IT HER : A missclassified eclipsing binary

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1) : AAVSO - 185 Alewife Brook Pkwy Ste 410, Cambridge, MA 02138-1104,United States

2) BSN Project - https://bsnp.info/

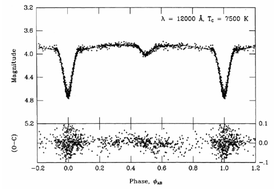
3) : Société Astronomique de France – Commission des Etoiles Doubles - 3, Rue Beethoven, 75016 Paris, France

4) : Groupe Européen d'Observations Stellaires (GEOS), 23 Parc de Levesville, 28300 Bailleau l'Evêque, France

5) : Society for Astronomical Sciences (SAS) - Pr 9302 Pittsburgh Ave, Suite 200, Rancho Cucamonga, CA 91730, United States

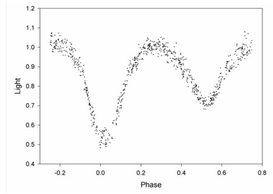
6) Journées de la SF2A Atelier S06 Gemini, 4 juillet 2025 Toulouse

IT Herculis



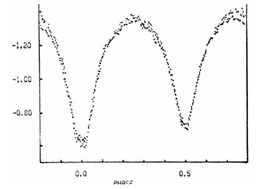
Algol

Fig. 1 : Graph of an Algol-type lightcurve



β Lyra

Fig. 2 : Graph of an Beta Lyrae



W UMa

Fig. 3 : Graph of a W Ursae Majoris

We distinguish three morphological types of lightcurve, all of which are observable with amateur equipment
Mind the curves : Shapes tell us the type of stars present.

Interest in this star was sparked by its classification, with it being classified as RR Lyrae (General Catalog of Variable Stars (Samus+ 2007-2011)).
Stars of this type are relatively old and pulsating stars, called population II stars, therefore showing low metallicity.

However, the apparent magnitude of IT Her is between 12.4 and 12.8, (RA 18:45:46.41 and DEC:25;19;59.4 in J2000)

In the AAVSO catalog, we note that the IT Her star is an EW type eclipsing binary whose two components fill their Roche lobe and have a very ellipsoidal shape.

The observatory's O-C ephemeris website SOHURA Asronomical Observatory indicates that this star is listed as RR Lyrae of type RR under the id 400237 400237 IT Her 18h 45m 46.4s 25o 19' 59" |RRC | 12.9 0.226038 and announces a change in the O-C of the star.

Our primary observations did not match some of these descriptions, so we decided to study it in more depth

What we found in photometry and spectroscopy

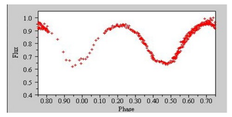


Fig. 8 : V-band light curve obtained from our observation data

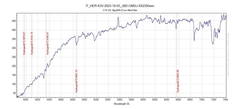


Fig. 9 : IT Her spectrum with instrumental correction and location of Balmer lines which are very inactive.

From the data made available to us and the parameters from the article cited above, we carried out the following simulation using the Binary Maker 3.0 software (Bradstreet and Steelman, 2002) :
Note on the light curve above that the maxima are not at the same height (O'CONNELL effect), this being due to the presence of spots (equivalent to sunspots) on one of the stars or to the presence of dust around the system.
The 3D modeling was obtained from light curve data. We see very clearly the mass ratio as well as the presence of a spot on the second star.
Note that there then exists around each star a special surface, which is the one which is in contact (at the Lagrange point L1) with its centered counterpart. We call this part: Roche surface, and the volume it contains, the Roche lobe.

Here are the parameters used to carry out the simulation:
According to Gaia, we have IT Her A (secondary star): 0.34059461664501695 and IT Her B (primary star): 2.7219529361897408, Tilt: 81°, Temperature: 5.399°, Period: 0.3392 day. Even if this modeling remains imperfect, it allows us to know how this system is constituted and concretizes our hypothesis from the beginning.

One of our references specified that IT Her was a type A5 star. As already discussed in the introduction of this document, one of the specificities of type "A" stars is the appearance of Balmer lines and therefore of hydrogen. This is due to the ionization of hydrogen atoms which are very active at 10,000 degrees Kelvin.
Hydrogen electrons are particularly active between temperatures between 6,000K and 40,000K, which means that type "A" stars in particular demonstrate Balmer lines, namely H alpha, beta, gamma, delta, epsilon and zeta.
To compare with our star IT Her, during our reference searches we discovered, among other things, that on the "site research of Gaia", the spectrum displayed did not correspond to the reference literature either. In the raw spectrum of IT Her, hydrogen lines were not very present, but other elements found led us down a path.

