

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:

Hambsch, F.-J.; Le Borgne, J.-F.; Poretti, E.; GEOS association, 2012, The Journal of the American Association of Variable Star Observers, vol. 40, no. 1, p. 177

Boninsegna, R.; Vandenbroere, J.; Le Borgne, J. F.; GEOS Team, 2002, ASP Conference Proceedings, Vol. 259. 166

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.

GEOS RR Lyr Database

Aim of the database : Maintaining an up-to-date list of observed maxima of RR Lyr stars.

Starting idea in 1999: updating the data published in the book “RR Lyr Stars” written by Vladimir P. Tsessevich in the years 1960’s (1966, 1969 for the English translation).

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



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

Access to data

- Complete list of stars with maxima
- Access by constellation and GCVS names
- Access by coordinates
- Access by star name

Apply

- List observers
- Bibliography
- Statistics on RR Lyr maxima
- The Blazhko star catalog
- RR Lyr star spectroscopy

Database numbers

Date of last updates

General RR Lyr catalog: 2016-05-10 14:06:51
(62281 entries)

Element table: 2016-04-21 17:44:54
(18029 entries)

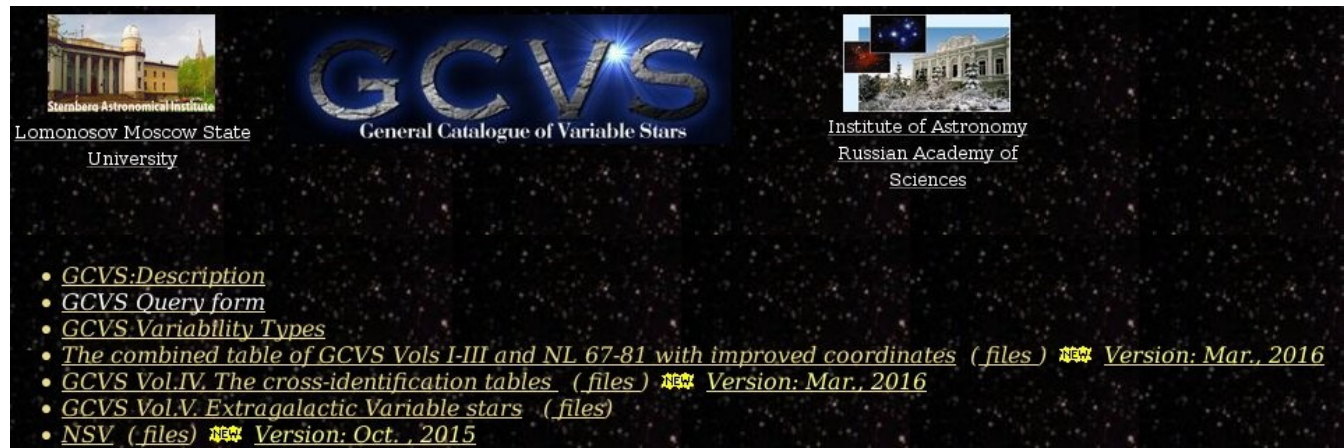
Maximum table: 2016-05-13 13:23:27

80337 maximums on 3899 stars

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/>

[↑ Up to higher level directory](#)

Name

+footg5.gif
+footg8.gif
ReadMe
refs.dat.gz
versions
vsx.dat.gz
vsx_id.dat

Size

4 KB
54 KB
29 KB
1779 KB

05/09/2016 10:01:00 AM
05/09/2016 10:01:00 AM
05/09/2016 09:56:00 AM
05/09/2016 09:56:00 AM

05/09/2016 09:51:00 AM
12270 KB
50 KB
05/09/2016 09:50:00 AM
05/09/2016 09:50:00 AM

Last Modified

GEOS RR Lyr database:HP Pup - Mozilla Firefox

Mozilla Firefox Web Br... x Fedora Project - Start... x 5. Preparing a USB fl... x Index of /observations x GEOS RR Lyr databas... x

rr-lyr.irap.omp.eu/dbrr/rrdb-v2.0_08.3.php?HP+Pup&en

Search

Link to VSX record

Element table: 2016-07-26 19:32:33 (18122 entries)
Maximum table: 2016-09-09 13:54:00
81709 maximums on 3904 stars

Elements

By default the database elements are used in O-C calculation. If several elements are available 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.

Elements available in database:

☐ 2426743.574 + 0.7363225 E (GCVS (Kholopov et al.; 1988-2006))

☒ 2426743.574 + 0.7363225 E (GCVS (Samus et al.; 2012)) **Default**

Apply

Reset to default elements

Custom Elements:

Origin

Period

Quad. term*

Apply

Reset to database elements

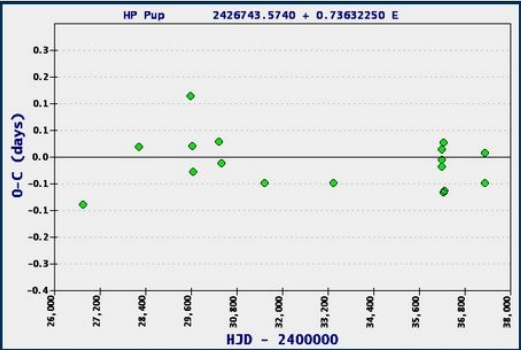
Or

* Quadratic term must be given in units of 10¹⁰ day

Current elements: 2426743.574 + 0.7363225 E

List of maxima

HP Pup 2426743.5740 + 0.73632250 E



17 maxima

Graphics options:

Plot O-C as function of

☒ HJD ☐ Cycle number

Submit

Toggle period shift

☒ ON ☐ OFF

Submit

Symbol colors: green: photographic; yellow: visual; red: photoelectric; bleu: ccd; no color: unknown

