

Project Proposal

PH 556 : Astrophysics

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Team : UzUMa-KI

Goal

Study an RR Lyrae variable and calculate luminosity, mass, distance, age and spectral class. As a secondary goal, try to verify the Blazhko effect by proving that the light curve has a modulation above the primary period.

Parameters to Calculate

Variability period - Using images across varying brightness.

Total Luminosity from multiple period-luminosity relations / period-total-luminosity relation.

Mass from mass-luminosity relation.

Tentatively:

Distance by comparing luminosity and apparent brightness from the images.

Radius using a radius-period relation [1].

Temperature using total luminosity and radius.

Spectral Class using temperature, mass and total luminosity.

Given Parameters

We're given an RR Lyrae variable and are assuming it follows the known period-luminosity relations, mass-luminosity relation, radius-period relation.

We're also given multiple images from which we assume we can obtain apparent brightness and measure period.

Verification

Will compare obtained values to known metrics from existing literature:

Variability period [2]

Luminosity in various bands [3]

Radius [1].

Spectral Class [4]

Blazhko period [5]

Target Star

We have chosen the target star UZ UMa ([Simbad link](#)), which is an RRab variable[2].

We chose this star due to the following reasons:

- A variational period of $0.46689\text{d} = 11.2\text{h}$ [2] makes it possible to obtain sufficient data to predict a period within one night, but also gives us the option of accessing the missing component of the period just a few days later (if 8 hours of a period are visible one night, the remaining 3 will be visible in the night after the next).
- A declination of $\sim 73^\circ$ ($< 90^\circ - 34^\circ$) means UZ UMa is circumpolar as viewed from GIT, and hence visible throughout the night.
- A Blazhko period of 26 days[5] is small enough to obtain maximum variation within the month of March itself.

Magnitude and Coordinates

RADEC J2000 :

$$\text{RA} = 08^{\circ}18' 53''.9127454200$$
$$\text{DEC} = +73^{\circ}05' 47''.926302000$$

Apparent Magnitudes : [3]

gg 14.7030

r 14.1269

i 14.2903

z 14.3070

Visibility Curves

The following are visibility curves for UZ UMa with observer location 78.965317°E 32.778921°N 4500 m +5.5h (the coordinates, altitude and time zone of GIT) obtained from Staralt/Starobs and airmass.org. The hourly visibility curves are obtained for 1st March 2023.

