

Newsletter of the AAVSO Short Period Pulsator Section

Number 3

Northern Autumn/Southern Spring 2024

In this third Newsletter of the SPP section we look at an interesting star well-placed for observing in the next few months which has been studied by asteroseismology methods. Comments and suggestions about the newsletter remain welcome and can be emailed to Horace Smith (smithhh@msu.edu).

Asteroseismology

When we think of seismology, we think of earthquake waves moving through the Earth. Those waves tell us of the internal structure and composition of our planet. Asteroseismology uses stellar oscillations to investigate the interior structure and composition of stars. Helioseismology, asteroseismology of the Sun, has many excited pulsation modes to work with, but often only a few are detectable in other stars. The information which can be gleaned from stars pulsating with a single period is limited, but sometimes more can be learned from stars which pulsate simultaneously with multiple periods. Space-based observations, which can provide long and uninterrupted series of observations, are ideal for asteroseismology studies, but are limited in the sample of stars which can be studied. Observations from the ground are interrupted by daylight, except during long polar nights, complicating asteroseismology studies, but observations from different time zones can help fill in the gaps.

RV Ari: A Delta Scuti Variable with Multiple Periods

RV Ari (RA 02 15 07.46 DEC +18 04 28.0 J2000)

Our featured star, RV Ari, belongs to the group of delta Scuti variables. Such stars have periods shorter than 0.3 days and sometimes pulsate with more than a single period. Although delta Scuti variables often have amplitudes smaller than 0.1 magnitude in the V-band, some have higher amplitudes. RV Ari is a high amplitude delta Scuti variable well-placed for observing in the next few months. The paper by

J. Guzik (2021 <https://arxiv.org/pdf/2105.12553>) titled *Highlights of Discoveries for δ Scuti Variable Stars from the Kepler Era* discusses the class of variable star in more detail.

RV Ari has a main period so short that more than a single cycle can be observed in a single night. Its strongest period is 0.093128 days long, equal to 2.235 hours. However, the light curve of RV Ari does not repeat precisely from one cycle to the next, and analyses showed that it is pulsating with more than one period.

