La contribution des amateurs à l'observation des Binaires à Eclipses

Laurent Corp

Andromède 4A (Aveyron) - AAVSO – BAA - GEOS - T60- Com. Etoiles doubles SAF

Sommaire

Généralités et rappels

Les différentes contributions

Ressources et questions

Les étoiles variables = un zoo stellaire

- 36 000 connues, 14 000 suspectées
- Toute étoile sera un jour variable...
- Les grandes classes
  - Etoiles pulsantes
  - Etoiles cataclysmiques
  - Etoiles E.B.

Etoiles variables

Classes d'étoiles variables

périodique

non-périodique

(étoiles éruptives)
certaines novae
supernovae

périodes longues **périodes courtes**

Variations de magnitude dues à des pulsations de l'atmosphère stellaire

Supergéantes rouges

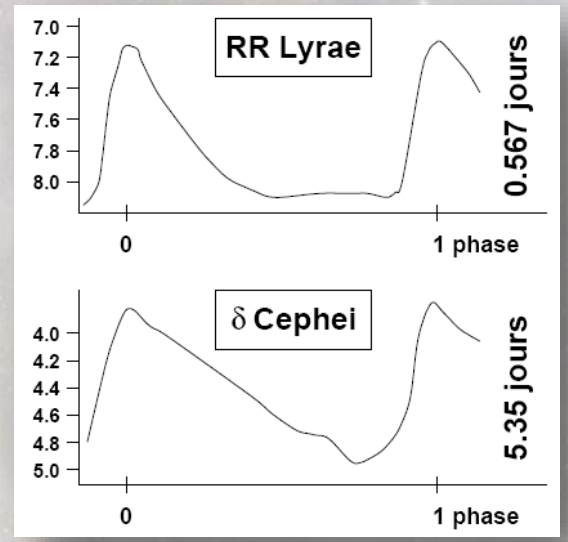
(T jusqu'à quelques années)

Céphéides (T= 1 à 50 jours)

Variables d'amas (RR Lyrae)

(T = quelques heures à quelques jours)

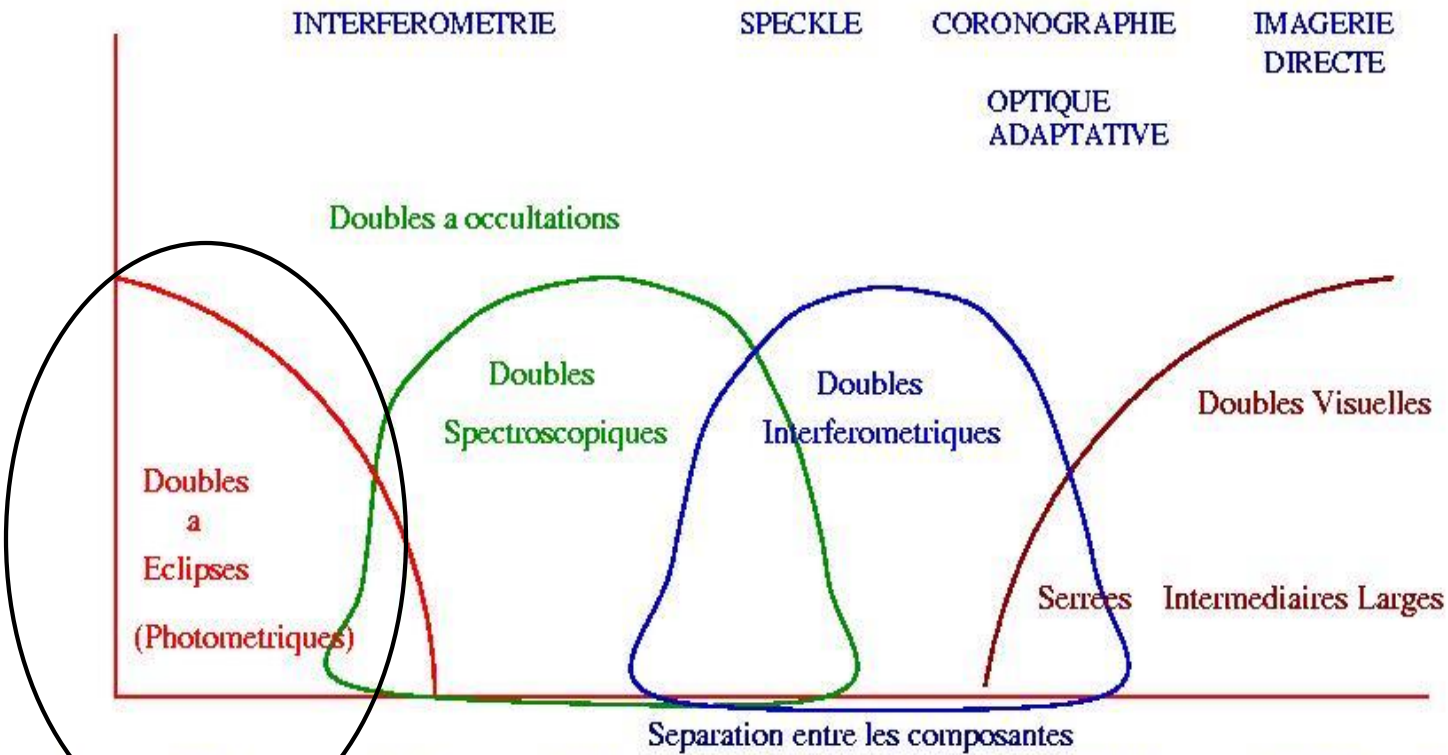
Et les Binaires à Eclipses



Généralités et rappels

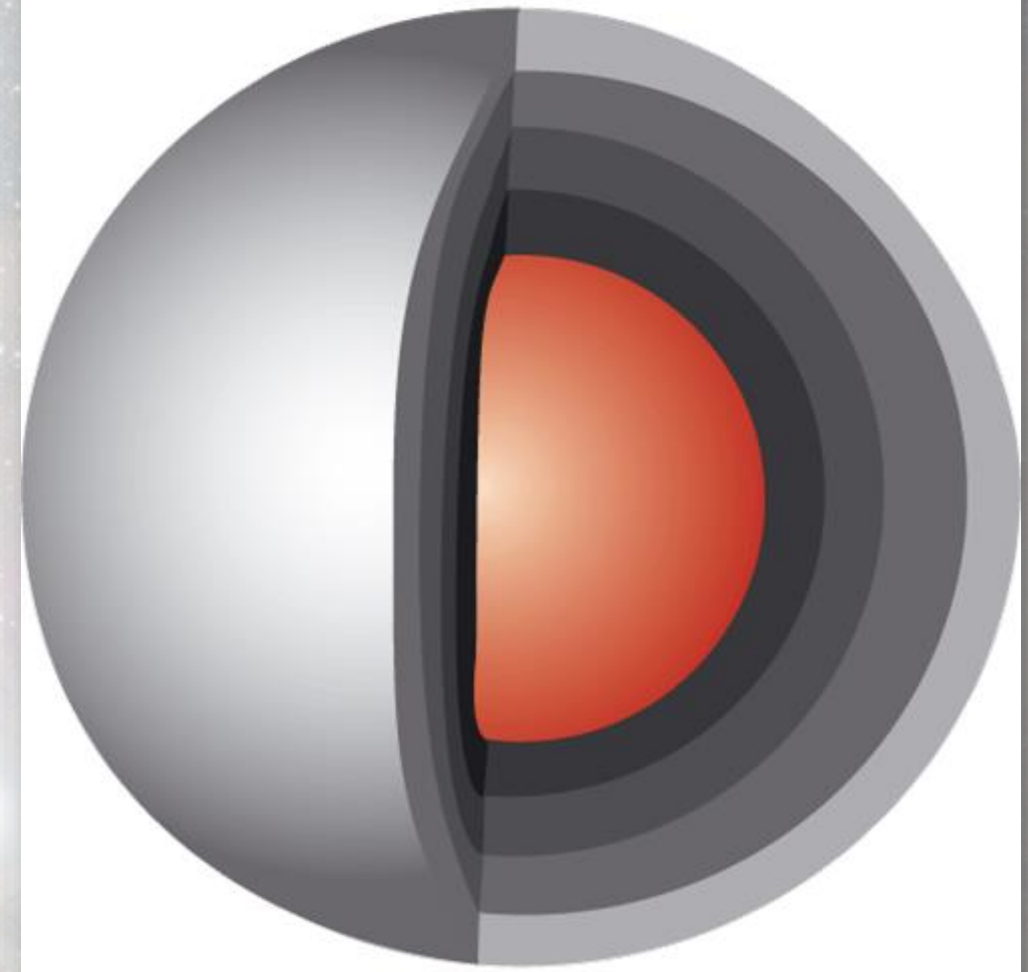
LES CATEGORIES D'ETOILES DOUBLES ET MULTIPLES

(dependent des techniques d'observation)

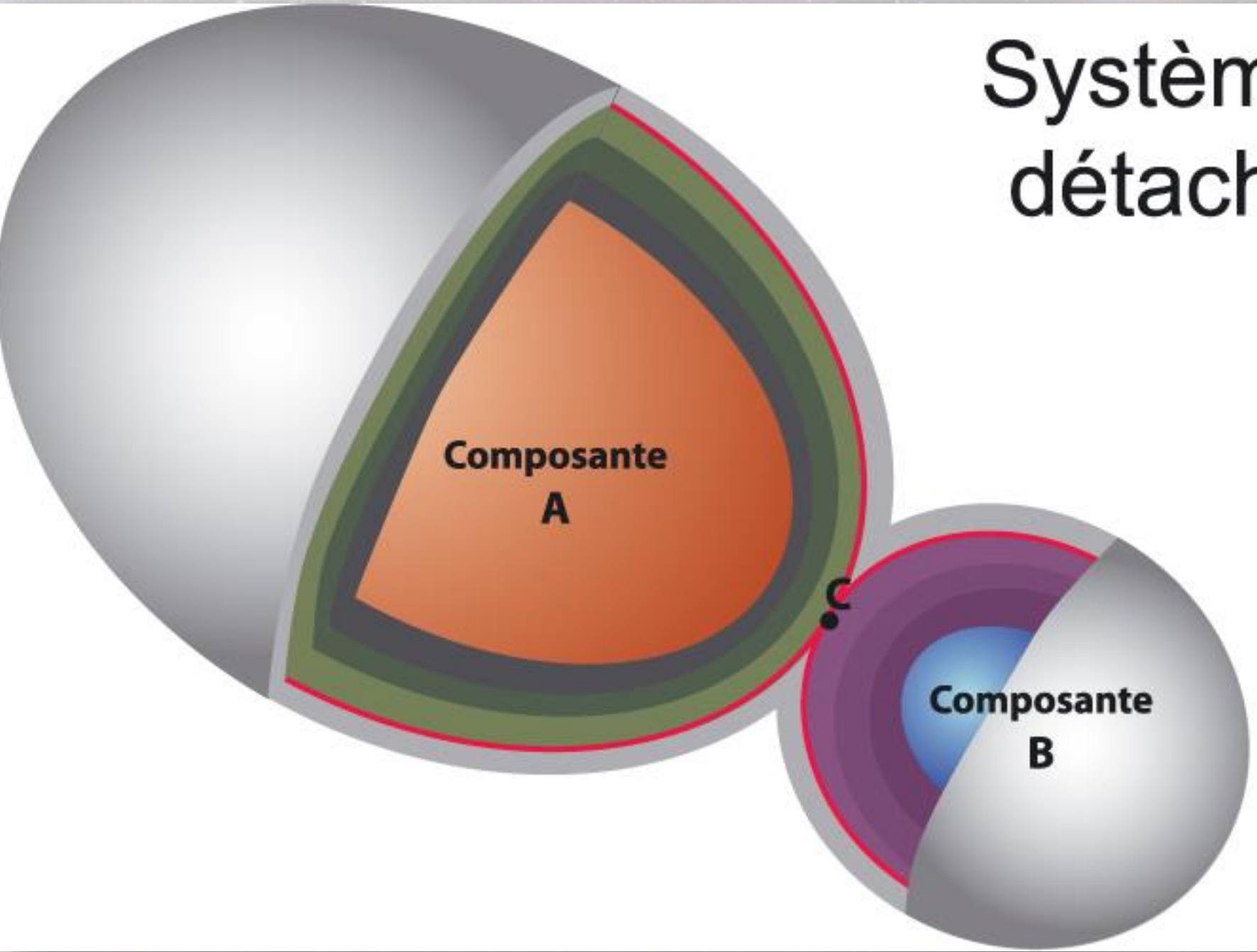


Separation intrinseque (UA)	.01 UA	< 1 UA	10 UA	50 UA	100 UA	1000 UA	10000 UA
Separation angulaire (")		< .001"	~ .01"	.02-.03"	~.1"	> 1"	

