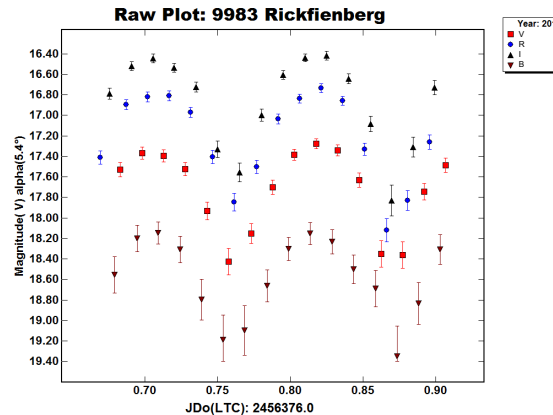
Compare spectra (above) with catalog data from IRTF and 2MASS:



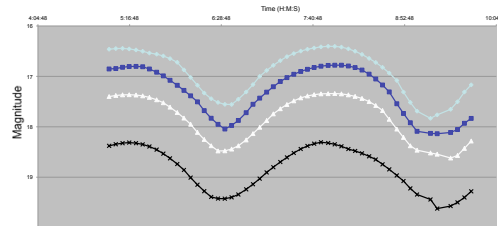
IRTF IR Spectrum of 9983 Rickfienberg [Source: Catalog of Asteroid Spectra <http://smass.mit.edu/catalog.php>]



Asteroid Spectral Characteristics from 2MASS Study [Source: Bus and Binzel, Icarus: 158, 146-177, 2002]



### Quadratic Fits to Lightcurves (time phased)



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