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

Star name	HJD	Unc. (day)	O-C (day)	E	period shift	Ref.	Observer	meth.	comments
HP Pup	2426743.4440	0.130	0	0	Gessner,1966	H. Gessner	pg		
HP Pup	2428210.3560	0.028	1992	0	Gessner,1966	H. Gessner	pg		
HP Pup	2429575.6390	0.169	3846	0	Gessner,1966	H. Gessner	pg		
HP Pup	2429631.4610	0.030	3922	0	Gessner,1966	H. Gessner	pg		
HP Pup	2429642.4350	-0.041	3937	0	Gessner,1966	H. Gessner	pg		
HP Pup	2430326.5610	0.042	4866	0	Gessner,1966	H. Gessner	pg		
HP Pup	2430382.4630	-0.017	4942	0	Gessner,1966	H. Gessner	pg		
HP Pup	2431530.3350	-0.072	6501	0	Gessner,1966	H. Gessner	pg		
HP Pup	2433331.3800	-0.071	8947	0	Gessner,1966	H. Gessner	pg		
HP Pup	2436193.5590	0.022	12834	0	Gessner,1966	H. Gessner	pg		
HP Pup	2436198.6660	-0.025	12841	0	Gessner,1966	H. Gessner	pg		
HP Pup	2436199.4210	-0.007	12842	0	Gessner,1966	H. Gessner	pg		
HP Pup	2436227.4490	0.041	12880	0	Gessner,1966	H. Gessner	pg		
HP Pup	2426228.5200	-0.097	12883	0	Gessner,1966	H. Gessner	pg		

Related external links

- General Catalog of Variable Stars
- Bundesdeutsche Arbeitsgemeinschaft für Veränderliche Sterne, RR-Lyr web page
- AAVSO Short Period Pulsator Section
- The International Variable Star Index
- ААВСО VSX
- Переменные Звезды
- Centre de Données Stellaires
- Simbad Astronomical Database
- VizieR Catalog Service
- NASA Astrophysics Data System
- Preprints astro-ph
- The Blazhko Project, Vienna
- Open European Journal on Variable stars

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A professional-amateur project

Hamburg, 17.9.2016

Access to data and functions

Access to data

- 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: 2016-07-26 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 Section
-  The International Variable Star Index AAVSO VSX
-  Переменные Звезды
-  Centre de Donnees Stellaires
-  Simbad Astronomical Database
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Hamburg, 17.9.2016

GEOS RR Lyr database: - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Mozilla Firefox Web Br... Fedora Project - Start... 5. Preparing a USB fl... Index of /observations GEOS RR Lyr database: +

rr-lyr.irap.omp.eu/dbrr/rddb-v2.0_03.0.php?NamedStar Search

GEOS RR Lyr Catalog: Access by coordinates

Central coordinates Box limits Search around star

Search around star mode

Enter star name and search box size (degrees):
Star name Search box size (radius)
SW And 1 Apply

Enter magnitude constraints (mag at min):
Mag. of highest brightness Mag. of lowest brightness
0 20 Apply

5.929542 29.401 1
Coordinate range:
ra: 0:19:43.0901 -> 0:27:43.0901 (4.929542 -> 6.929542 degrees)
dec: 28° 24' 3.600" -> 30° 24' 3.600" (28.401 -> 30.401 degrees)
Field of view: 2 degrees
magnitude range: 0 20

J2000 00 23 43.090 +29 24 23.60

Stars in GEOS catalog

2 stars in coordinate box from GEOS RR Lyr catalog

Ra	Dec	Id.	Type	max. mag	min. mag		Name	Wiki	Simbad	GCVS
5.929542	29.401	002343.09+292403.6	RRab	9.14	- 10.09	V	And			
6.40718	28.64793	002537.72+283852.5	RRab	16.35	- 17.23	CV	SW And CSS_J002537.7+283852	Wiki	Simbad	GCVS

Stars in VSX catalog

VSX version 2016-03-14 (CDS Simbad)

Name	Ra	Dec	Type	max. mag/ mean mag	min. mag/ amplitude	Period (day)
CSS_J002001.5+285203	0:20:1.5312	28° 52' 3.504"	RRAB/BL	16.46	(0.68)	0.48231
V0487 And	0:21:27.0000	30° 13' 23.016"	EB	11.6	11.76	1.04068
TSVSC1 TN-N322122010-6-67-2	0:21:55.3584	29° 53' 14.388"	VAR	15.06	0	0.363058
NSVS_J0022245+301252	0:22:24.5448	30° 12' 51.588"	MISC	11.76	(0.34)	96
CSS_J002232.9+293257	0:22:32.8992	29° 32' 57.192"	EB	15.02	(0.55)	0.41905
LR And	0:22:49.8792	29° 27' 15.408"	ELL	7.1	7.15	1.432321
TSVSC1 TN-N322130012-234-67-2	0:23:38.9208	28° 37' 47.388"	VAR	12.82	0	0.094684
SW And	0:23:43.0896	29° 24' 3.600"	RRAB/BL	9.14	10.09	0.4422618
CSS_J002429.3+283121	0:24:29.3088	28° 31' 21.108"	EW	15.47	(0.19)	0.4137
CSS_J002512.6+292530	0:25:12.6288	29° 25' 30.684"	EW	15.89	(0.11)	0.394457
CSS_J002532.6+293737	0:25:32.6592	29° 37' 37.596"	EW	15.25	(0.13)	0.28896
CSS_J002532.7+293737	0:25:32.7312	29° 37' 37.200"	EW	15.28	(0.16)	0.28896
CSS_J002537.7+283852	0:25:37.7232	28° 38' 52.548"	RRAB	16.786	(0.44)	0.616473
CSS_J002553.0+300712	0:25:53.0304	30° 7' 12.900"	EA	13.75	(0.31)	1.0354668
NSVS_J0026307+291646	0:26:30.6936	29° 16' 46.272"	L:	10.405	(0.301)	129
CSS_J002650.3+285656	0:26:50.3712	28° 56' 56.112"	EW	17.09	(0.37)	0.250592
CSS_101212:002657+284933	0:26:56.5488	28° 49' 32.988"	UG	15.5	20	0
CSS_J002705.5+292738	0:27:5.5800	29° 27' 38.592"	EW	15.76	(0.2)	0.330874