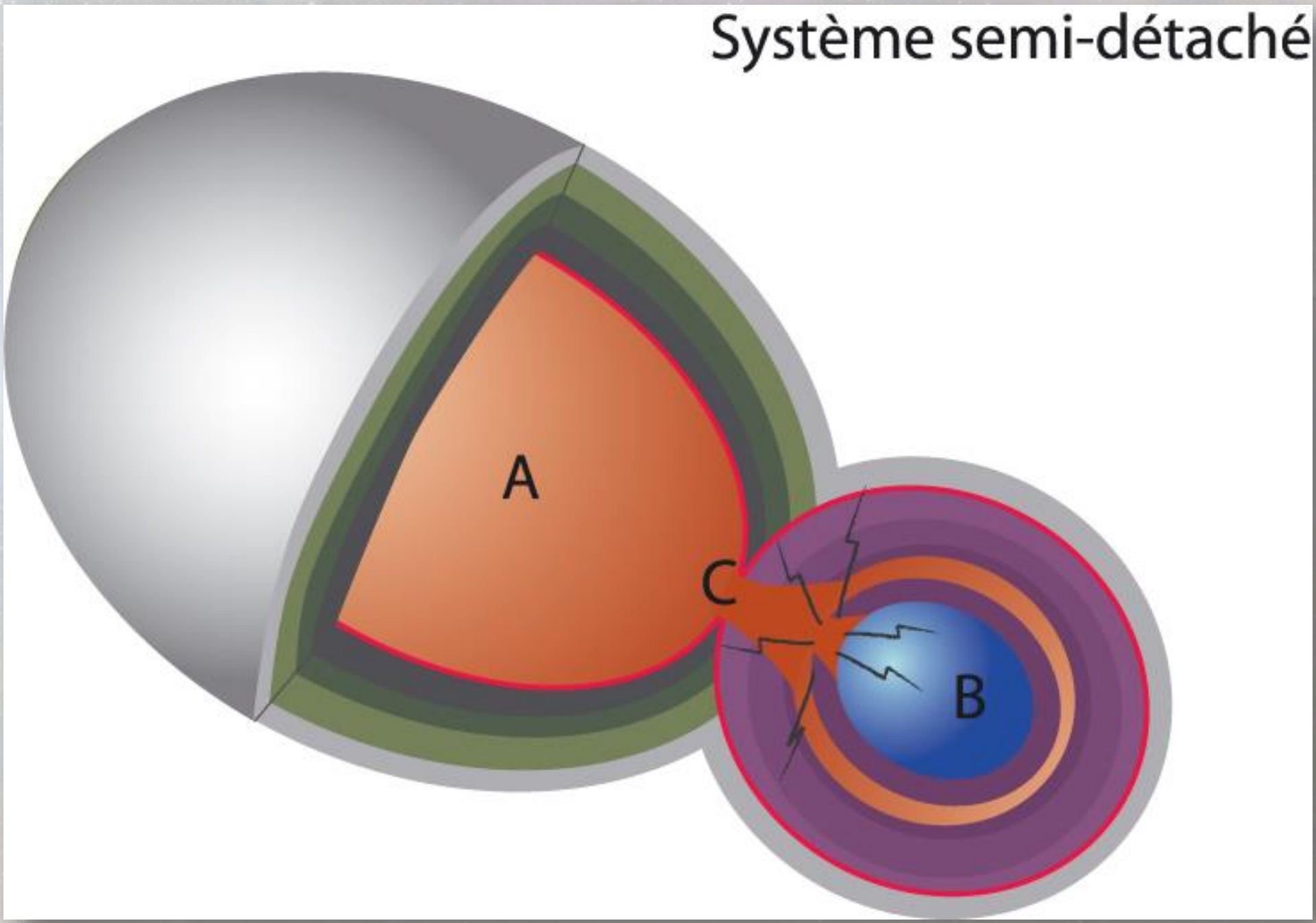
Etoile simple



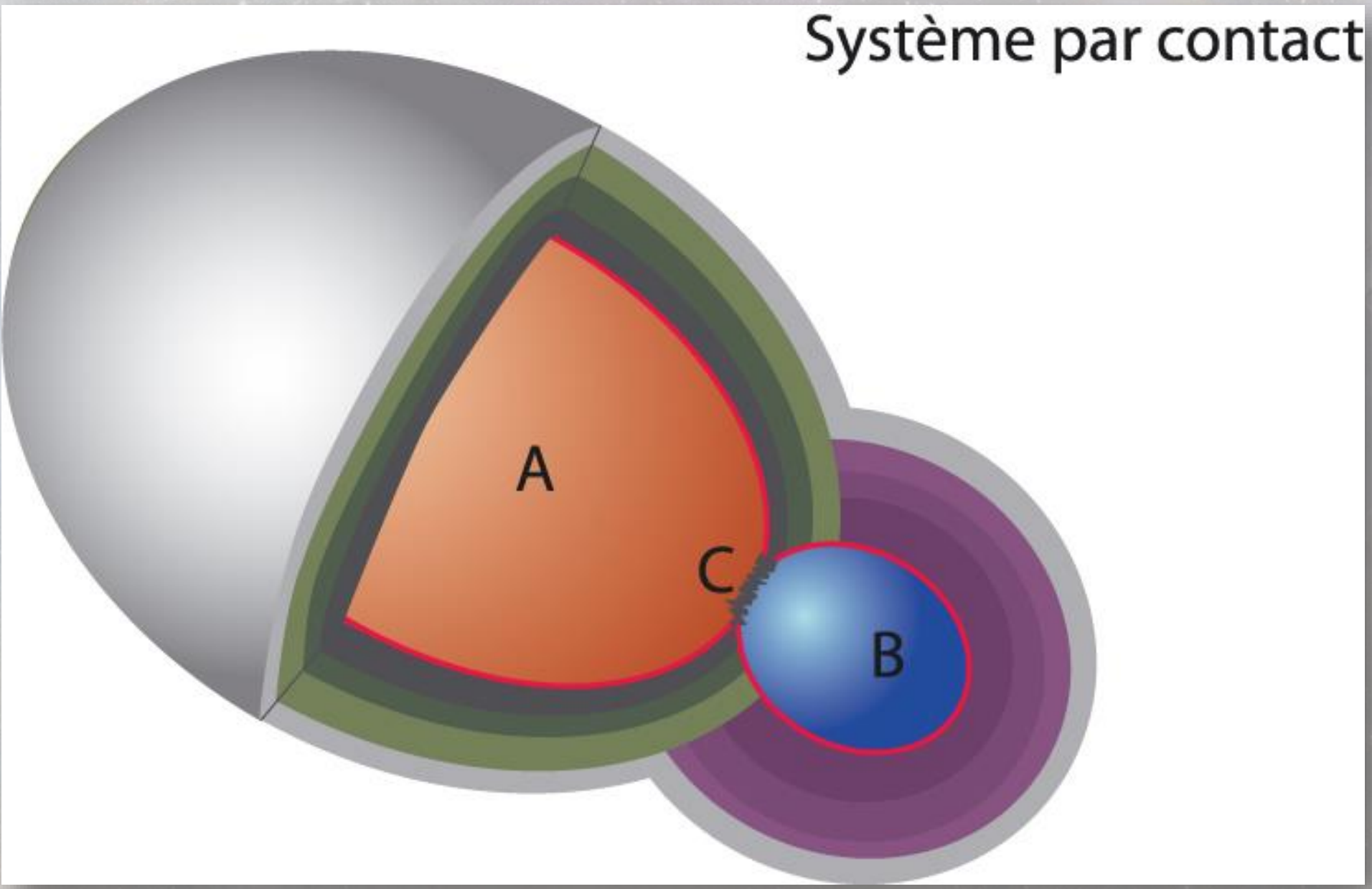
Système détaché



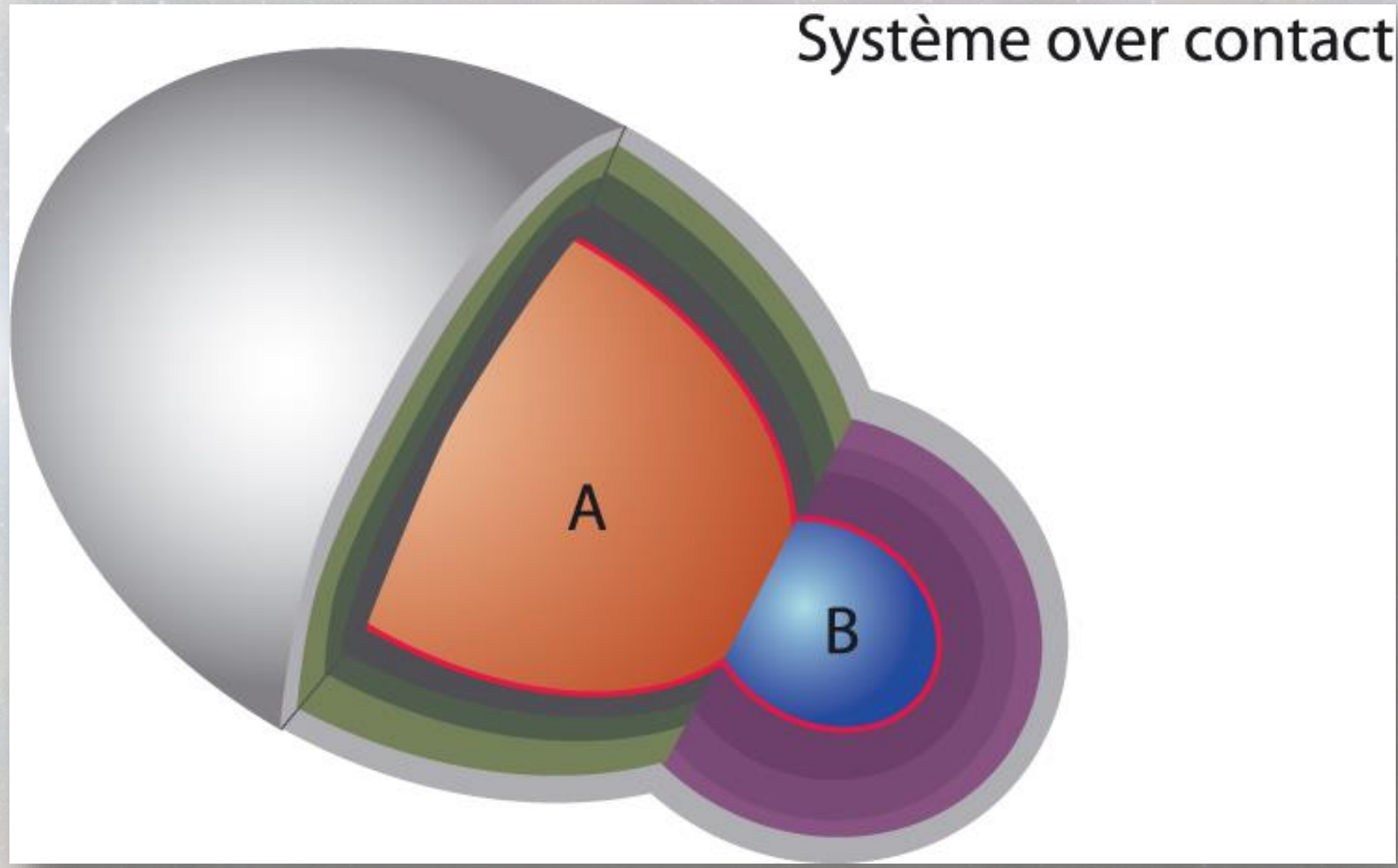
Système semi-détaché



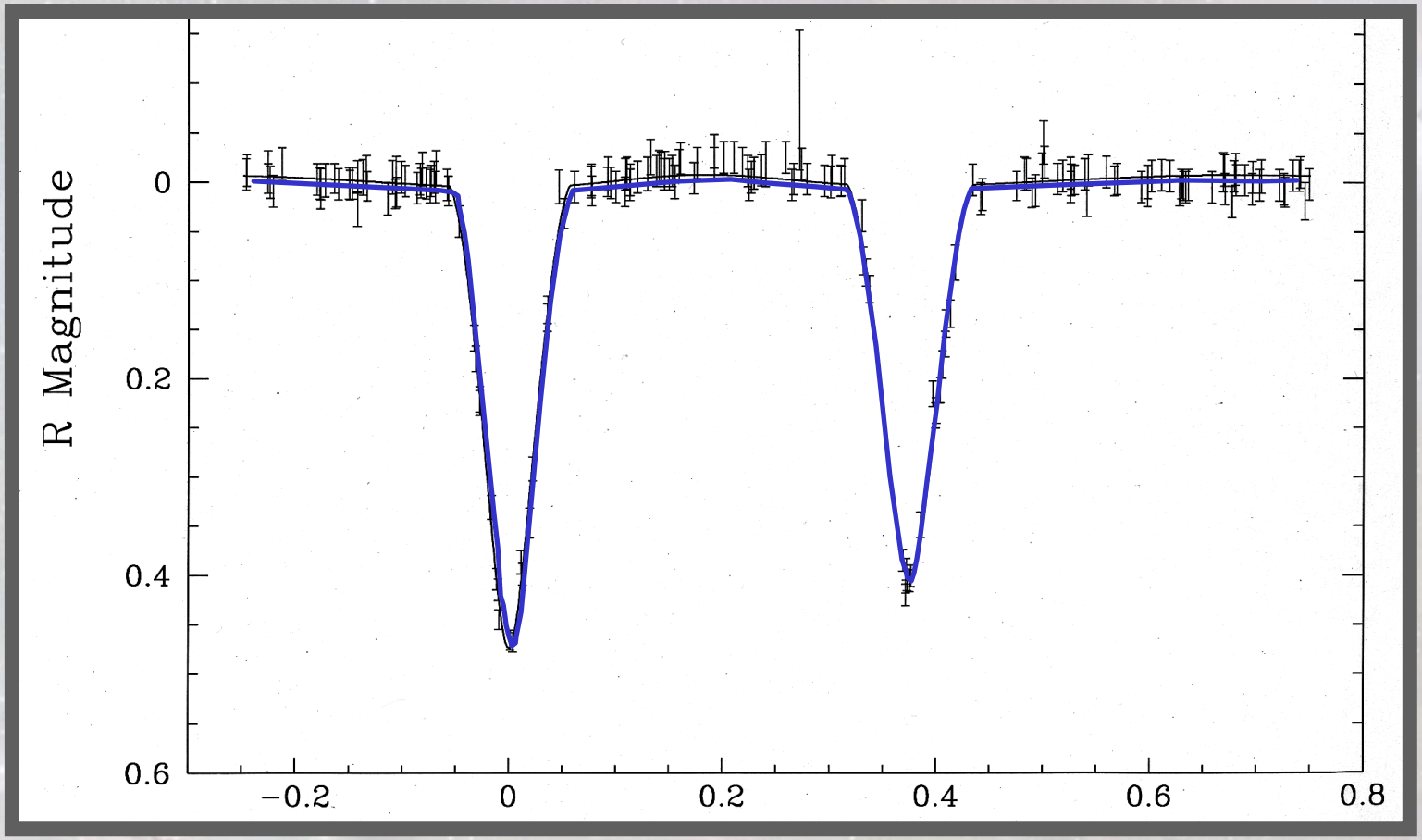
Système par contact



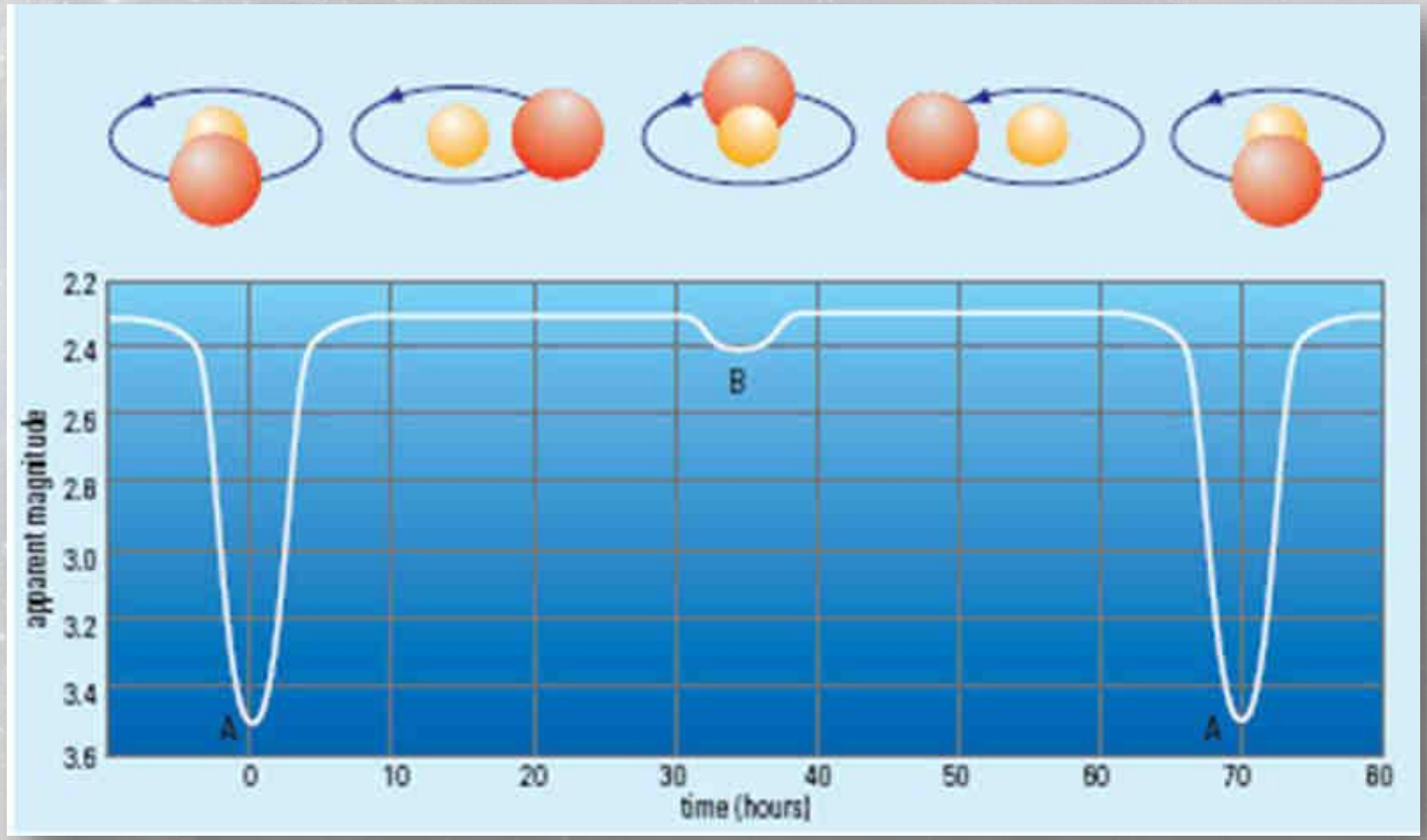
Système over contact



Binaires à éclipses

