The GEOS RR Lyr database and survey
A professional-amateur project

Jean-François Le Borgne

GEOS
Groupe Européen d'Observation Stellaire
IRAP
Institut de Recherche en Astrophysique et Planétologie
Observatoire Midi-Pyrénées, Université Paul Sabatier
Toulouse, France
GEOS:  http://geos.upv.es/

- Created in 1974, already European and pro-am.
- Promote research among amateur astronomers in Europe
- The basic idea is that amateurs should themselves extract scientific information from their observations and publish their results.
- Recent initiative: creation of a RR Lyr star maxima database.
- During the past years the study of RR Lyr stars has become the main field of interest of GEOS but other variable stars are also studied: eclipsing binaries, δ Scuti stars, Cepheids ... essentially “fast” varying stars

References:


GEOS RR Lyr Database

A tool for the study of RR Lyr stars

http://rr-lyr.irap.omp.eu/dbrr/

Allow to follow period variations since star's discovery, some times over 100 years ago.

Help to preparation of observations of RR Lyr stars,

GEOS RR Lyr Survey

Add significantly more maxima timings of the brightest RR Lyr stars essentially using robotic telescopes.

Study fainter understudied stars to refine their period and find new stars which exhibit Blazhko effect.

Characterize the Blazhko effect, and other long term variations of RR Lyr stars.
Aim of the database: Maintaining an up-to-date list of observed maxima of RR Lyr stars.


And make it available on the web,

First, collecting published historical times of maximum made with the efficient help of Anton Paschke, Massimiliano Martignoni and Francesco Acerbi in the early years of the project.

We make a survey of recent publications periodically

A couple of days ago: 81714 maxima on 3904 stars

To access data: a web interface to the database list of maxima, O-C curves, basic data of the stars

The web site is hosted by IRAP.
GEOS RR Lyr Database: 2000-2016
3 versions

V1:
Interface coded in html, static
Maximum data in ascii files

V2:
Interface coded in html + php
Web pages created dynamically
Maximum data in database mysql
Indexed on gcvs star names

V3:
Interface coded in html + php + css
Web pages created dynamically
Maximum data in database mysql
Indexed on unique star identification
Uses alias names

The GEOS RR Lyr database and survey
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Hamburg, 17.9.2016
Database tables

- Catalog: coordinates, type, magnitudes
- Alias names
- Elements
- Maximums
- References
- Comments

Web interface

Access to data:

- Access by constellation and GCVS names
- Access by star name
- Complete list of stars with maxima
- Access by coordinates / Access to catalog
  - Center of field or field limits
  - Center on given star
Making of the RR Lyr catalog

Access to GCVS and VSX catalogs

VSX catalog is updated every Monday at CDS
GCVS is updated irregularly at scale of several months

Index of ftp://cdsarc.u-strasbg.fr/pub/cats/B/vsx/

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**Elements**

By default the database elements are used in O-C calculation. If several elements are available, the user can choose one of them. A form allows the user to enter his/her own elements. If they are given, current elements until the button "Reset to database elements" is pressed.

Current elements: \(2426743.574 + 0.7363225 \text{ E}\)

**List of maxima**

17 maxima

**Graphics options:**

- Plot T-C as function of
  - HJD
  - Cycle number

- Toggle period shift
  - on
  - off

To download the maximum list as a text file, click here.

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<th>HJD</th>
<th>Unc. (day)</th>
<th>T-C (day)</th>
<th>E</th>
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Access to data and functions

- Complete list of stars with maxima
- Access by constellation and GCVS names
- Access by coordinates
- Access by star name
- List observers
- Bibliography
- Statistics on RR Lyr maxima
- The Blazhko star catalog
- RR Lyr star spectroscopy

HP Pup:
- Compute ephemeris
- Search Period from maximum list
- GEOS RR Lyr wiki page
- Simbad
- AAVSO VSX record
- Download measurements from AAVSO
- AAVSO WebObs Search Results

Lightcurve from AAVSO data

Enter JD of beginning and end of lightcurve and click on the "AAVSO lightcurve" button.

---

Database numbers

- **Date of last updates**
  - General RR Lyr catalog: 2016-05-16 17:29:37
    (62281 entries)
  - Element table: 2016-02-21 19:32:33
    (18122 entries)
  - Maximum table: 2016-09-09 13:54:00

- **81709** maximums on **3904** stars

Related external links

- General Catalog of Variable Stars
- Bundesdeutsche Arbeitsgemeinschaft für Veränderliche Sterne, RR-Lyr web page
- AAVSO Short Period Pulsator
- The International Variable Star Index
- AAVSO VSX
- Центра данных переменные звезды
- Centre de Donnees Stellaires
- Simbad Astronomical Database
- VizieR Catalog Service
- NASA Astrophysics Data System
- arXiv.org astro-ph
- The Blazhko Project, Vienna
- Open European Journal on Variable stars
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List of predicted maxima

All predicted maxima are listed in the following table according to the selected elements. Those potentially observable from the observatory specified above, have their geometric date printed in red. The reason for non-observability is printed in grey on the same line. This may be because the star is not set, the star is not rising, or the maximum occurs in twilight (Sun altitude > 12°). When maximum occurs at an altitude > 90°, it is not set as observable but the date is printed in grey. The printed date are hour angle, altitude azimuth and air mass at the time of maximum. The air mass 2 hours before and after maximum are also printed. The times in 24h format when visible at the site.