18 variable stars found

Stars in GCVS

GCVS version: Version: Mar. 21, 2014

Name	Ra	Dec	Type	max	min	Period (day)
SW And	0:23:43.0901	29° 24' 3.600"	RRAB	9.14	- 10.09 V	0.4422618
LR And	0:22:49.8799	29° 27' 15.400"	ELL	7.1	- 7.15 V	1.432321
V487 And	0:21:27.0000	30° 13' 23.000"	EB	11.6	- 11.76 *	1.04068

Access to data

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- NASA Astrophysics Data System
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- The Blazhko Project, Vienna
- Open European Journal on Variable stars

powered by php

Linux Powered by APACHE 2.0

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A professional-amateur project

Hamburg, 17.9.2016

GEOS RR Lyr Survey

Started 2004

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

Human observers: Study of fainter understudied stars
(magnitude at minimum range ~ 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 $2^\circ \times 2^\circ$

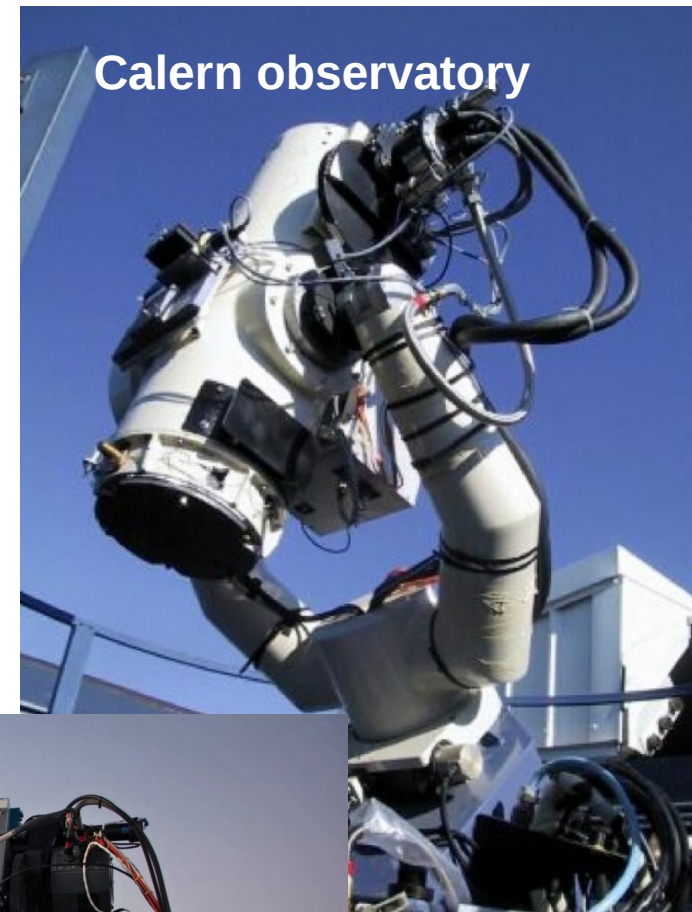
RR Lyr star survey is one of the additional programs
(~40% observing time)

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



Calern observatory

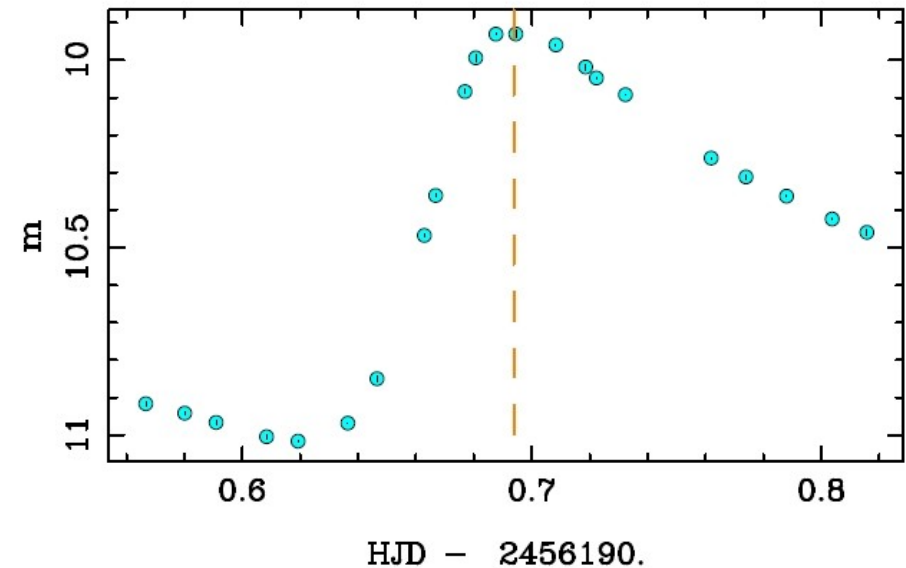


La Silla observatory

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)