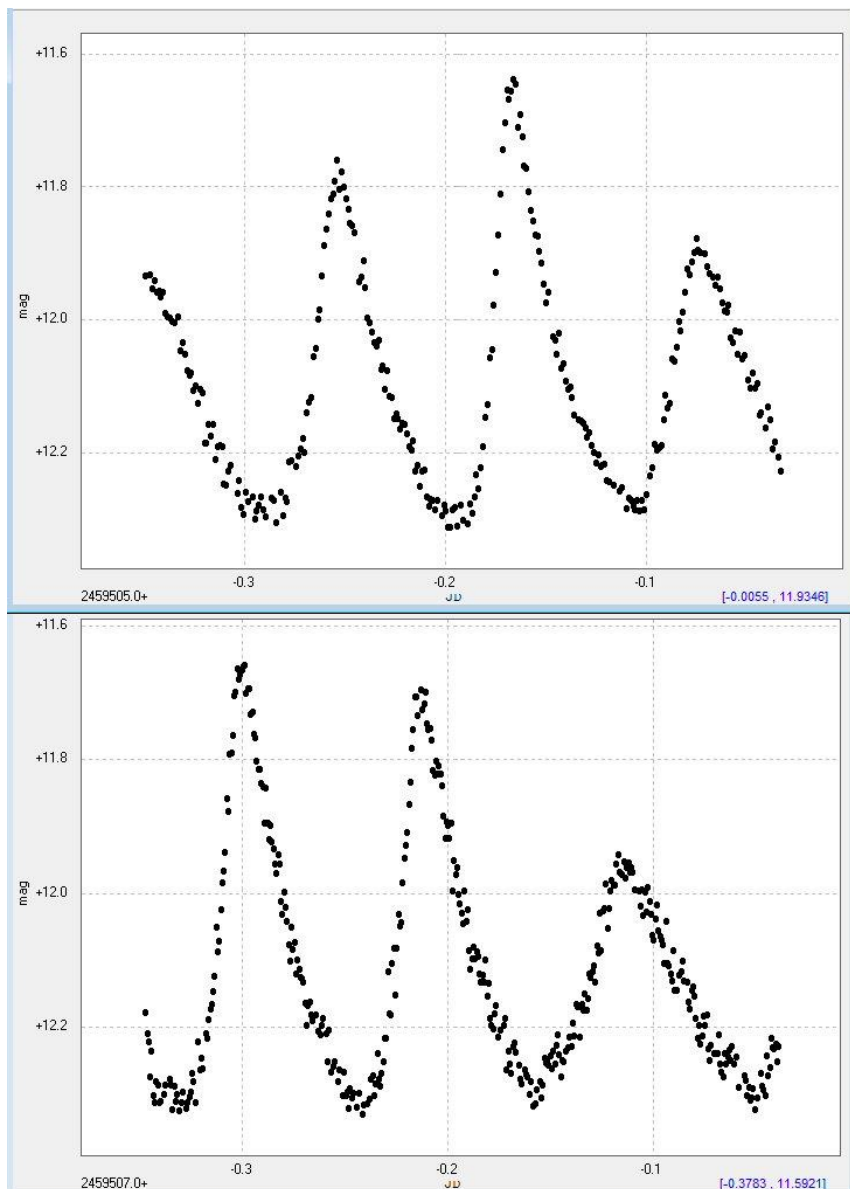


Figure 1. Two nights of V-band photometry of RV Ari. Courtesy of G. Samolyk. RV Ari has a chart and comparison stars available on the AAVSO website.

Ground-based observations revealed that RV Ari pulsated with two periods, the 0.093128-day period mentioned above, but also with a shorter 0.071947-day period. Those periods are generally interpreted as the radial fundamental and radial first overtone pulsation modes. However, there was evidence of a third period as well. Observations with TESS (the Transiting Exoplanet Survey Satellite), confirmed a low-amplitude third period, 0.07346505 day – close to but not equal to the known second period. Unlike the first two periods, this third period is believed to be due to a nonradial pulsation.

Its multiple periods have made RV Ari a target for analysis by theorists. Most recently J. Daszyńska-Daszkiewicz, P. Walczak, W. Szewczuk, and W. Niewiadomski (2023 *Monthly Notices of the Royal Astronomical Society*, 526, 1951) carried out asteroseismology modeling of RV Ari, suggesting that the star may be at the start of hydrogen-shell burning.

What can we learn from continued ground-based observations of RV Ari? They can be used to study period changes of at least the two radial pulsation modes, as well as changes in their amplitude. G. Samolyk has found that the longest period has been stable over the past three years. However, Pocs, Szeidl, and Viraghalmy (2002 *Astronomy and Astrophysics*, 393, 555) had earlier found slow rates of change in the two radial pulsation modes. Oddly, while they found the longer period to be decreasing, they found the 0.0719-day period to be slowly increasing. What is happening now?

Richard Wagner, an AAVSO observer of RV Ari, adds these comments: “It has no near companions in my images or in DSS (nearest star reported by GAIA is 22 arcsec away and about 5.4 magnitudes fainter)

“Its range is roughly mag 11.6 to 12.3. This is a nice magnitude to be easily shot with almost any sized telescope. There is a nice selection of comp stars in the field from mag 11.9 to 13.6 given by AAVSO VSP.

“There is a strong first overtone signal which makes the light curve vary dramatically from cycle to cycle. Fundamental period in my data was 0.09313386d, first overtone at 0.07195d with about 1/4 of the fundamental amplitude. My periods are slightly different from those I calculated from TESS and from ASAS-SN data so the periods may be changing.”

For a star such as RV Ari, series of observations several hours long are more valuable than a few scattered observations. Observations in the V-band alone can

aid period change studies. Multi-filter observations, for example B and V, provide colors for RV Ari and can help with theoretical studies. Because of the short periods of RV Ari, a relatively rapid observing cadence is needed to define the light curve.

We can endorse the closing line of the Pocs et al. paper: “By all accounts RV Ari is a very interesting star and deserves further study.” We thank Joyce Guzik and Richard Wagner for their assistance with this issue of the SPP newsletter.