

Rotation Parameter Group

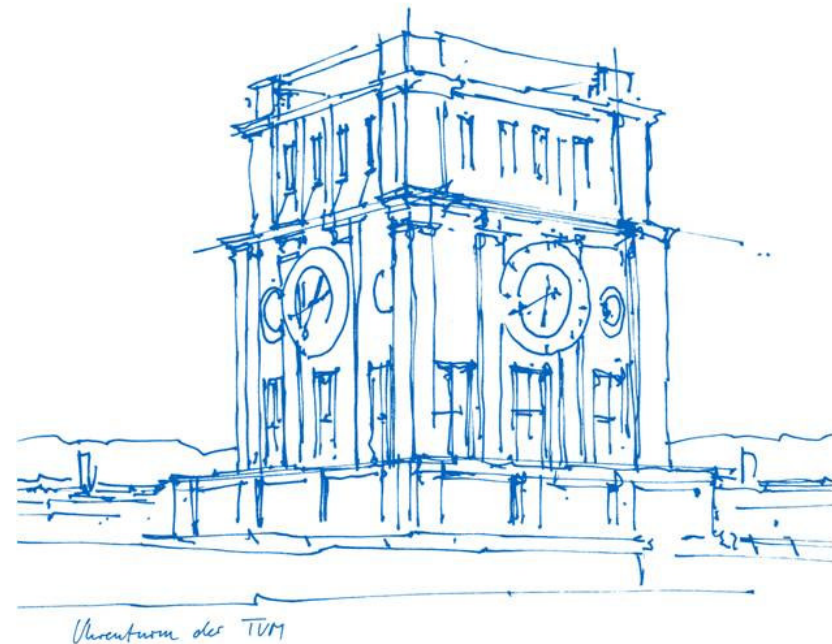
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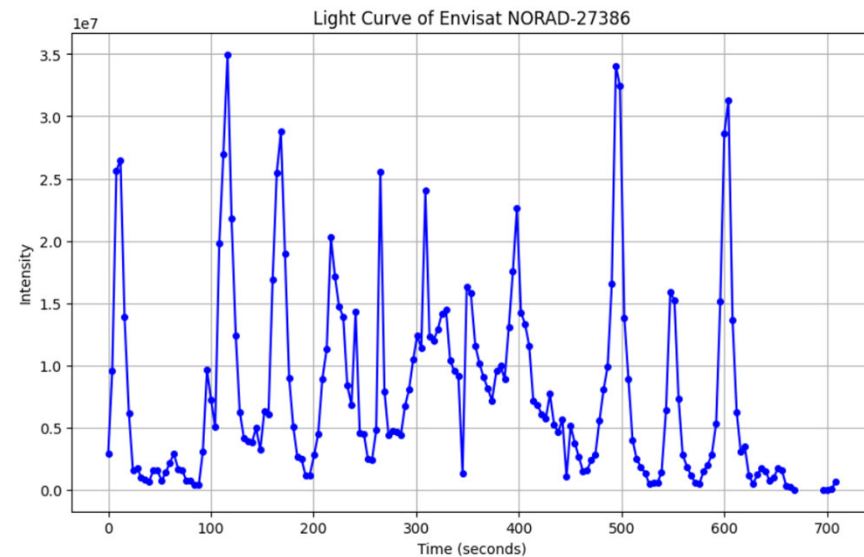
Outline

- Light Curves
- Analyzed Objects
- Methods
- Results of the Analyzed Objects
- Conclusion

Light Curves

A light curve is a graphical representation of the changes in brightness of an object over time.