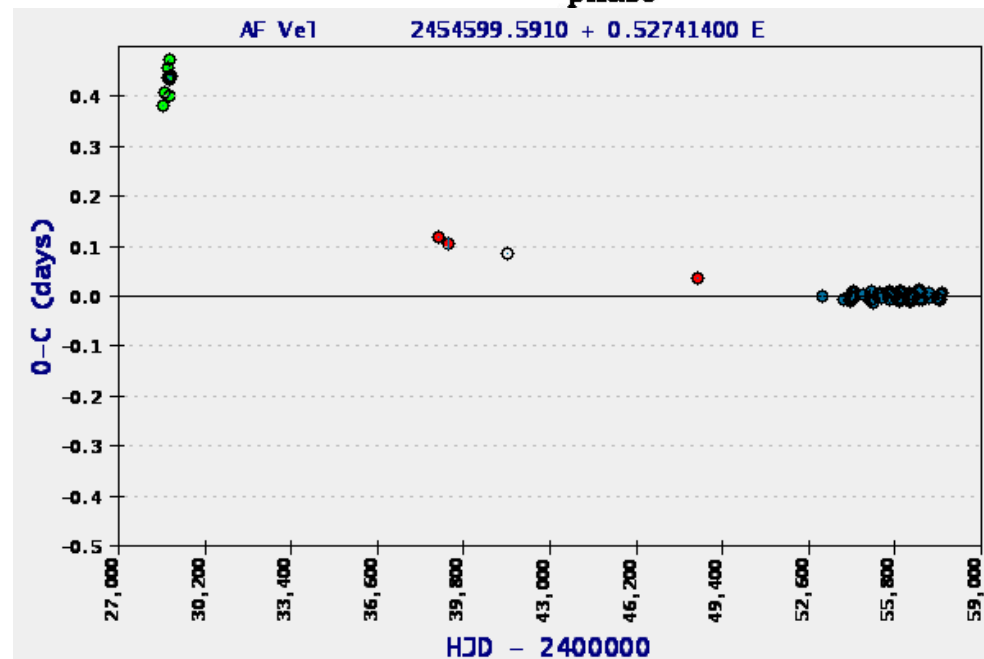
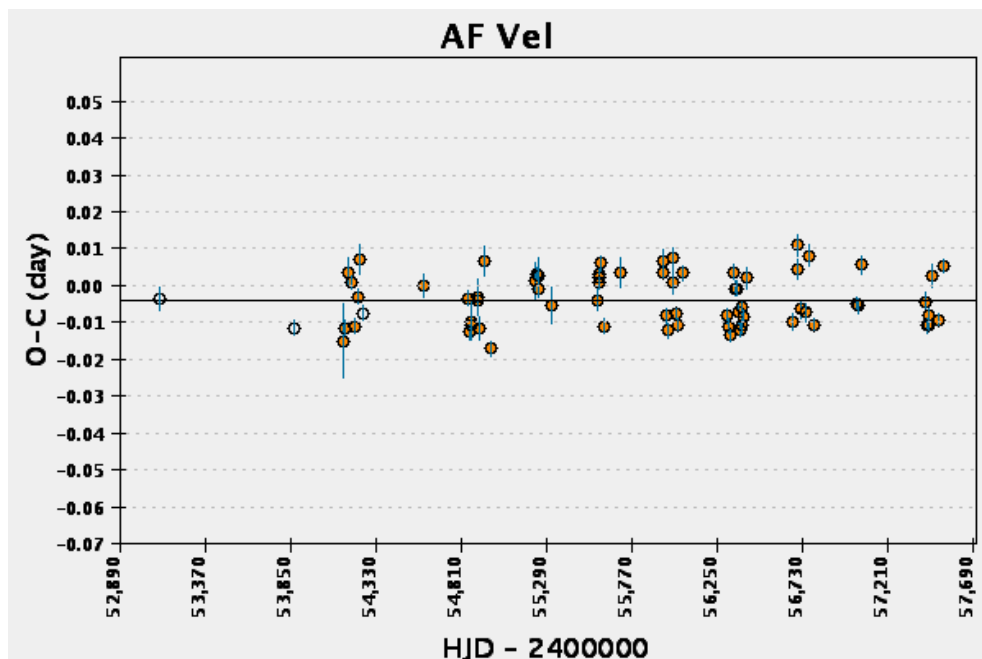
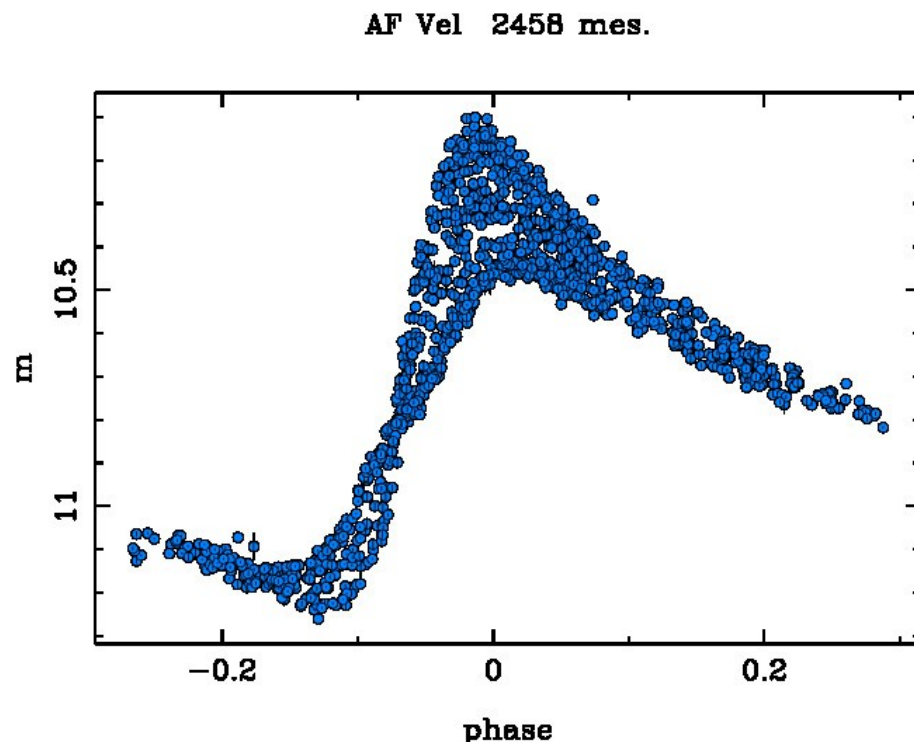