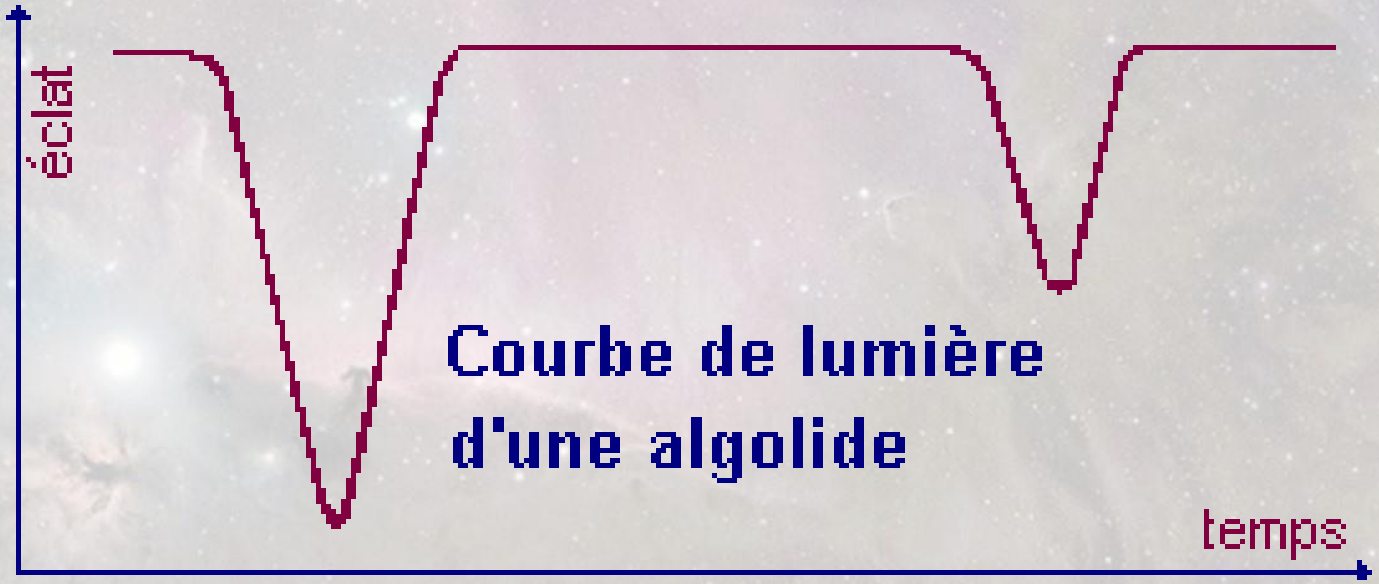


Binaires à éclipses

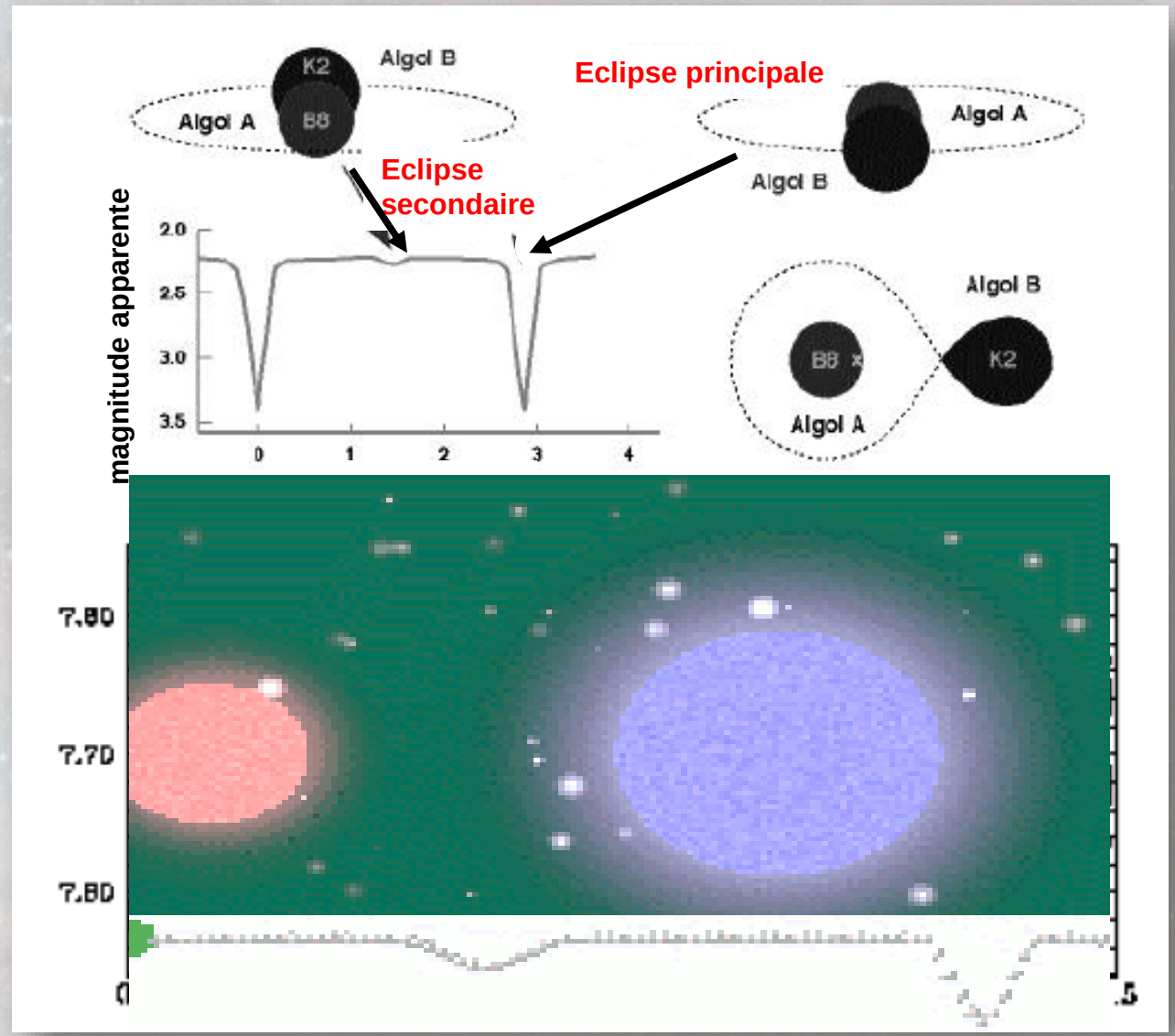


3 types de E.B.

- EA = Algolides
  - minimum principal bien marqué, minimum secondaire important ou presque indécelable



Etoiles variables périodiques binaires

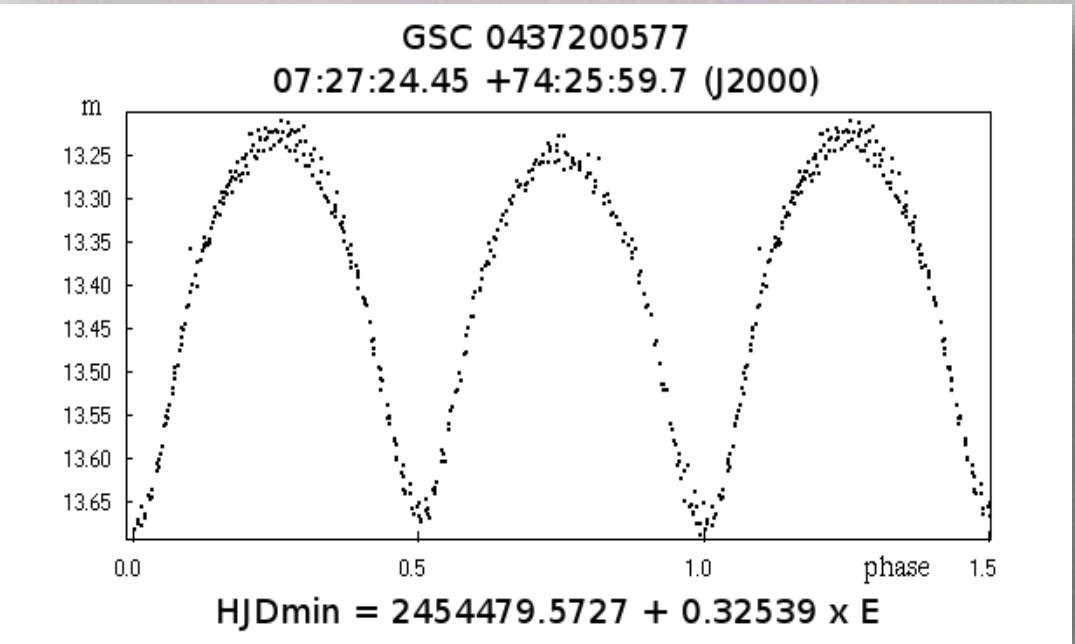


3 types de E.B.