- help to understand the rotation of an object
- Brightness patterns reflect shape, reflective properties and rotation



Analyzed Objects

- **Ariane:** launcher, large structure, not actively controlled
- **Envisat:** Earth observation satellite with complex structures and materials, no longer active
- **ION-Satelliten:** Small CubeSats with simple geometric shape, reflective material
- **SPOT_4:** Earth observation satellite, also inactive



Envisat



CubeSats

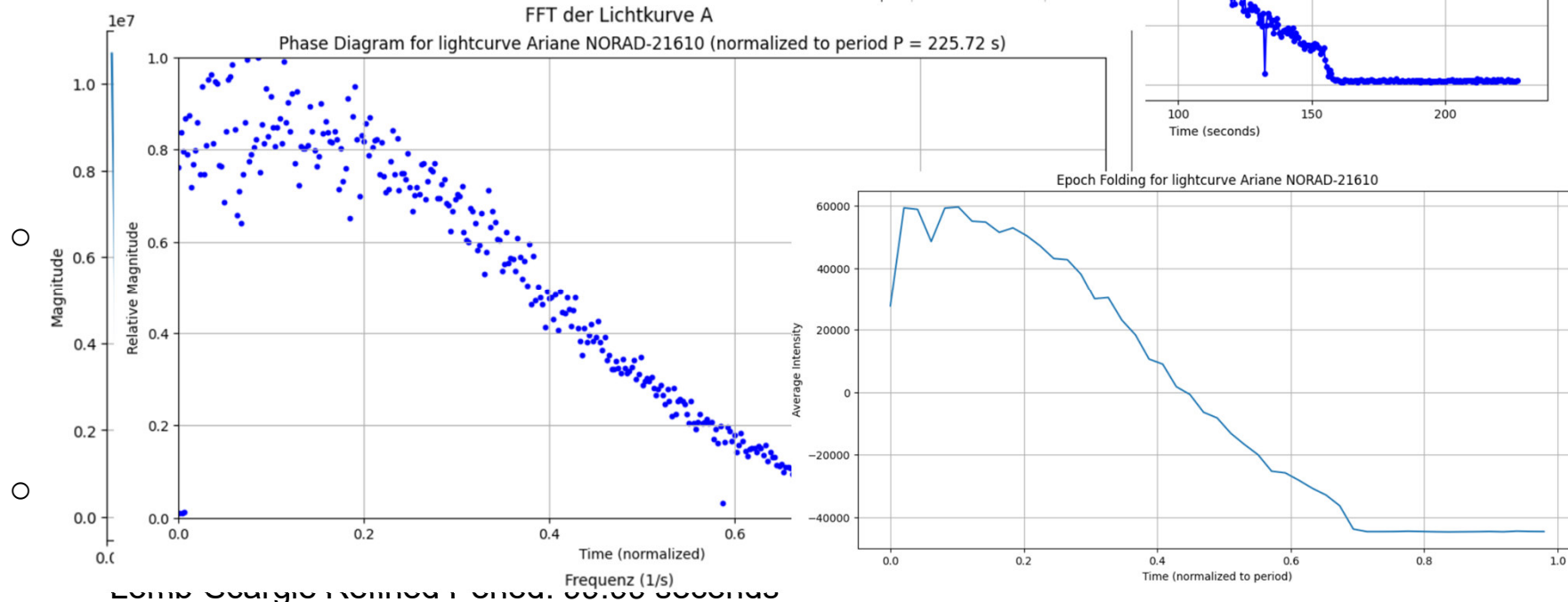
Methods

- **Fast Fourier Transform (FFT):**
Converts data from the time domain into data from the frequency domain. Periodic signals are identified by recognizing dominant frequencies.
- **Periodogram:**
A method for displaying the spectral density of signals that also recognizes frequencies with smaller amplitudes.
- **Welch's method:**
An advanced version of the periodogram method for noise reduction.
- **Lomb-Scargle periodogram:**
was developed for unevenly sampled data and estimates the power spectral density.
- **Epoch folding method:**
The data is convolved over a certain period of time and the results are averaged to improve the signal-to-noise ratio. By convolving the data, the periodic signals become clearer.
- **Epoch reconstruction method:**
Refines the estimates of the rotation periods by reconstructing the phase of the light curve based on them, providing better visualization of periodic features.