Thursday 3 March 2016

JD	Star	N*	observation time (JD)		observation time (UT)		Maximum HJD		O-C (day)	Observer/Telescope
			from	to	from	to	Predicted	Observed		
2457451	BQ Vir	16	0.409	0.508	21.8	0.2				Tarot - Calern
2457451	RR Leo	26	0.312	0.517	19.5	0.4				Tarot - Calern
2457451	EX UMa	20	0.315	0.434	19.6	22.4	2457451.343	2457451.348 \pm 0.004	0.005	Tarot - Calern
2457451	IM Leo	36	0.396	0.628	21.5	3.1	2457451.518	2457451.519 \pm 0.002	0.001	Tarot - Calern
2457451	RV UMa	28	0.560	0.706	1.4	4.9	2457451.619	2457451.622 \pm 0.002	0.002	Tarot - Calern
2457451	RX Leo	48	0.466	0.707	23.2	5.0	2457451.570	2457451.574 \pm 0.003	0.004	Tarot - Calern
2457451	TW Boo	38	0.578	0.698	1.9	4.8	2457451.646	2457451.643 \pm 0.001	-0.003	Tarot - Calern
2457451	V1361 Cen	2	0.899	0.900	9.6	9.6				Tarot - Chile
2457451	BI Cen	20	0.511	0.728	0.3	5.5	2457451.558	2457451.568 \pm 0.003	0.011	Tarot - Chile
2457451	ET Hya	22	0.545	0.783	1.1	6.8	2457451.650	2457451.652 \pm 0.003	0.003	Tarot - Chile
2457451	IU Car	24	0.595	0.799	2.3	7.2	2457451.687	2457451.694 \pm 0.004	0.006	Tarot - Chile
2457451	TY Aps	22	0.644	0.860	3.5	8.6	2457451.670	2457451.672 \pm 0.003	0.002	Tarot - Chile
2457451	V476 Vir	34	0.727	0.899	5.4	9.6	2457451.827	2457451.894 \pm 0.005	0.067	Tarot - Chile
2457451	V689 Car	16	0.501	0.706	0.0	4.9	2457451.573	2457451.569 \pm 0.004	-0.005	Tarot - Chile
2457451	X Crt	34	0.714	0.891	5.1	9.4				Tarot - Chile

Routine followup of bright RR Lyr stars, type R Rab

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 R Rab 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)

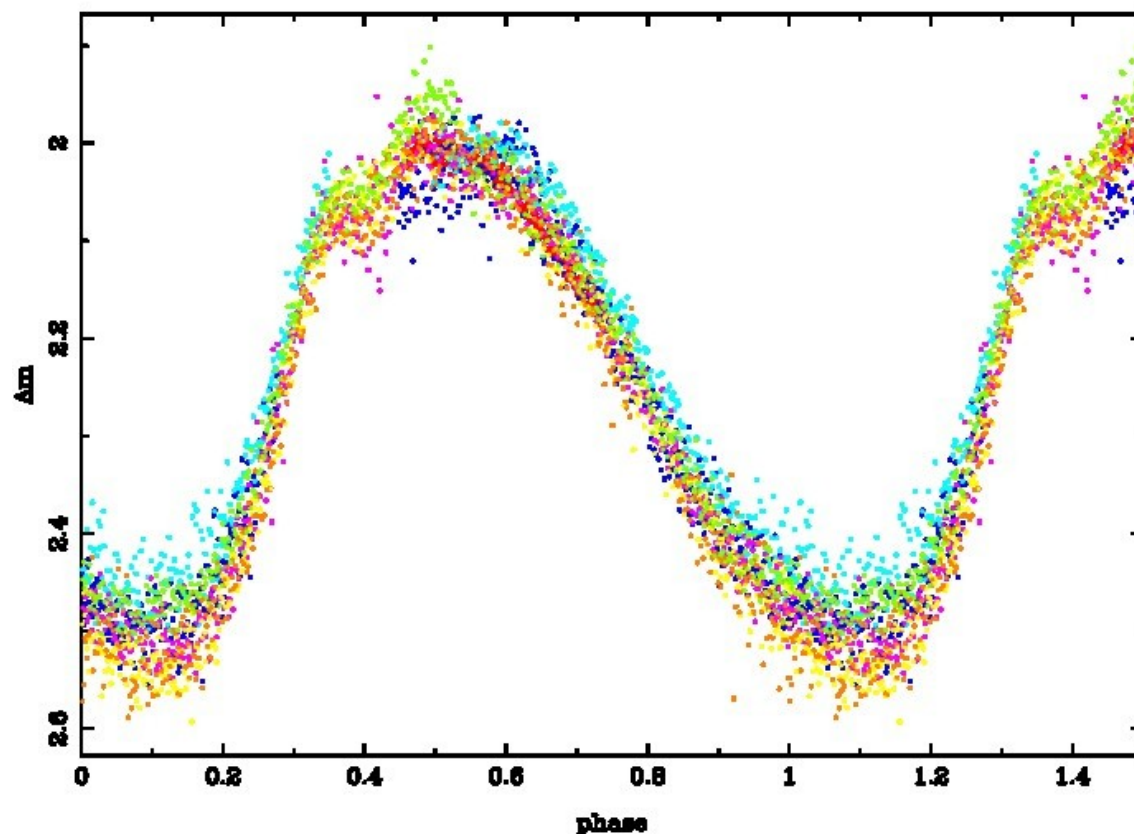
CM Leo 3357 mas.