- EB = Beta Lyrae
  - Minimum principal bien marqué, minimum secondaire aussi important que le primaire
  - Courbe arrondie due à l'attraction gravitationnelle des étoiles

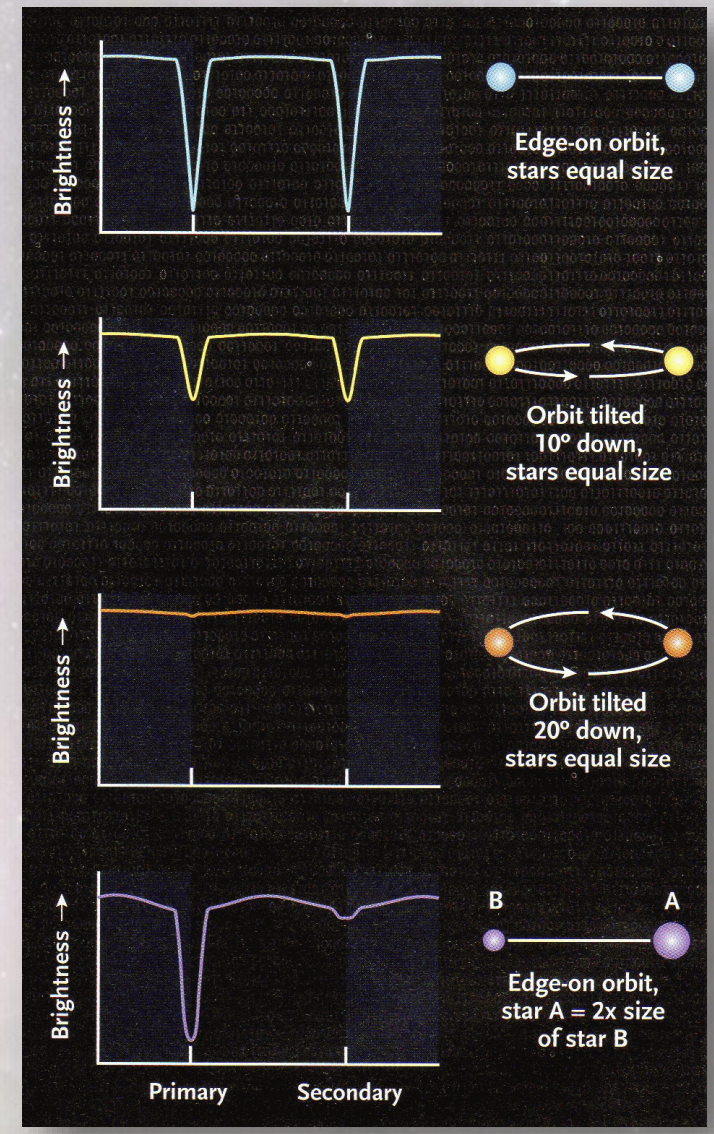
3 types de E.B.

- EW = W Ursae Majoris
  - Minimum principal quasiment identique au minimum secondaire.
  - Courbe arrondie due à l'attraction gravitationnelle des étoiles
  - Etoiles naines agées en contact dont la période est inférieure à la journée



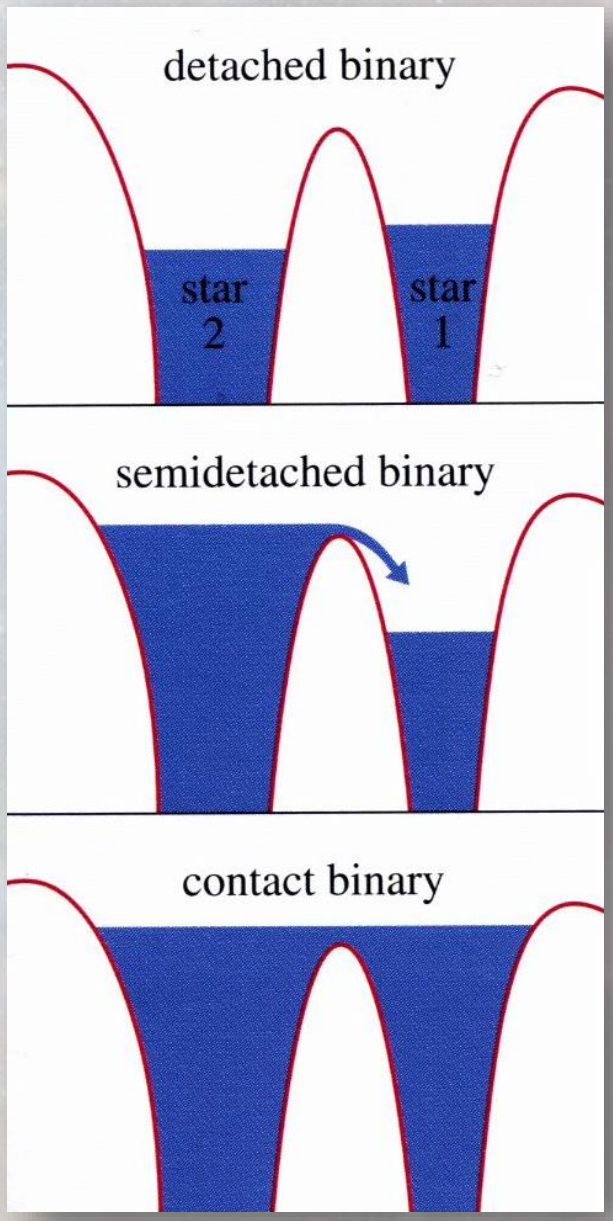
Binaires à éclipses

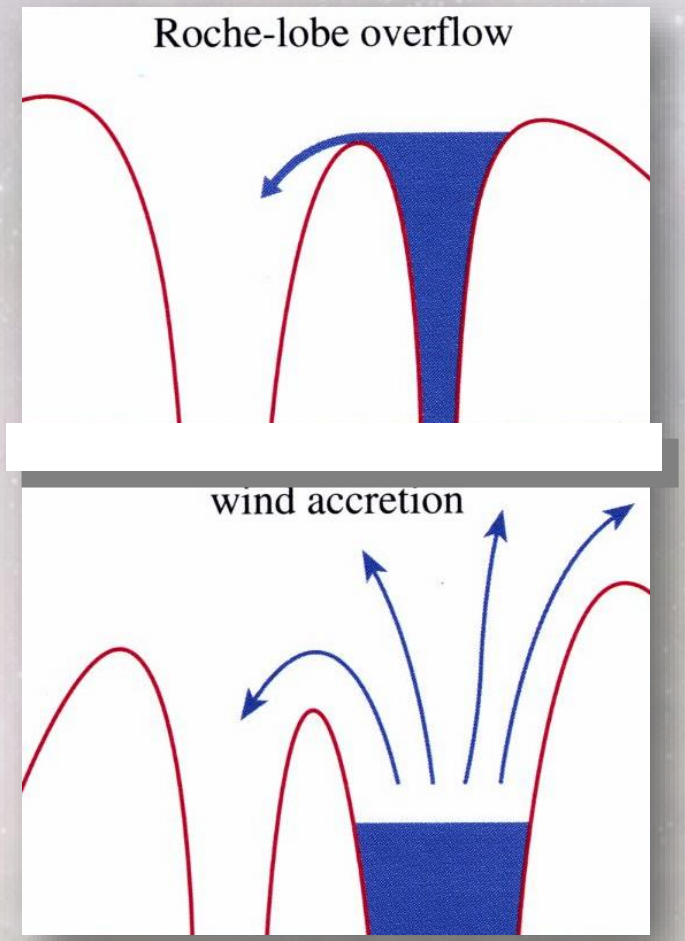
La courbe de lumière résultante en fonction du plan orbital de la deuxième composante



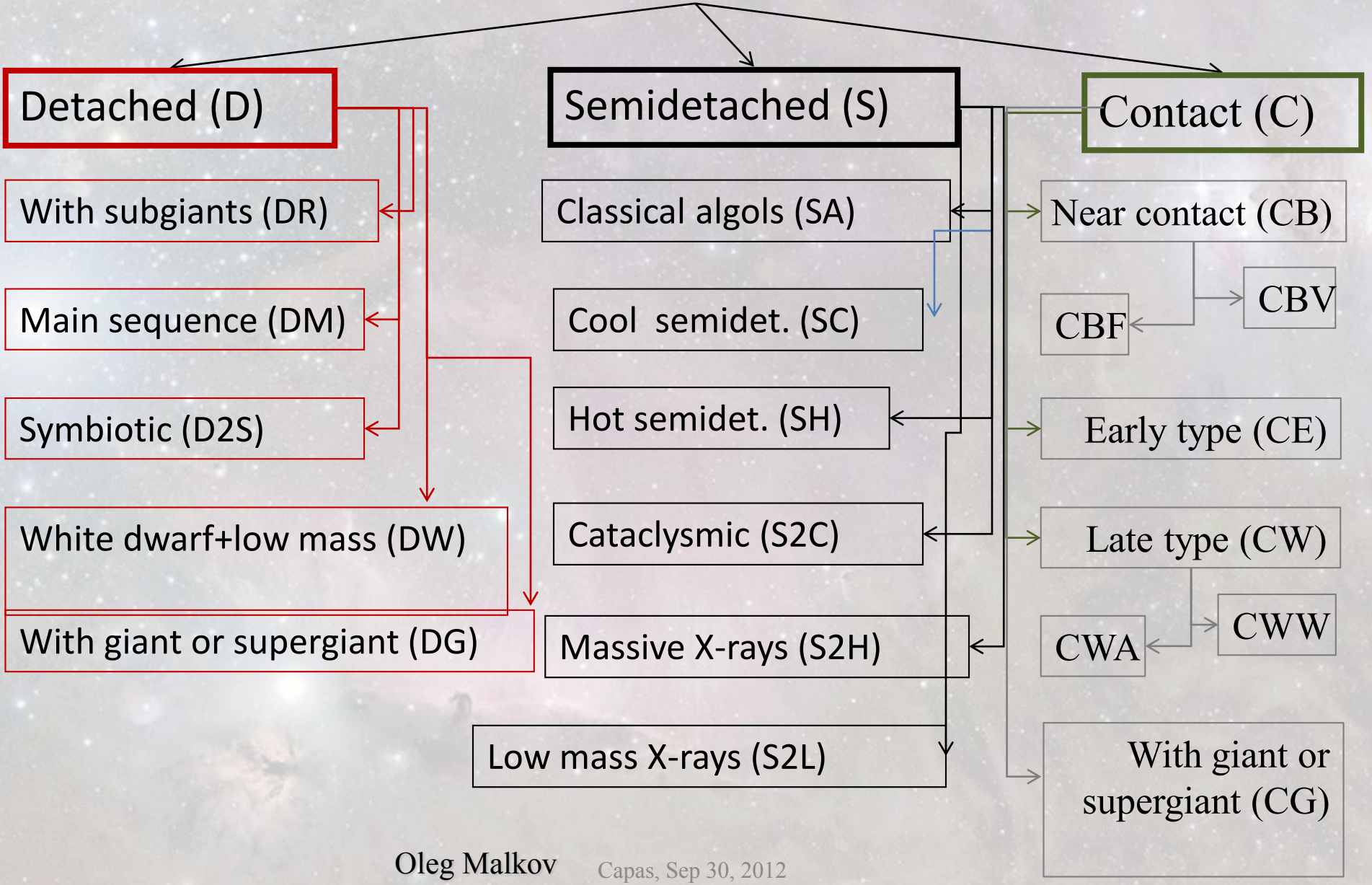
Source : « ***Sky and telescope*** » Août 2012 – page 34 : Auteur : DIRK TERRELL