Results: Ariane_NORAD-21610

- **FFT and Periodogram Analysis:**
 - Dominant Frequency: 0.0044 1/s
 - Rotation Period: 225.72 seconds
 - Apparent Spin Rate: 15.949 degrees/hour

- **Welch Method:**



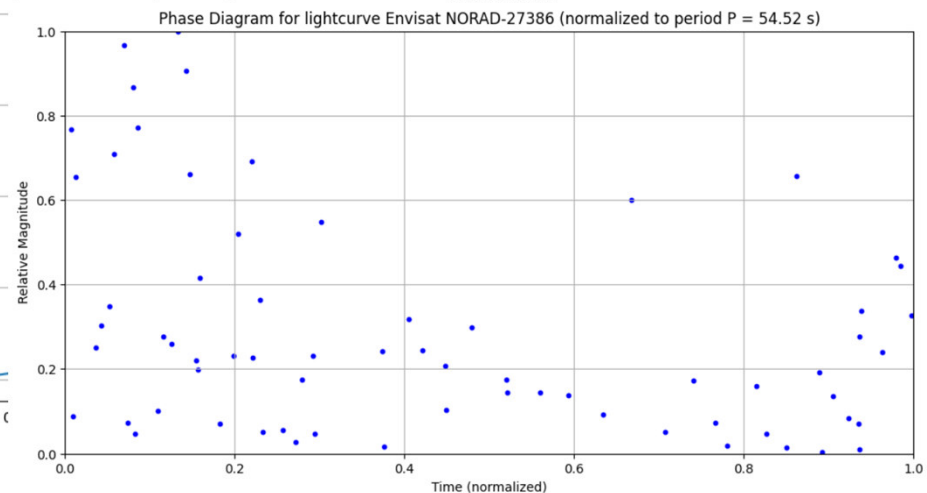
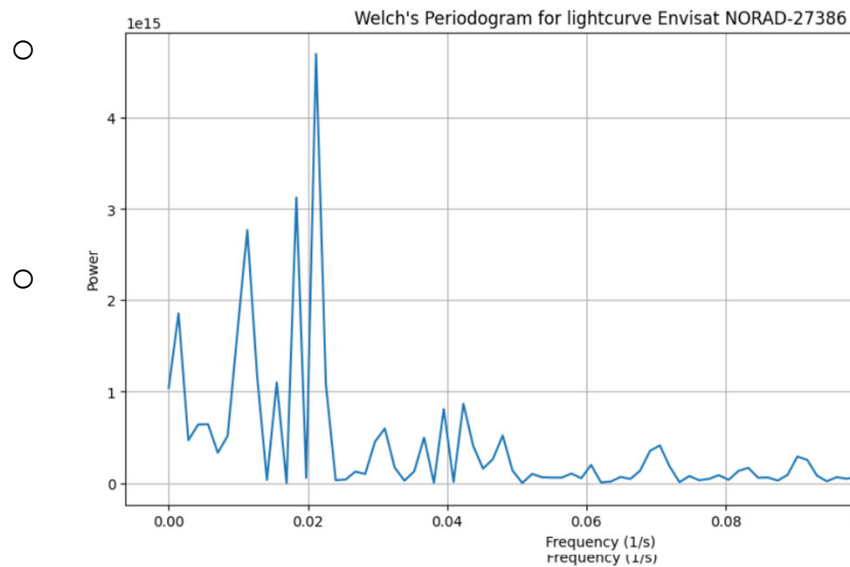
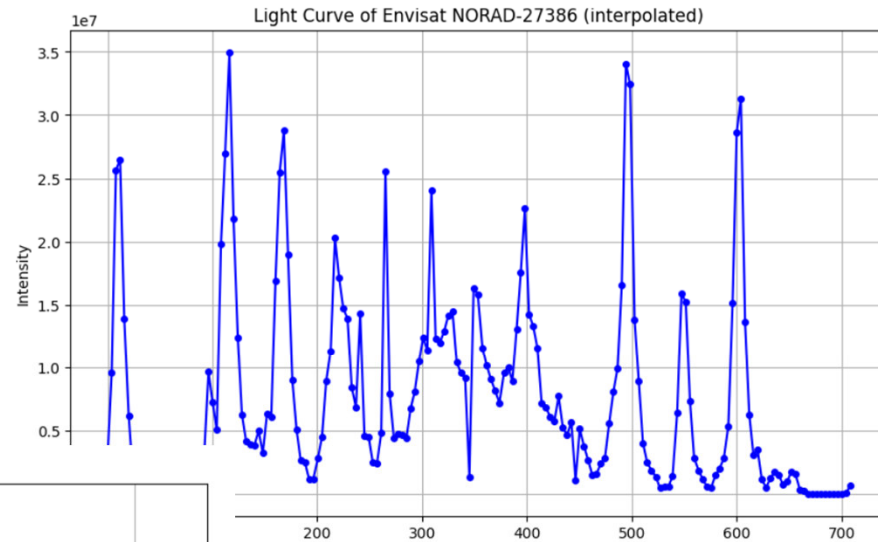
Results: Envisat_NORAD-27386