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<th>Altitude</th>
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Elevation curve: JD 2457645

Hamburg, 17.9.2016
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Hamburg, 17.9.2016

GEOS RR Lyr Survey

Started 2004

Robots: routine observations of maximums of bright RRab stars (magnitude at minimum $\leq 13$).
Aim: survey light curve variations at large time scales ($\geq 10$ years)

Human observers: Study of fainter understudied stars (magnitude at minimum range $\sim 13-15$).
Aim: refine or find period and find possible new Blazhko effects,

Human observers: Followup of RR Lyr itself with small dedicated instruments
Robotic Telescopes Tarot
« Télescope à Action Rapide pour les Objets Transitoires »

PIs: M. Boër (OCA) and A. Klotz (IRAP)

Dedicated to followup of gamma ray bursts
And observation of earth satellites for CNES.
Mirror diameter 25 cm
Robotic and fast
CCD cameras 2000x2000, field 2°x2°

RR Lyr star survey is one of the additional programs
(~40% observing time)

Calern, France: since 2004
8557 maximums 294 stars

La Silla, Chile: since 2006
7364 maximums 360 stars

Magnitudes: 9 to 13

Automatic data reduction:
bias, flat fields, photometry
Routine followup of bright RR Lyr stars of type RRab

6 to 8 maxima scheduled on each telescope every night
Precision of ToMs: ~0.002 days (3mn)

<table>
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<th>JD</th>
<th>Star</th>
<th>N*</th>
<th>observation time (JD)</th>
<th>observation time (UT)</th>
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Routine followup of bright RR Lyr stars, type RRab

An example: Blazhko star AF Vel observed at La Silla over 10 years, 68 maxima, 2458 measurements
Human observers: Study of understudied stars

Many RR Lyr stars fainter than magnitude 13 at minimum are understudied.
  Pulsation period and type are not accurately known
  We do not know if there is a Blazhko effect

Observers use telescopes of 20 to 60 cm diameter

Observing plan: get complete folded light curve in a short time (about one week) and do it again several weeks or months later.

Variable number of amateur astronomers contribute to the program
Presently from Europe and Japan
Since 10 years, 25 astronomers have contributed, from Europe, Japan, Australia, USA and Namibia

~100 understudied RR Lyr stars observed

Several Blazhko effect discovered
An example: CM Leo

Known as RRab proved to be an RRc

Observers: 2011-2015
Laurent Corp and collaborators, T60 Pic du Midi, France
Marco Nobile, 20cm Savosa, Switzerland
Maurice Audejean, 30cm, Chinon, France
Also Francesco Fumagalli and Gisela Maintz (BAV)

Observed period: 0.366 jour

GCVS: RRAB
Magnitude: 13.8-14.9 (B)
Period: 0.361732 jour
V568 Cas: A long period Blazhko effect

GCVS: RR:
  Magnitude 13.1-14.0 (p)
  Period: 0.623 jour

Observed period: 0.51404 days
Blazhko effect period: 325 jours

Observers: 2008-2016
  Eric Denoux, Caussade, France, 28cm
  Mercè Correa, Sabadell Spain, 50cm
  Ramon Moliner, Sabadell Spain, 50cm
Followup of the Blazhko effect of RR Lyr itself

RR Lyr
magnitude 7-8,
period 0.51 jour
Blazhko effect period ~40 days.

Variable Blazhko effect:
Preston et al. (1965) observed disappearance of Blazhko effect in 1963.
The phenomenon has a time scale of a few years,

Study of Variable Blazhko effect needs continuous observation during several years,

Instrumentation: VTT, Design: Alain Klotz
Camera CCD Audine kaf400
Photo lens 135mm F/2.8
Mount HEQ5 GOTO controlled by computer

A job for ants!
2008-2016:

2 VTTs:
980 nights of observations
394 maxima

In total with other observers (+literature)
587 maxima (438 different)

**Disappearance of Blazhko effect in 2014**
as in 1963 (Le Borgne et al. 2014) and
**Restart in 2015**

From Poretti, Le Borgne, Klotz, Audejean, Hirosawa, 2015, Conference "RRL2015 - High-Precision Studies of RR Lyrae stars", held in Visegrad (Hungary)
2008-2016:

2 VTTs:
980 nights of observations
394 maxima

In total with other observers (+literature)
587 maxima (438 different)
Conclusion

To find new things on RR Lyr stars, no need of giant telescopes.

But need to observe a lot (short time sampling, minutes), during a long time (years): this is slow science!

Solution: collaborative work and use of automated/robotic telescopes.

GRRS observation density 2004-2016:
Robotic telescopes Tarot:

Humans, understudied stars:

VTTs, RR Lyr itself:
Thank you