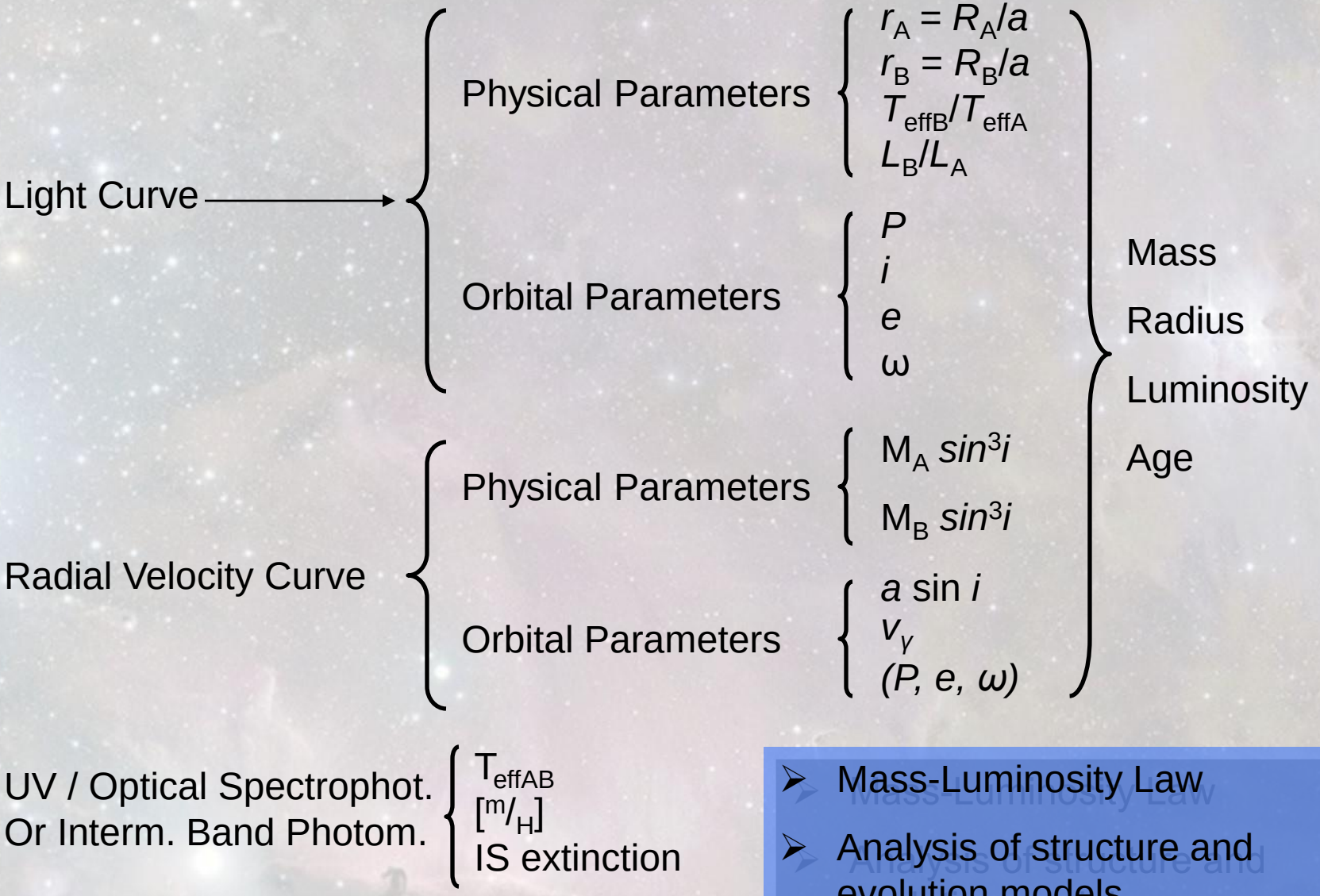
Configurations et transferts de masses





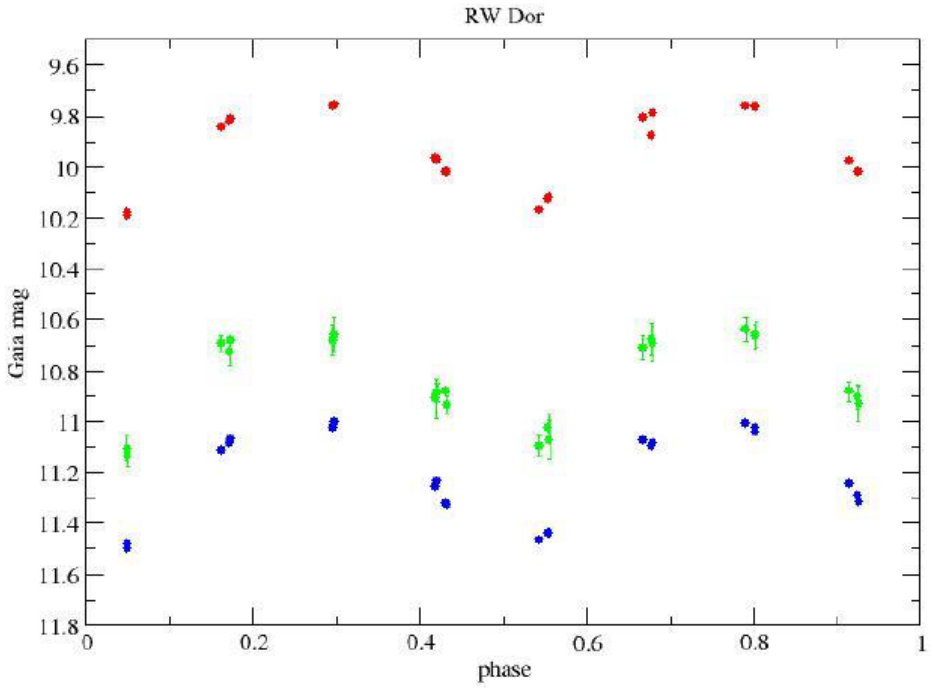
Evolutionary classes



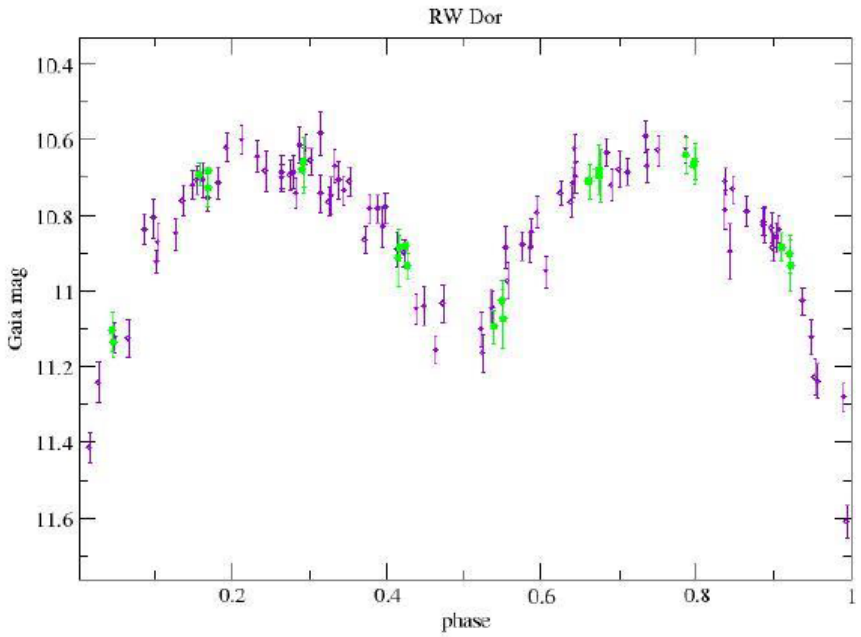


- Mass-Luminosity Law
- Analysis of structure and evolution models
- Distance determination
- ...

Eclipsing binary



Early in the mission



Source : C. Jordi
University of Barcelona, Institut de Ciències del Cosmos, Institut d'Estudis Espacial de Catalunya

Utilisation des binaires à Eclipses en évolution stellaire

- Test theoretical stellar models
  (e.g. Pols et al. 1997MNRAS.289..869P)
- Apsidal-motion test of stellar structure
  (e.g. Claret 2007A+A...475.1019C)
- Investigate the chemical enrichment law
  (Ribas et al. 2000MNRAS.313...99R)
- Test model atmospheres via limb darkening
  (see Howarth arXiv:1106.4659)
- Star and binary star formation scenarios
  (e.g. Albrecht et al., 2009Natur.461..373A)
- Host stars of transiting extrasolar planets
  (Southworth 2009MNRAS.394..272S)

Source : John Southworth (STFC Advanced Fellow) Keele University, UK

Utilisation des binaires à Eclipses – distance des étoiles

- HD23642 in the Pleiades
  (e.g. Southworth et al.,2005A+A...429..645S)
-HV2274 in the LMC
  (Guinan et al.1998ApJ...509L..21G)
- M31VJ0044380+41292350 in M31
  (Ribas et al., 2005ApJ...635L..37R)
- D33 J013346.2+304439.9 in M33
  (Bonanos et al., 2006ApJ...652..313B)

Source : John Southworth (STFC Advanced Fellow) Keele University, UK

Ou en sommes nous ?

123 binaires à éclipses bien connues en 100 ans

- GCVS: 1982 binaires à éclipses (de type EA) en date du 06-10-2011
- AAVSO VSX à 5900 EA jusqu'à la Mv 6,14
- SuperWASP a probablement 50.000 courbes de lumières
- GAIA va produire 10^6 courbes, 10^5 seront sans doutes utiles
- LSST va trouver 24 millions EBs (Presa et al. 2011AJ....142...52P)
  - 6.7 million devraient être utiles !!!!

Cinquante amateurs réparties sur la planète pour les observer…..

Source : John Southworth (STFC Advanced Fellow) Keele University, UK

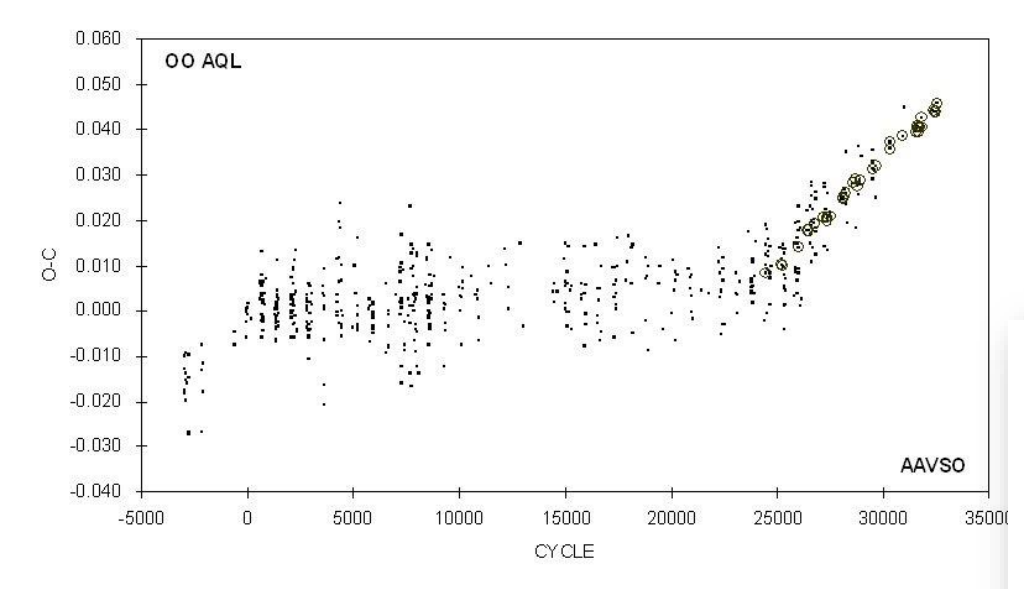
Les différentes contributions

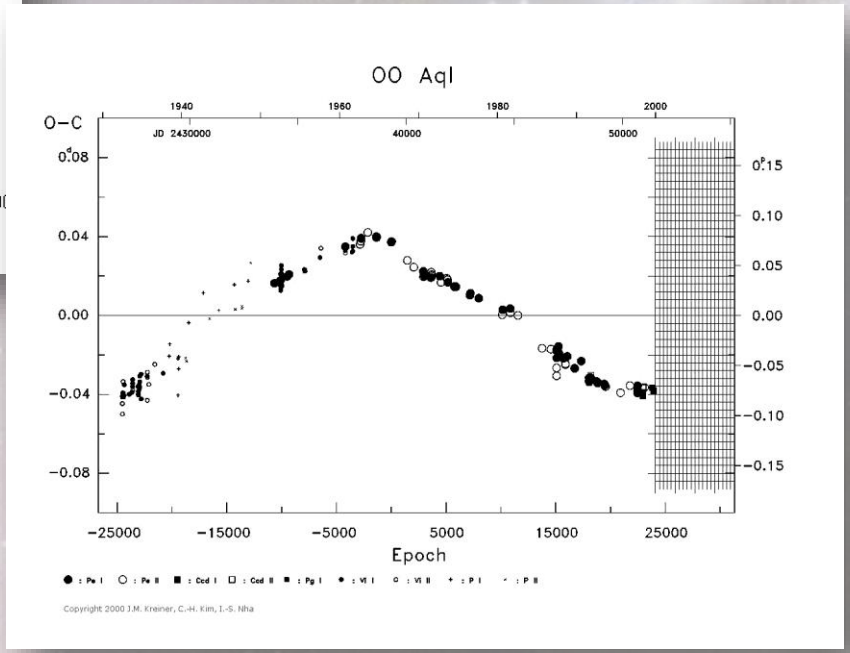
- O-C
- Effet O’Connell
- oEA stars
- et autres étoiles Ebs

Les différentes contributions

O$_{\text{bservé}}$ moins C$_{\text{alculé}}$

OO AQL (9.2 – 10.8 EW/DW)





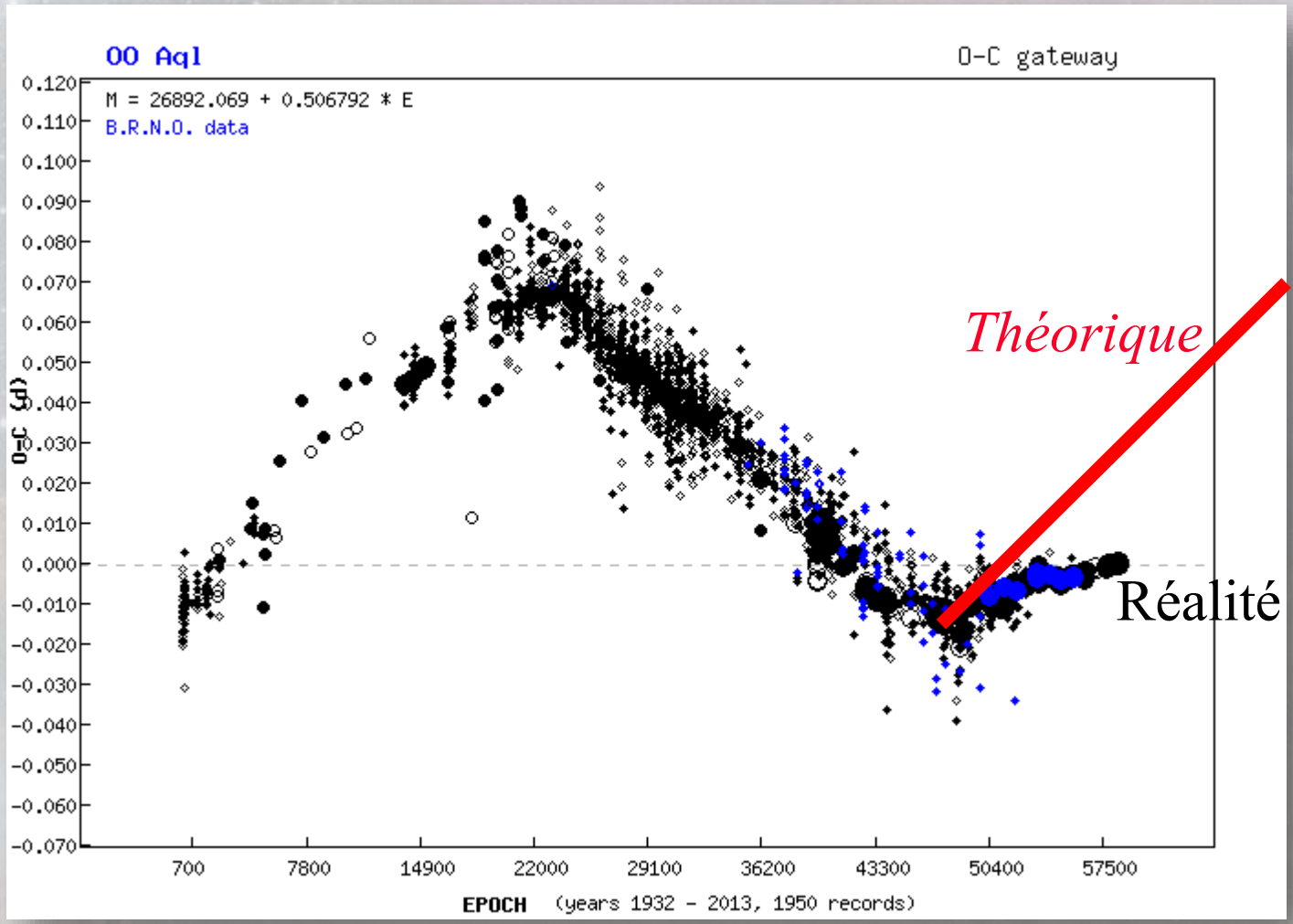
Construction de la courbe O-C sur une durée de 60 ans

Si on reprend sur une courbe tout les instants des minima, nous obtenons la courbe des O-C (Observations-Calculés), en abscisse l'instant de la mesure et en ordonné l'écart de la mesure.