- **FFT and Periodogram Analysis:**

- Dominant Frequency: 0.0183 1/s
- Rotation Period: 54.5160 seconds

- **Welch Method:**

- Dominant Frequency: 0.0212 1/s
- Rotation Period: 47.2472 seconds



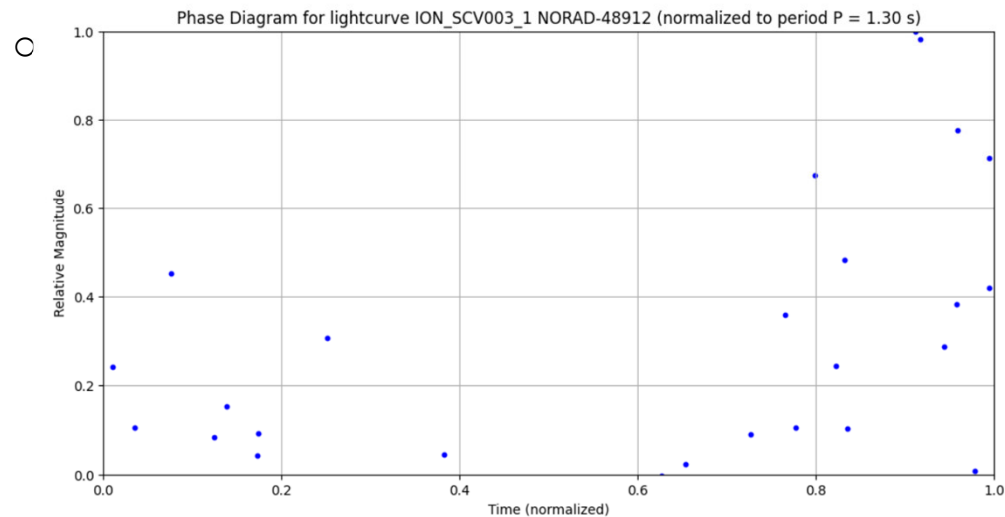
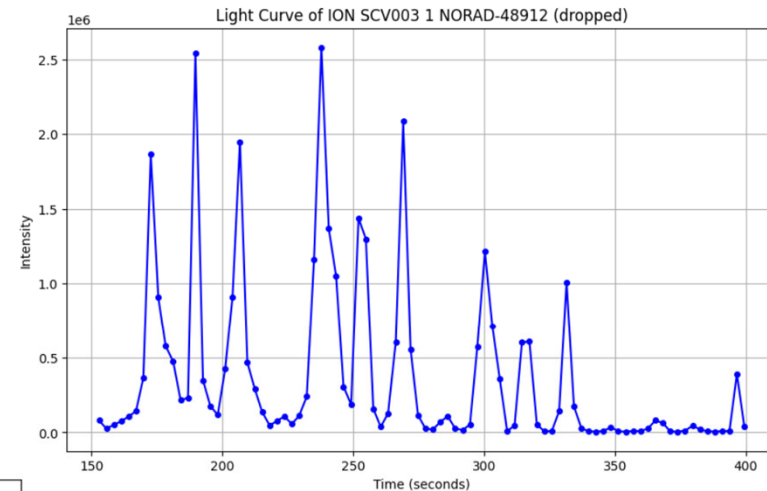
Results: ION_SCV003_1_NORAD-48912