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

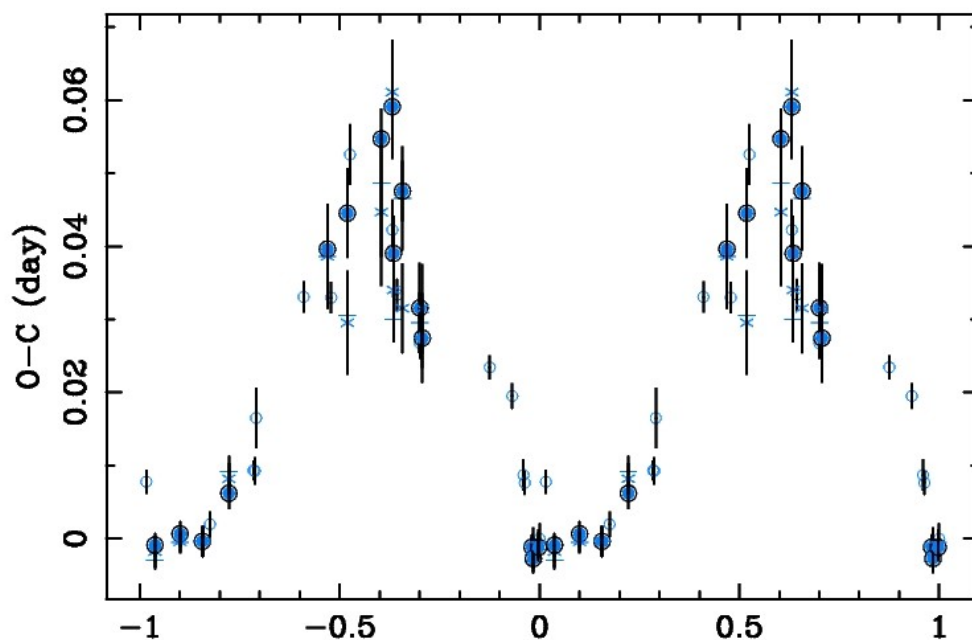
Blazhko effect period: 325 jours

Observers : 2008-2016

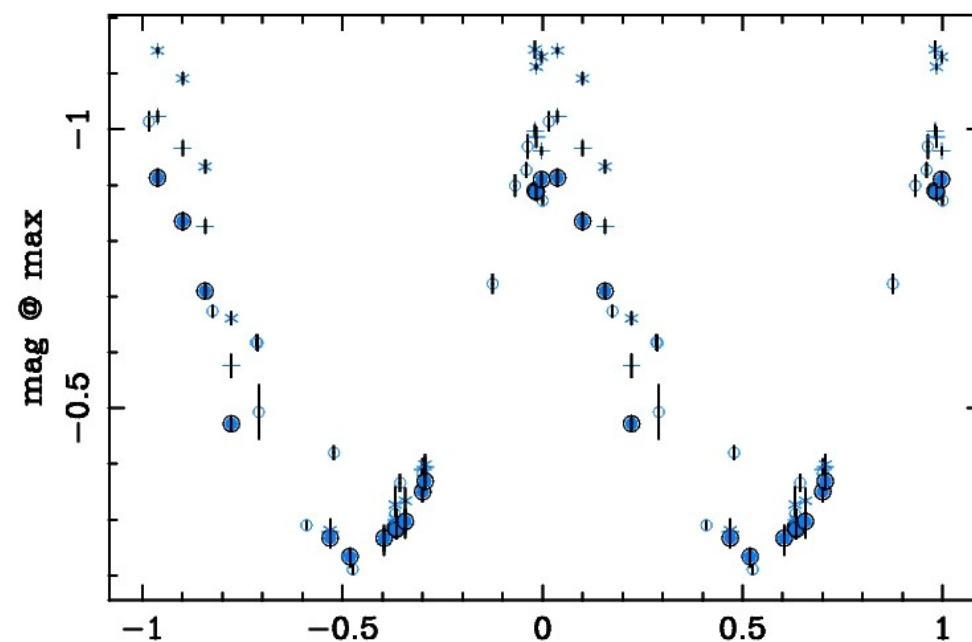
Eric Denoux, Caussade, France, 28cm

Mercè Correa, Sabadell Spain, 50cm

Ramon Moliner, Sabadell Spain, 50cm



Blazhko phase



Blazhko phase

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,

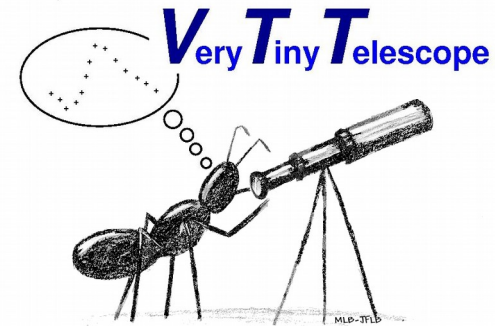
Instrumentation : **VTT**, Design : Alain Klotz