Pour en savoir plus, vous pouvez consulter ce lien :

http://vs-compas.belastro.net/bulletin/issue/3/p8

OO AQL (9.2 – 10.8 EW/DW)



Chaque point représente un minima (mesures amateurs)

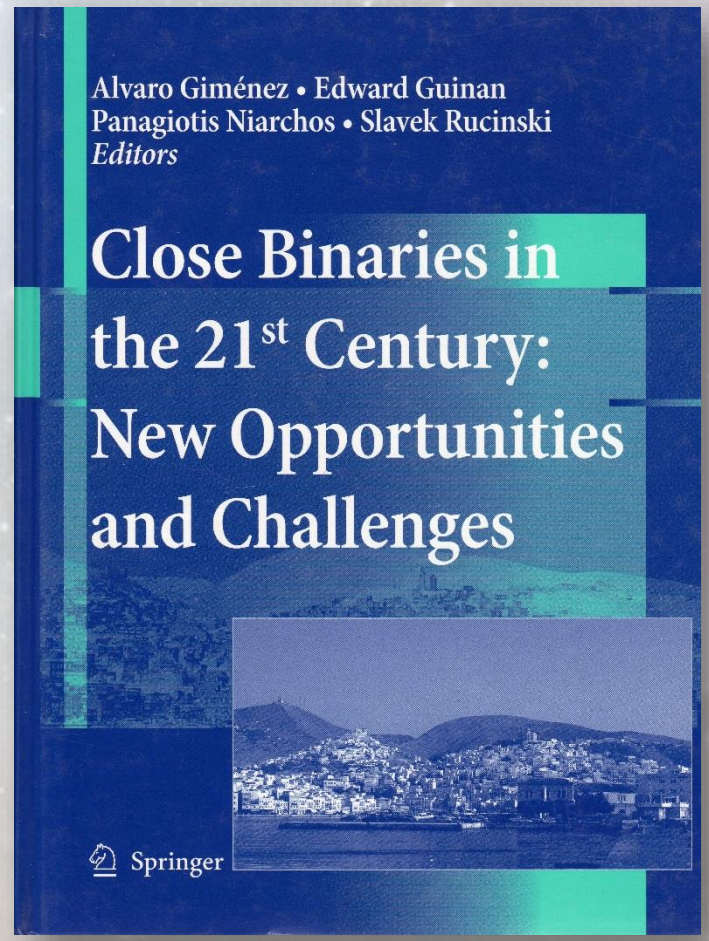
http://var.astro.cz/ocgate/ocgate.php?star=OO%20Aql

OO AQL (9.2 – 10.8 EW/DW)

Trois études bien distinctes montrent que en fait nous ne voyons pas une étoile double mais en fait une étoile double avec deux corps qui orbitent autour.

Les études :

Eclipsing Binaries with Possible Light Time Effect (Petr Zasche – Miloslav Zejda – Lubos Brat) : ref : Astrophys Space Sci (2006) 304:175-177 décrit l'existence de plusieurs corps sans en préciser la période.



OO Aql and T LMi, another variation was found, so there is a possibility of a presence of the fourth body in the system, or magnetic activity in them. But we have not enough data to make a final decision. So the consequence is, that for the confirmation of the presence of LITE in these systems, we need detailed photometric, spectroscopic or astrometric data of these binaries.

Acknowledgements This research has made use of the SIMBAD database, operated at CDS, Strasbourg, France, and of NASA's Astrophysics Data System Bibliographic Services. This investigation was supported by the Czech-Greek project of collaboration RC-3-18 of Ministry of Education, Youth and Sport and by the Grant Agency of the Czech Republic, grant No. 205/04/2063

References

Applegate, J.H.: ApJ **385**, 621 (1992)
Budding, E.: BICDS **27**, 91 (1984)
Budding, E.: A&A **417**, 263 (2004)
Cester, B. et al.: A&A **36**, 273 (1979)
Frieboes-Conde, H., Hertzeg, T.: A&AS **12**, 1 (1973)
Halbedel, E.M.: IBVS **2549**, 1 (1984)
Irwin, J.B.: AJ **64**, 149 (1959)
Mayer, P.: BAICz **41**, 231 (1990)
Naimiy, H.M.K., Al-Masharfeh, T.H.S.: ApSS **273**, 83 (2000)
Yang, Y., Liu, Q.: AJ **122**, 425 (2001)

OO AQL (9.2 – 10.8 EW/DW)

Deuxième étude :

The low-mass interacting binary system OO Aql revisited: a new quadruple system
(T. ˙ I¸cli1, D. Ko¸cak1, G. C¸ . Boz1 and K. Yakut) http://arxiv.org:1302.6686

Les auteurs indiquent une période de 52 ans pour le quatrième corps et 20 ans pour le troisième corps.

The low-mass interacting binary system OO Aql revisited: a new quadruple system

T. İçli[1], D. Koçak[1], G. Ç. Boz[1] and K. Yakut[1,2]
Department of Astronomy and Space Sciences, University of Ege, 35100, Bornova–İzmir, Turkey
Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge CB3 0HA, UK

Table 2: Orbital elements of the quadruple system OO Aql. The standard errors 1σ, in the last digit are given in parentheses.

Parameter	Unit	Value
Binary system – Star AB		
Initial epoch, T_o	HJD	24 38239.696(2)
Period, P_{bin}	day	0.50679020(8)
Period change ratio $\frac{\dot{P}}{P}$	yr	$4(1) \times 10^{7}$
Mass transfer ratio, $\frac{\dot{M}}{M}$	$M_\odot yr^{-1}$	$5(1) \times 10^{-8}$
Seperation between stars, a	$R_\odot$	3.34(2)
Parallax, π	mas	7.35
Star C		
Initial epoch, $T_o(C)$	HJD	24 54392
Orbital period, P_C	yr	20(1)
Amplitude, A_C	day	0.0041(2)
Eccentricity, e		0.44(7)
Longitude of the periastron, ω'_C	$^\circ$	164
Mass function, $f(m_C)$ l	$M_\odot$	0.0011
Minimum mass, $M_{C(\min)}$	$M_\odot$	0.19
Mass, $M_{C,i'=60^\circ}$	$M_\odot$	0.23
Mass, $M_{C,i'=30^\circ}$	$M_\odot$	0.47
Angular distance, a''_C	mas	76
Star D		
Initial epoch, $T_o(D)$	HJD	24 55622
Orbital period, P_D	yr	52(2)
Amplitude, A_D	day	0.019(1)
Eccentricity, e		0.220(20)
Longitude of the periastron, ω'_D	$^\circ$	20
Mass function, $f(m_D)$	$M_\odot$	0.0130
Minimum mass, $M_{D(\min)}$	$M_\odot$	0.42
Mass, $M_{D,i'=60^\circ}$	$M_\odot$	0.49
Mass, $M_{D,i'=30^\circ}$	$M_\odot$	0.95
Angular distance, a''_D	mas	138

OO AQL (9.2 – 10.8 EW/DW)

Troisième étude :

Eclipsing Binaries with Possible Tertiary components (LeRoy F. Snyder), voir http://www.socastrosci.org/images/SAS_2013_Proceedings.pdf pour télécharger l'article.

l'auteur fait l'interprétation de la courbe O-C et trouve une période de 19.77 ans pour le troisième corps

Eclipsing Binaries with Possible Tertiary Components

LeRoy F. Snyder
King Canyon Observatory
357 Coventry Drive Carson City, NV 89703
snyderlf@att.net

Abstract

Many eclipsing binary star systems (EBS) show long-term variations in their orbital periods which are evident in their O-C (observed minus calculated period) diagrams. This research carried out an analysis of 324 eclipsing binary systems taken from the systems analyzed in the Bob Nelson's O-C Files database. Of these 18 systems displayed evidence of periodic variations of the arrival times of the eclipses. These rates of period changes are sinusoidal variations. The sinusoidal character of these variations is suggestive of Keplerian motion caused by an orbiting companion. The reason for these changes is unknown, but mass loss, apsidal motion, magnetic activity and the presence of a third body have been proposed. This paper has assumed light time effect as the cause of the sinusoidal variations caused by the gravitational pull of a tertiary companion orbiting around the eclipsing binary systems. An observed minus calculated (O-C) diagram of the 324 systems was plotted using a quadratic ephemeris to determine if the system displayed a sinusoidal trend in theO-C residuals. After analysis of the 18 systems, seven systems, AW UMa, BB PEG, OO Aql, V508 Oph, VW Cep, WCrv and YY ERI met the benchmark of the criteria of a possible orbiting companion. The other 11 systems displayed a sinusoidal variation in the O-C residuals of the primary eclipses but these systems in the Bob Nelson's O-C Files did not contain times of minimum (T_{min}) of the secondary eclipses and therefore not conclusive in determining the presents of the effects of a tertiary companion. An analysis of the residuals of the seven systems yields a light-time semi-amplitude, orbital period, eccentricity and mass of the tertiary companion as the amplitude of the variation is proportional to the mass, period and inclination of the 3rd orbiting body. Knowing the low mass of the tertiary body in the seven cases the possibility of five of these tertiary companions being brown dwarfs is discussed.

4.3 OO AQL

OO Aql is a W UMa binary with a combined mass M_{1-2} of 1.5 $M_\odot$ and a period of 0.51 days. The O-C diagram, Figure 5, covers 37 years with 1035 data points. The quadratic equation

$$\int(e) = 38613.22334 (\pm 8.7^{-4}) + 0.5068 (\pm 1.5^{-7})E + 1.31150^{-11} (\pm 5.54^{-12}) E^2 \quad (3)$$

produced only a 4% improvement over the parabolic fit. The third body period is 19.77 years and requires a minimum mass of 0.155 $M_\odot$ since the mass function is

$$\int(M) = 0.0245\ M_\odot.$$

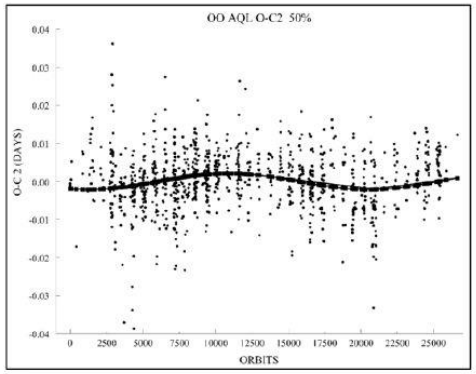
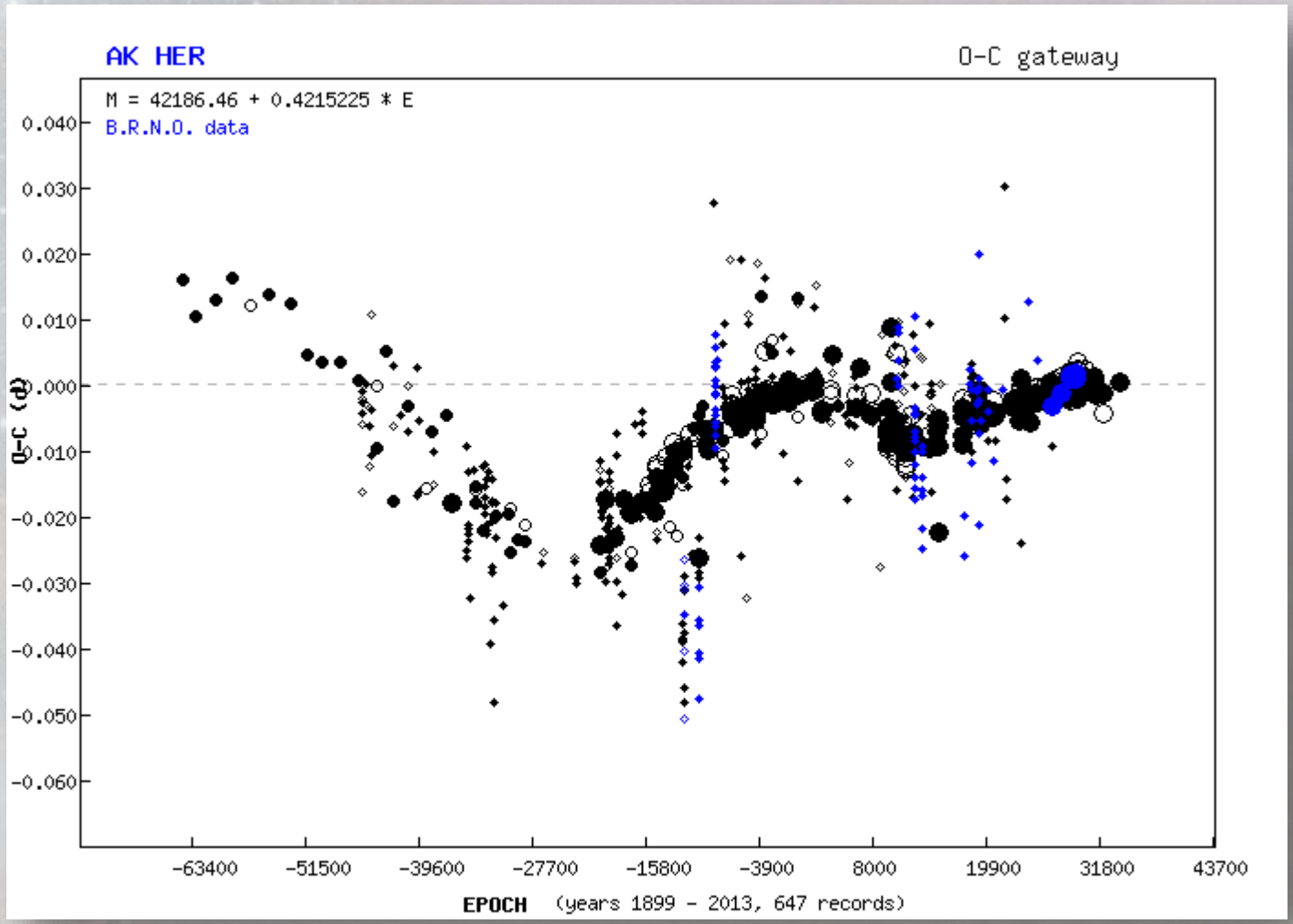