- **FFT, Periodogram and Welch Method:**

- Dominant Frequency: 0.0642 1/s
- Rotation Period: 15.5705 seconds

- **Lomb-Scargle Analysis:**

- Dominant Frequency: 0.7691 1/s
- Rotation Period: 1.3002 seconds



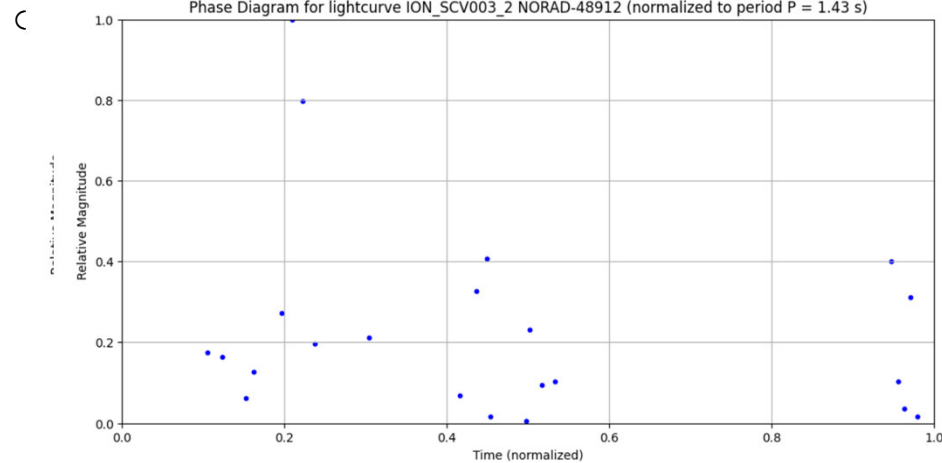
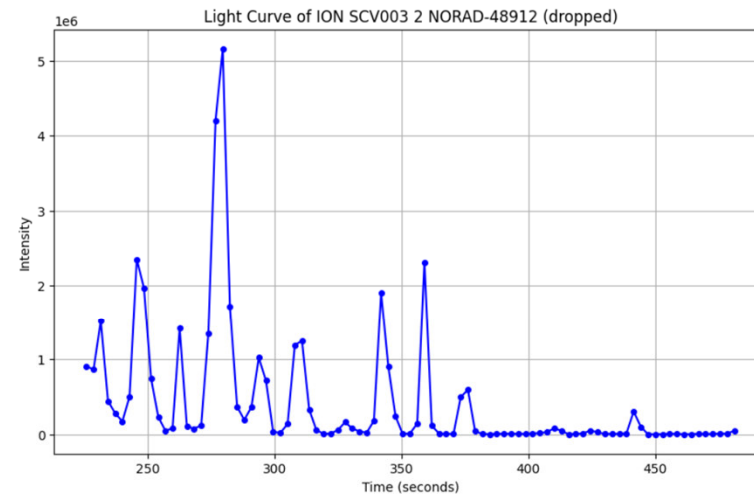
Results: ION_SCV003_2_NORAD-48912