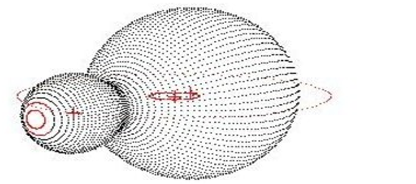


Fig. 10 : 3D Modelisation

Discussion and conclusion

Through our observations and analyses, we note that the IT Her star is indeed not an RR Lyrae (CDS, Simbad, GCVS), but rather an EW type eclipsing binary.

Several of these sources were bulletins from "Commission 27 and 42 of the IAU information bulletins on Variables Stars", others came from observatory observation reports dating back as far as 1992 and stipulating that the star IT Her was indeed a star of type RR Lyrae. Subsequently, our research also discovered other more recent documents which stipulated that the star was indeed an EW and their light curves are similar to ours as well as that imported by the TESS satellite.

In summary, particularly in photometry, our observations lead us to a W type star Ursae Majoris, EW, a contact binary both for its light curve and its short period,
In spectroscopy, we notice in the changes of Ca1 and Ca2, but in less intense quantities, Fe1 and Fe2, Na2, in short, we notice "metals" present in the stars much colder than the "A" type stars .
Following this publication and other observations, requests for corrections will be made according to the protocols of each database
For now, we propose a spectral classification between K3 and K4, since we assume that the binary star is still in the main sequence and that the average temperatures match our observations.

As professional observatories are expensive and cannot ensure long-term monitoring, and often, only passionate amateurs can, even with their small telescopes, make interesting follow-ups and validate what we sometimes think is "the truth".

In 2025, the adventure continues,

Observations context

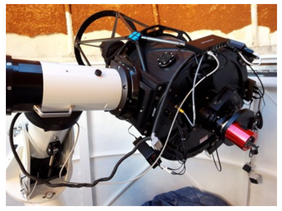


Fig. 4 and Fig. 5 : The Pic du Midi observatory and the 50 cm telescope

Fig. 6 and Fig. 7 : The Obsevatory Mont Saint Joseph and the two parallel telescopes

1st instrumentation:
The Pic du Midi observatory is located in France in the Pyrenees at an altitude of 2,887 meters. This Mecca of French astronomy is home to several telescopes dedicated to Sun, planets and exoplanets observation.
Amateur astronomers can have - if they request it to the T60 Association - a 50 cm diameter telescope to carry out their own observations.

Instrument features:
The model is a CDK 20 Planewave installed on a NOVA 120 mount built by Alcor-System.
Optical type: Dall-Kirkham with a 508 mm mirror and a focal length of 3,454 mm (F/6.8) reduced to F/4.5 with a focal reducer.

2nd instrumentation: OMSJ (Mont St-Joseph Observatory, Quebec-Canada)
Located in Quebec, on Mount St-Joseph, right in the middle of the world's first dark sky reserve, the OMSJ (Mont St-Joseph Observatory) benefits from a particular darkness, since the mountain hides the light pollution from the west and the trees, that from the northeast (Lac-Mégantic).
Two telescopes set in parallel on a CEM120 mount (Ioptron), the first is dedicated to "standard" photometry (ED127 APO-Triplet Scope - 127 mm diameter and 952 mm focal length F/7.5 (Explore Scientific), camera CCD SBIG ST8, filters CV, B, V, Rc, Ic, HA, OIII, SA200). Field (FOV): 1.95 arcsec/pixel.

References and contacts

- AAVSO American Association of Variable Star Observers : http://www.aavso.org
- CCD Observing Guide http://www.aavso.org/ccd-photometry-guide
- Variable Stars South : http://www.varstarssouth.org/
- Howell, Steve B., 2006, Handbook of CCD Astronomy, 2nd Edition (Cambridge: Cambridge U.Press)
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- Henden, Arne and Kaitchuck, Ronald, 1990, Astronomical Photometry (Richmond, VA: WillmanBell)
- W. Romanishin Universitiy of Oklahoma, An Introduction to Astronomical Photometry Using CCDs

- Martine Castets, co-observer during the missions in 2022 and 2023, without whom the observations at the Pic du Midi Observatory would not have been possible.
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