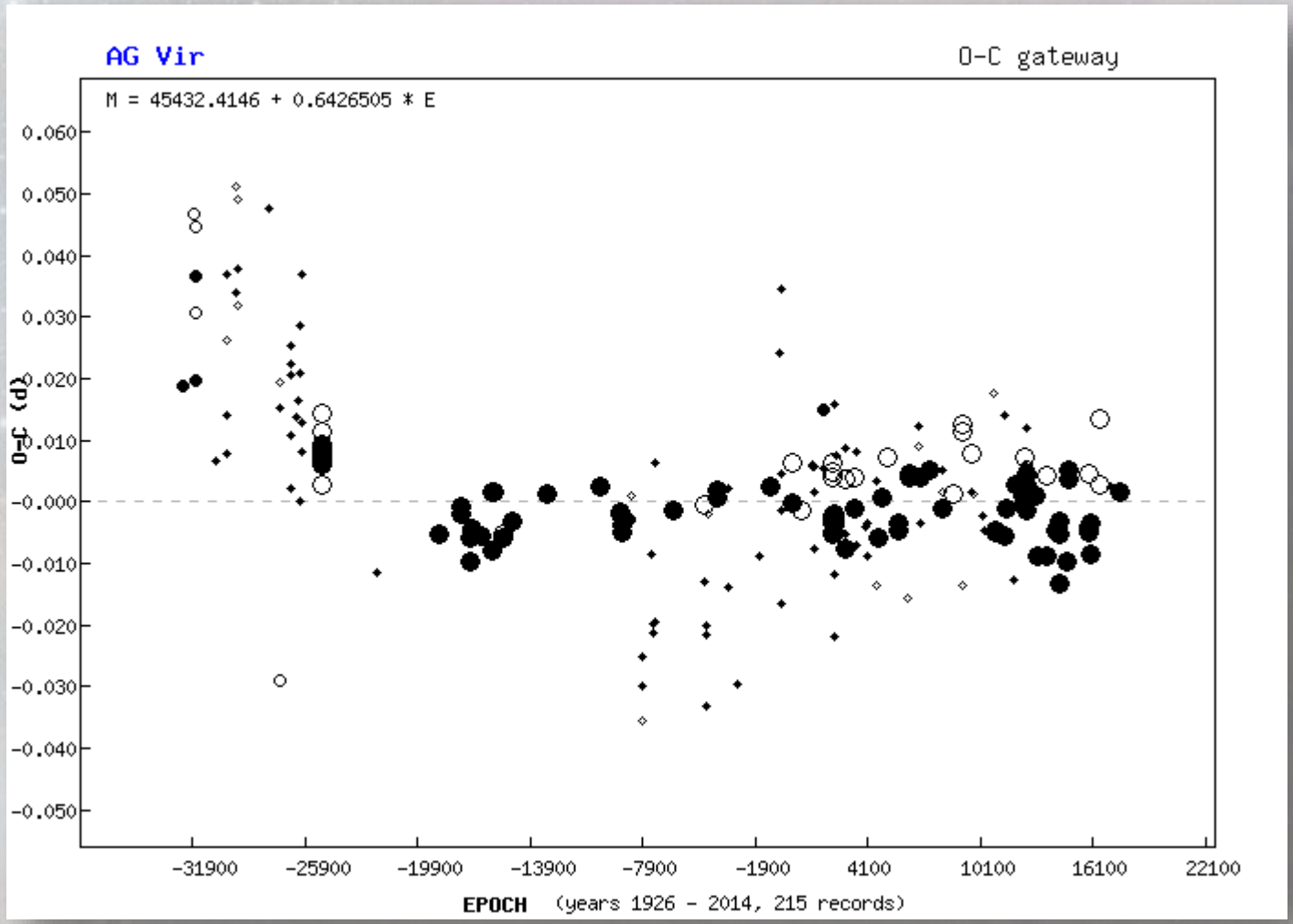
Figure 5. OO AQL.

Perspectives



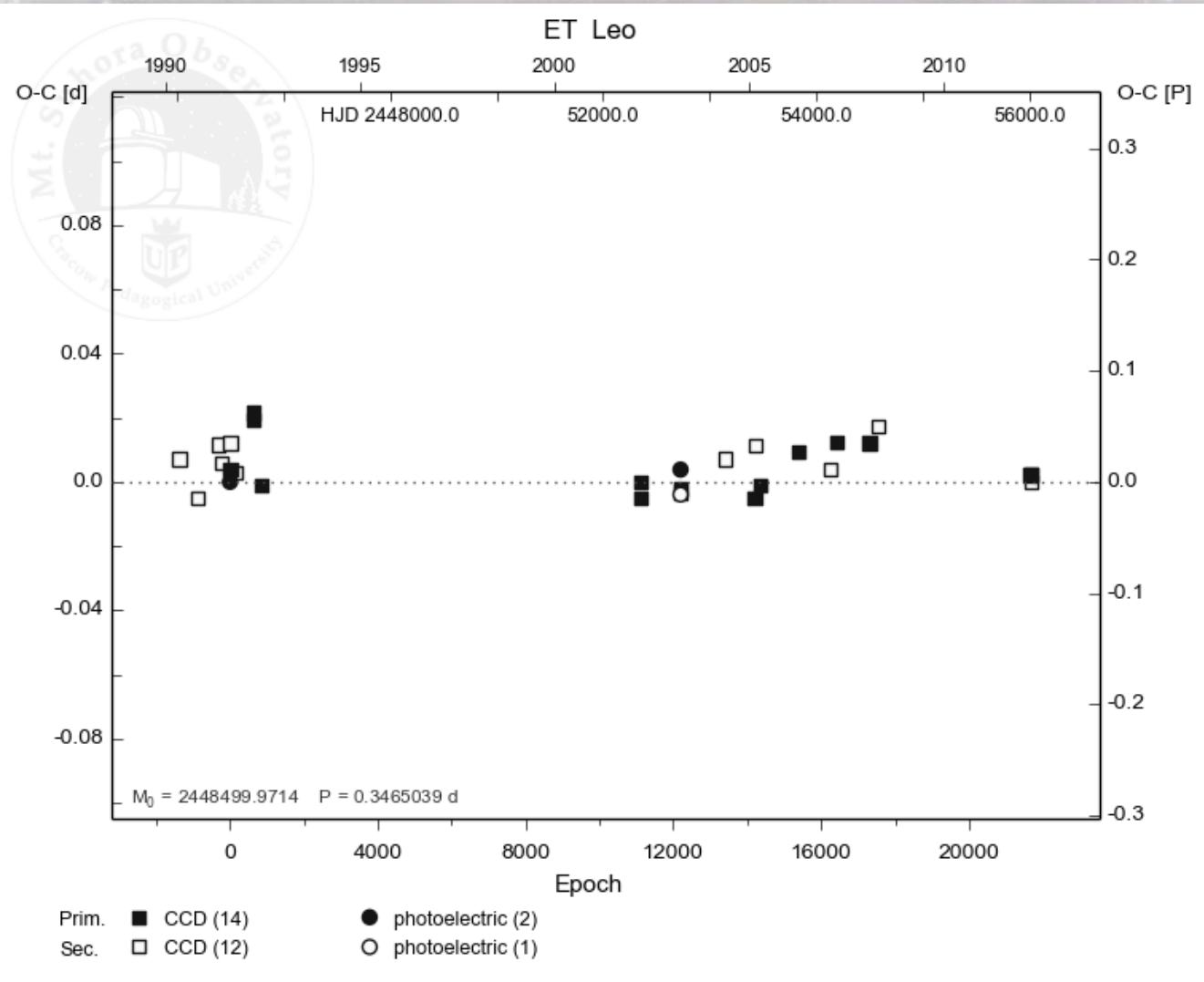
http://var.astro.cz/ocgate/ocgate.php?star=AK%20Her

Perspectives



http://var.astro.cz/ocgate/ocgate.php?star=AG%20Vir

Perspectives



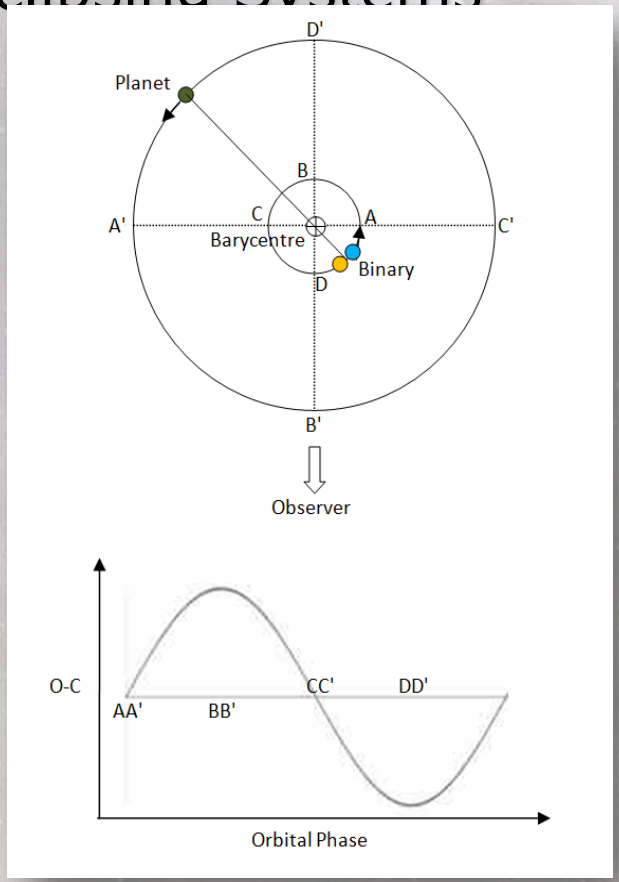
Autre cas : ET LEO

La recherche du troisième corps

SPADES

Search for Planets Around Detached Eclipsing Systems

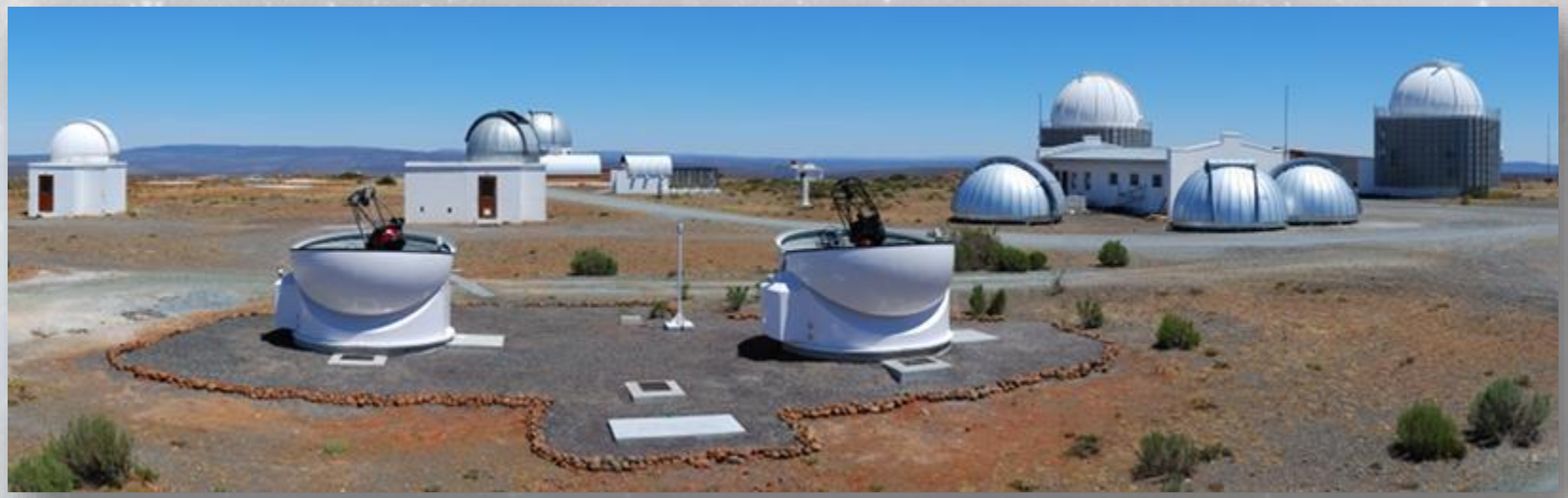
- Pour les photométristes CCD - BVR
  - Chefs de projet :
    - Dr Simon O'Toole (AAO) – Pro.
    - Dr Tom Richards (VSS) – Am.
  - Détection d'exoplanètes autour des EB
  - Listes par Constellations et RA
  - Coordinations et supports
  - Fichiers de données pour le logiciel « Ephemerides »
  - Http://www.varstarssouth.org