- **FFT, Periodogram and Welch Method:**

- Dominant Frequency: 0.0622 1/s
- Rotation Period: 16.0843 seconds

- **Lomb-Scargle Analysis:**

- Dominant Frequency: 0.7017 1/s
- Rotation Period: 1.4251 seconds



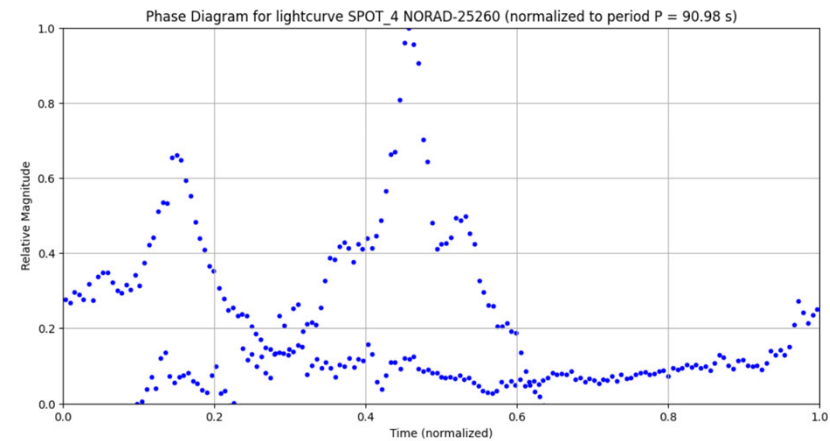
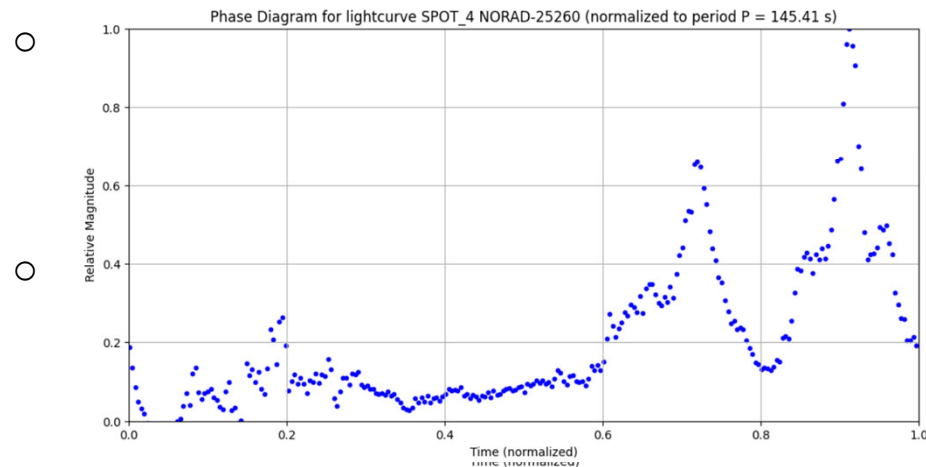
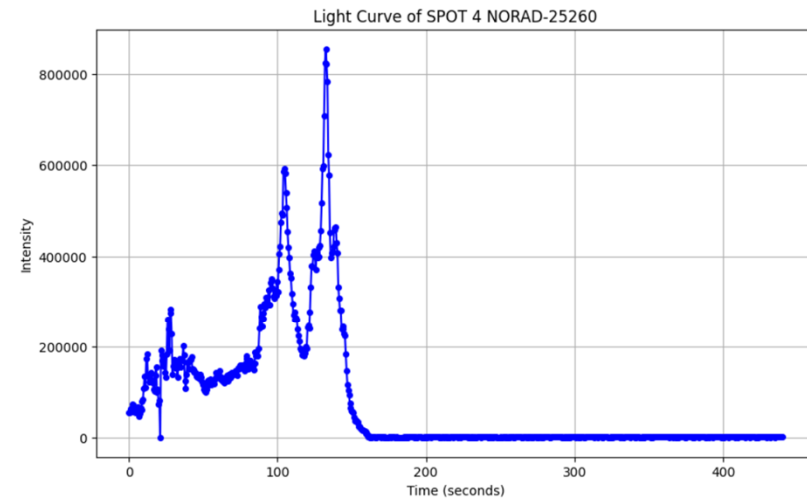
Results: SPOT_4_NORAD-25260

- **FFT and Periodogram Analysis:**

- Dominant Frequency: 0.0022 1/s
- Rotation Period: 447.016 seconds

- **Welch Method:**

- Dominant Frequency: 0.0069 1/s
- Rotation Period: 145.4080 seconds



Conclusion

- FFT, Periodogram and Welch Method usually provide very similar values.
 - Lomb-Scargle Analysis leads to significantly smaller periods for all analyzed objects.
- The results of the Lomb-Scargle analysis indicate differences between these methods, which could be due to different sensitivity to periodic signals in the light curve.
- By applying different techniques to light curve data, it is possible to characterize the rotation of these objects, which is essential for predicting their trajectories and controlling satellite operations.

Thank you for your attention!

Sources

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