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

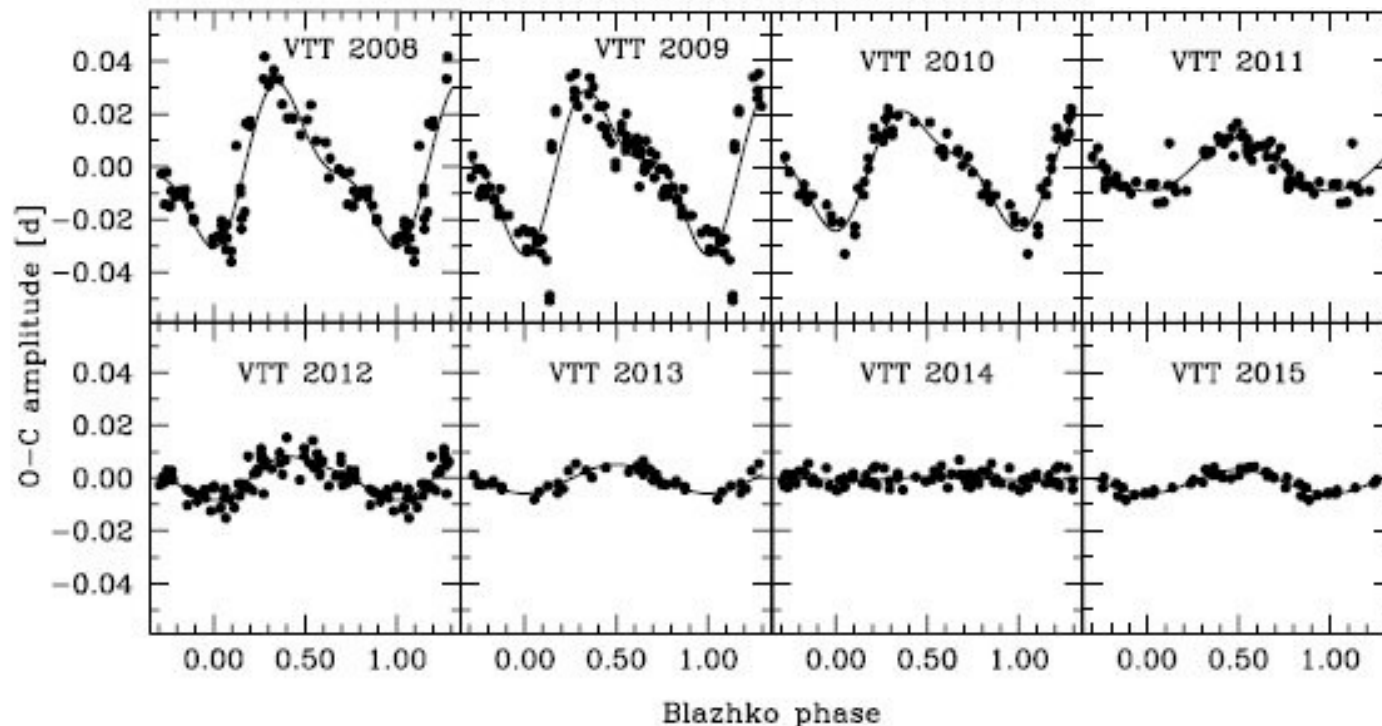
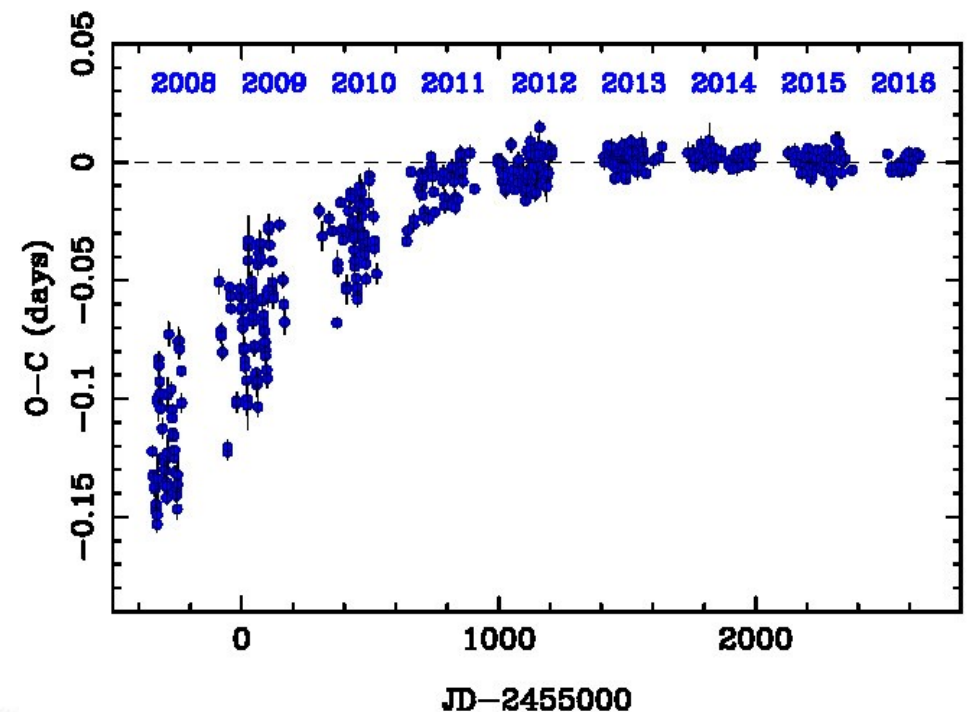
In total with other observers (+literature)

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, Hirosewa, 2015, Conference "RRL2015 - High-Precision Studies of RR Lyrae stars", held in Visegrad (Hungary)

2008-2016:

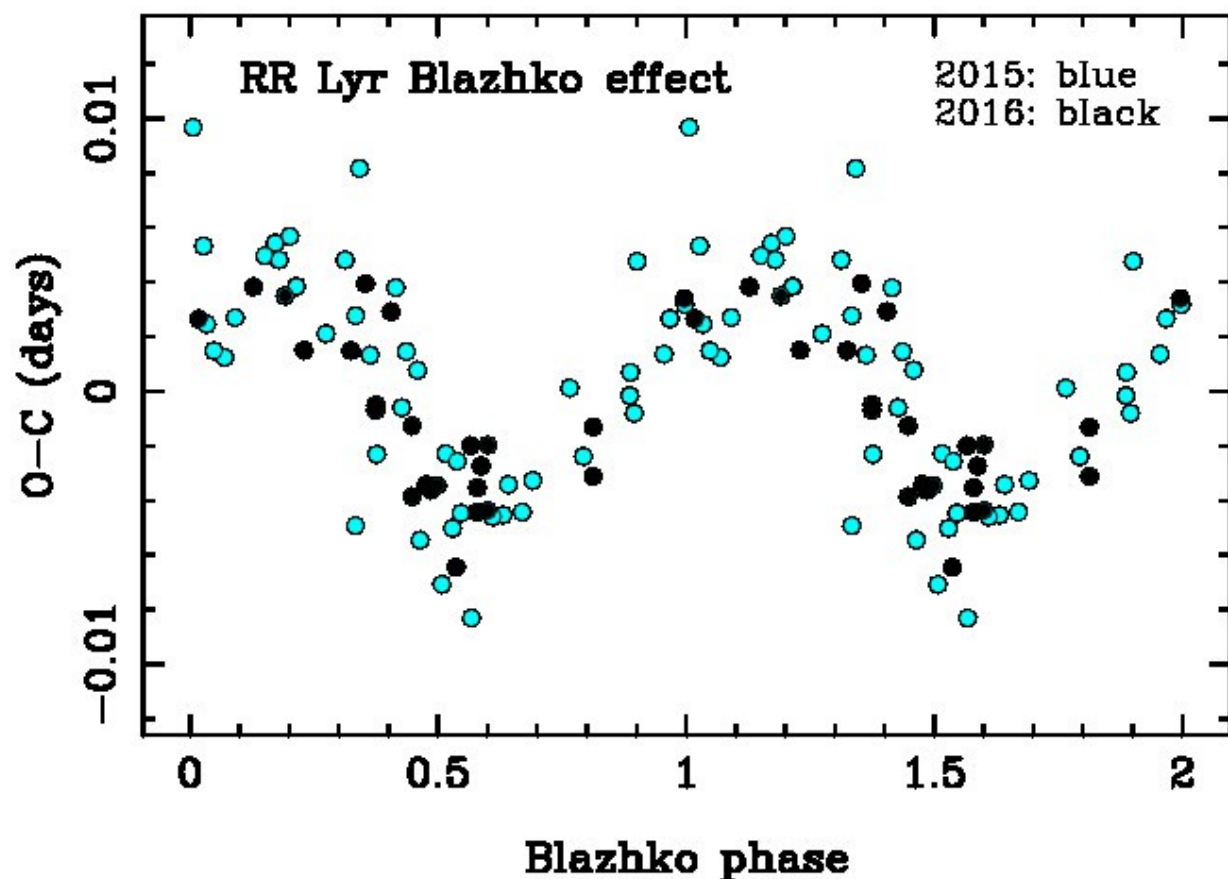
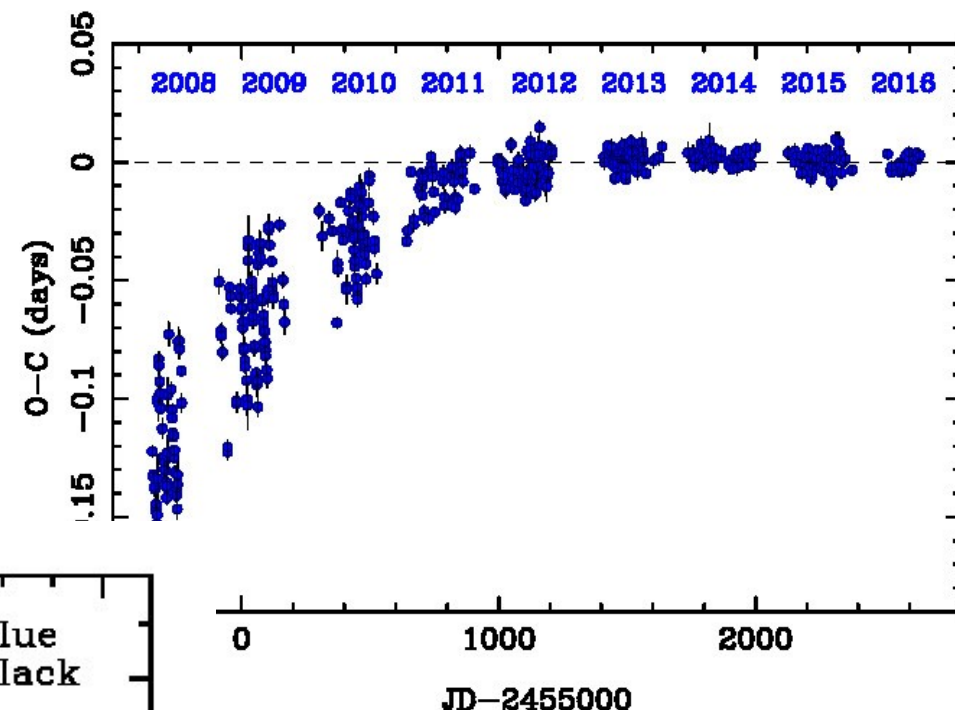
2 VTTs:

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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 !

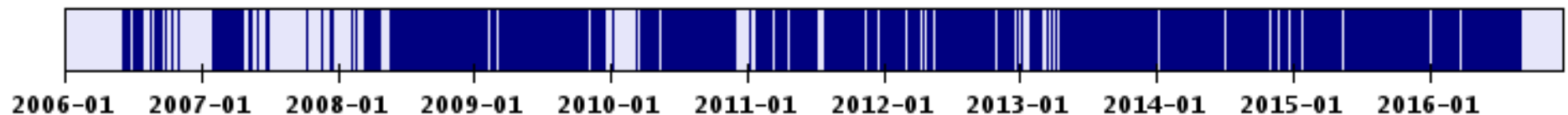
Solution: collaborative work and use of automated/robotic telescopes.

GRRS observation density 2004-2016:

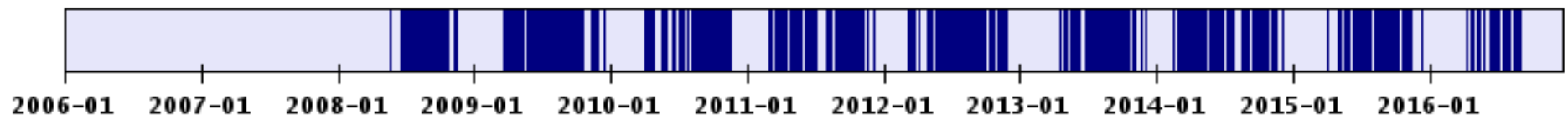
Robotic telescopes Tarot:



Humans, understudied stars:



VTTs, RR Lyr itself:



Thank you