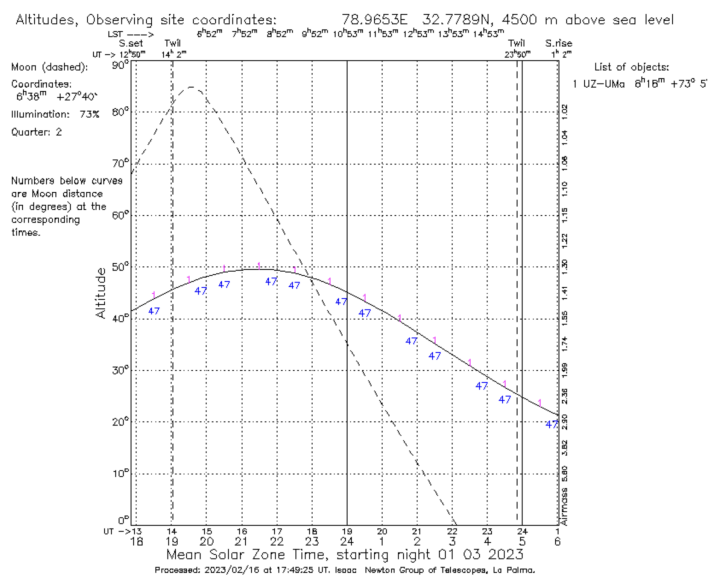


Figure 1: Hourly visibility curve for the night of 1 Mar 23 - Staralt

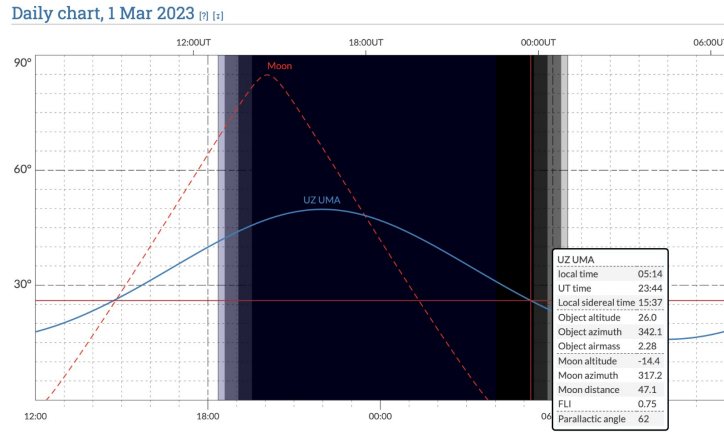


Figure 2: Hourly visibility curve for the night of 1 Mar 23 - airmass.org

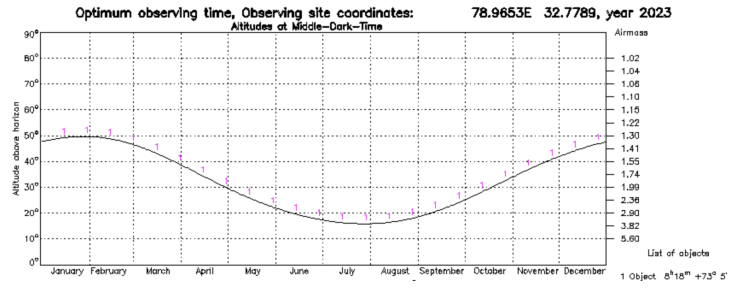


Figure 3: Monthly visibility curve - Starobs

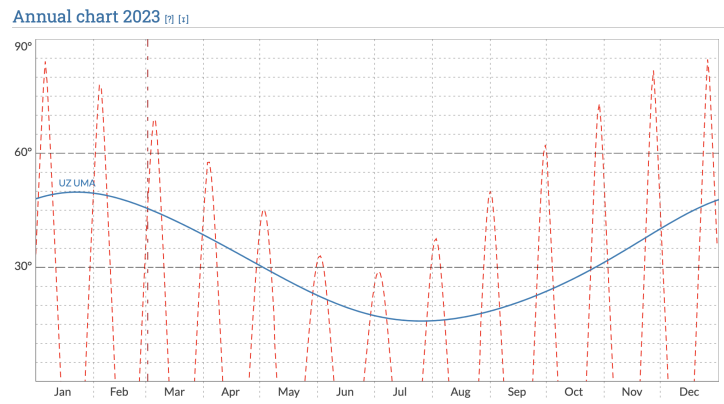


Figure 4: Monthly visibility curve - airmass.org

Image Requirements

Filter The z' filter, since it is closest to infrared out of the ugriz prime set of filters used by GIT.

The reasoning behind this choice is that RR Lyrae variables' period-luminosity relation is followed most strictly in the infrared IJHK bands [6], of which only the I band has an overlap with one of the ugriz bands, which is z'. [7]

Number of Images 10 for primary goals, 4 more at a later date to study Blazhko effect.

Cadence For original 10 images, 45 minutes between images (over a single night, preferably).

References

- [1] In: (). URL: <https://adsabs.harvard.edu/full/2004ASPC..310..502M>.
- [2] In: (). URL: <https://arxiv.org/abs/astro-ph/0601432>.
- [3] In: (). URL: <https://ui.adsabs.harvard.edu/abs/2016arXiv161205560C/abstract>.
- [4] In: (). URL: <https://articles.adsabs.harvard.edu/pdf/1960ApJ..131..632H>.
- [5] In: (). URL: <https://ibvs.konkoly.hu/pub/ibvs/5701/5705.pdf>.
- [6] In: (). URL: <https://arxiv.org/pdf/astro-ph/0406067.pdf>.
- [7] In: (). URL: <https://sites.astro.caltech.edu/~george/ay122/Bessel2005ARAA43p293.pdf>.

Team Name Etymology

We're studying the star **UZ UMa**, and being an RR-Lyrae it would have been ideal to study it in the **K** band, an **Infrared** band. While GIT doesn't have that capability, that didn't stop us from noting that the emboldened letters combined make a fantastic reference to a character who forever inspires, Uzumaki Naruto.