Source : **http://www.varstarssouth.org**

La recherche du troisième corps

SOLARIS – version pro de SPADES



- Réseau de 4 télescopes de 500 mm F/15 Ritchey Chretien – CCD ANDOR iKon-L 2k x 2k
- Australie - Afrique – Amérique du Sud
- 350 binaires à éclipses à mesurer (photométrie + spectro)

Source : **http://www.projectsolaris.eu/**

Les différentes contributions

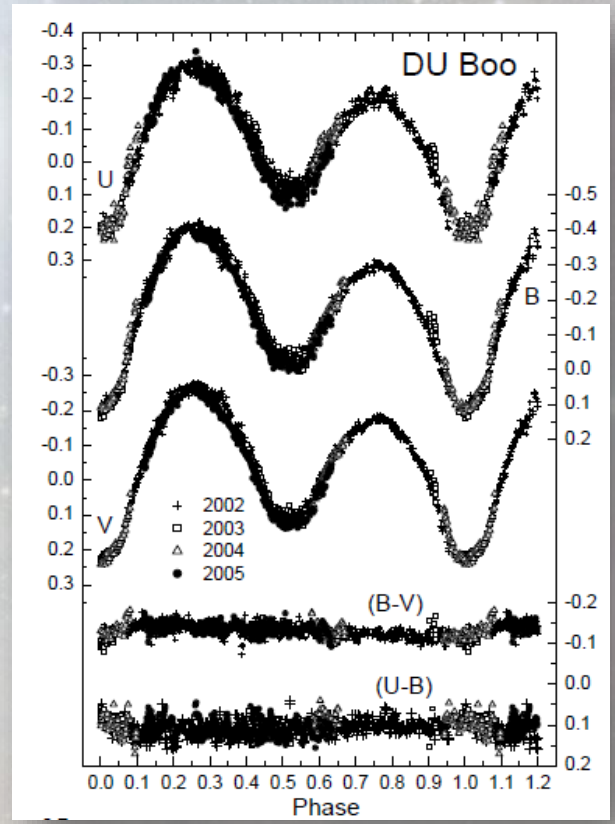
Effet O’Connell

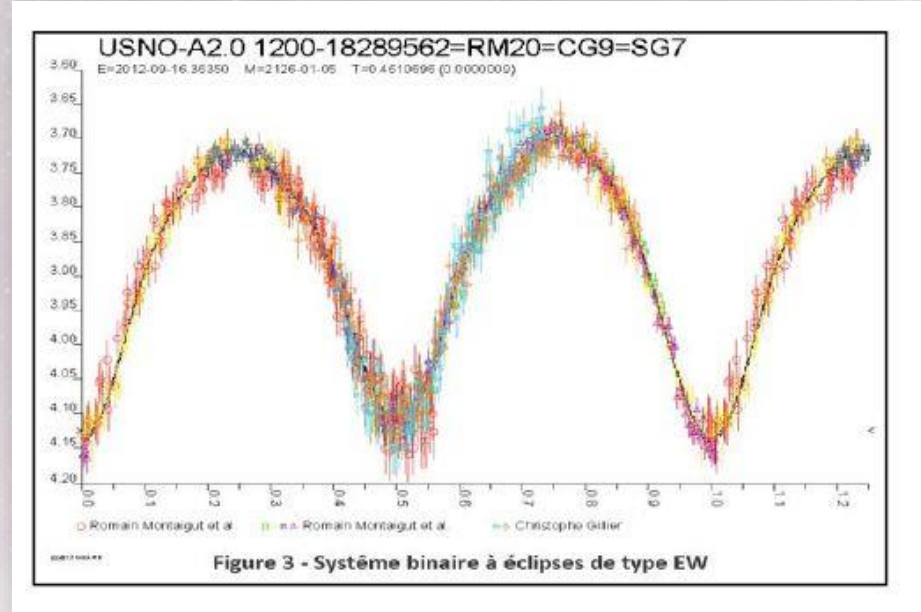
Effet O'Connell

Astron. Nachr. / AN **332**, No. 6, 607 – 615 (2011) / **DOI** 10.1002/asna.201111569

O'Connell effect in early-type contact binaries

DU Boo and AG Vir T. Pribulla et al.





RM20 – Source NGC69 – N°102 – Romain Montaigut

Cause possible : Hot spot sur l'étoile secondaire

THE ASTROPHYSICAL JOURNAL SUPPLEMENT SERIES, 55:571–584, 1984 August

A STUDY OF THE O'CONNELL EFFECT IN THE LIGHT CURVES OF ECLIPSING BINARIES[1]

T. J. DAVIDGE AND E. F. MILONE[2]
Rothney Astrophysical Observatory University of Calgary
Received 1983 November 3; accepted 1984 February 8

ABSTRACT

A modest attempt has been made to redo O'Connell's classic study of the light curve asymmetry between outside eclipse maxima, using *UBV* photoelectric data. In the current study, RS CVn–type and contact systems, as well as those containing an intrinsically varying component, are excluded. Using both parametric and nonparametric methods, we found significant correlations in at least one color between the size of the asymmetry, Δm, and (1) the color index of the asymmetry; the relative sizes of the (2) hotter and (3) smaller components; (4) the ratio of radii (and the logarithm of this quantity); the distortion of (5) the smaller and (6) the hotter component; (7) the relative separation of the stars; and (8) the logarithm of the period. Some of these parameters had also been found to be correlated to Δm_{pg} by O'Connell using a data base now known to contain variable Δm systems. We find, however, few correlations with Δm_B. The current study data set is characterized by lower mean amplitudes and a much more even distribution of the asymmetry with respect to sign than was O'Connell's. Contrary to O'Connell's results, there is a tendency for the brighter maximum to be the redder, so that the evidence against H^- absorption which he cited is not present here. The evidence suggests more than one mechanism for the O'Connell effect, but the data base is, at the present time, still regrettably small.

Subject headings: photometry — stars: eclipsing binaries

I. INTRODUCTION

The O'Connell effect is the name given by Wesselink and Milone (Milone 1968) to the height difference between the maxima in the light curves of certain eclipsing systems. The most intensive study of the phenomenon was done by O'Connell (1951), although Mergentaler's (1950) work on eight systems was an important precursor. Prior to this work it was widely believed that the asymmetry had its origin in tidal and radiation enhancements during periastron (e.g., Roberts 1906).

As a consequence of the study, O'Connell found correlations between the size of the asymmetry in magnitude measure, designated Δm, and parameters relating to the orbits and components of eclipsing systems. In almost all cases Δm was measured from visual or photographic light curves. Following O'Connell's convention, Δm is the magnitude difference maximum II − maximum I; i.e., it is the magnitude of the maximum after primary minimum subtracted from the magnitude of the maximum after secondary minimum. This means that if the maximum following primary minimum is brighter than that following secondary minimum, then $\Delta m > 0$.

O'Connell found that Δm_{pg} was nearly always positive in the photographic light curves among the nonvariable systems: only two of the 58 systems provided the exceptions (WZ Cep and CV Cyg). O'Connell's most significant correlations were Δm_{pg} versus $(\Delta m_{pg} - \Delta m_{vis})$, $(b/a)_s$, $(b/a)_g$, $\log(K = b_g/b_s)$, $\log(\rho_1/\rho_2)$; other significant correlations were Δm_{pg} versus $\log R_s$, $\log D$ and $\log \rho_1$. Here a and b are the relative radii of the stars in the line of centers and perpendicular to it in the plane of the orbit, P is the orbital period, R is a stellar radius in solar units, ρ is the mean density of a component, D is the true separation of surfaces, and s, g, and h designate the smaller, larger, and hotter component, respectively. Subscripts "1" and "2" denote greater and lesser in any given property; these designations were adopted in order to avoid confusion with the properties pertaining to the larger and smaller components. O'Connell found "barely significant" correlations between Δm_{pg} and M_1, M_2, R_g, ρ_2, $1-(a_s + a_g)$, and the spectral type of the fainter component. Here M is the mass of a component in solar units. He found no significant correlation with the period, mass ratio, absolute magnitude of either star, the difference in absolute magnitude, the spectral type of the brighter component, the difference in spectral types between components, or with the ratio of surface brightness. O'Connell concluded that at a wavelength of 4300 Å: (1) "Δm is positive for B (i.e., β Lyrae) type binaries with $b/a \gtrsim 0.95$ and separation $\gtrsim 0.5$"; (2) "Δm increases with increasing ellipticities of the stars and with increasing difference between the sizes and densities of the components"; and (3) "the smaller and denser the smaller star is, the bigger is Δm, the supergiant stars being taken separately." O'Connell did not investigate correlations with Δm_{pv} or Δm_v, which data were fewer and in many cases less precise, than Δm_{pg}. He did, however, make use of them for color studies: he found that Δm was greater in shorter wavelengths, with the fainter maximum being the redder. From this he concluded that the

[1] *Publication of the Rothney Astrophysical Observatory*, No. 22.
[2] Visiting Astronomer, Kitt Peak National Observatory and Cerro Tololo Inter-American Observatory, which are operated by the Association of Universities for Research in Astronomy, Inc., under contract with the National Science Foundation.

Les différentes contributions

oEA stars

Oscillating Algol-type stars (oEA)

- Modèles de Roche pour surfaces déformées par effets de marées (config. semi-détachée, type Algol)
- Evolution avancée: fin du transfert de masse rapide entre les composantes
- Composante de type spectral A ou F, étoile pulsante de la classe 'étoiles δ Scuti'
- Période(s) de pulsation courte(s) (~0.5 - 3 h)
- Amplitude(s) faible(s) (mmag)
- Qqs. douzaines détectées (Terre) → centaines identifiées (espace)

Source : Patricia LAMPENS – Observatoire Royal - Bruxelles

Autres suivies

Eclipsing variables: Catalogue and classification

E. A. Avvakumova[1]⋆, O. Yu. Malkov[2,3,4], and A. Yu. Kniazev[5,6]

[1] Department of Astronomy and Geodesy, Ural Federal University, 51 Lenin Street, Yekaterinburg 620000, Russia
[2] Institute of Astronomy of the Russian Academy of Sciences, 48 Pyatnitskaya Street, Moscow 119017, Russia
[3] Faculty of Physics, Moscow State University, Moscow 119992, Russia
[4] Observatorio Astronómico Ramón María Aller, Universidade de Santiago de Compostela, Avenida das Ciencias s/n, E-15782 Santiago de Compostela, Spain
[5] South African Astronomical Observatory, PO Box 9, Observatory 7935, South Africa
[6] Sternberg Astronomical Institute, Lomonosov Moscow State University, 13 Universitetskij Prosp., Moscow 119992, Russia

Table 1 Catalogue of eclipsing variables, main table, first fifteen lines

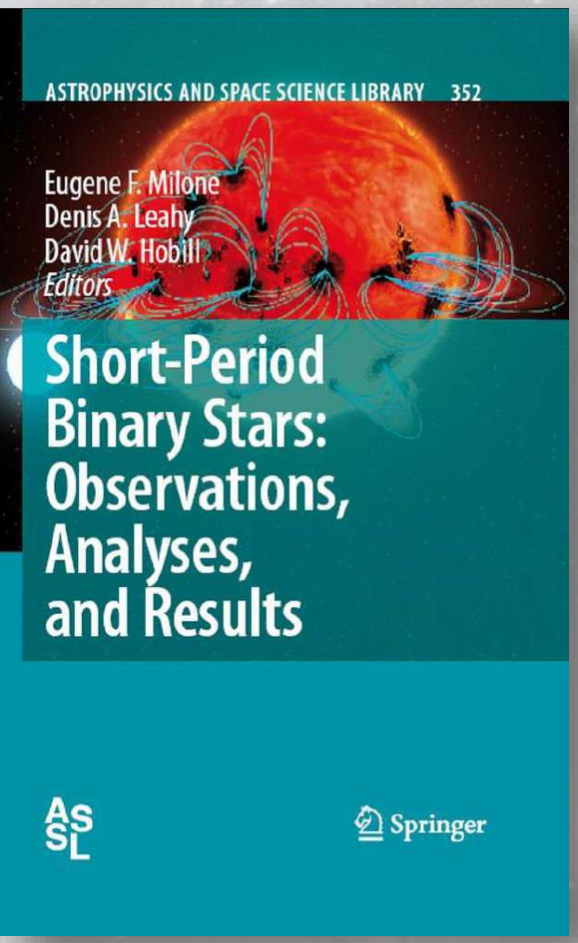
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
RT And	CB	EA	RS	8.97	0.41	0.31	V	0.6289	v	170	0	170	0		F8V+K1	a
SY And		EA		10.70	1.50	0.00	V	34.9085		60	27				A0+K1	
TT And	SA	EA		11.50	1.50	0.10	V	2.7651	v	140	0				A+G7IV	
TW And	SA	EA		8.98	2.06	0.15	V	4.1228	v	130	20				F0V+K0	
DK And		EW		12.50	0.60	0.60	p	0.4892			0		0		—	
UU And	SA	EA		11.20	3.00	0.20	V	1.4863	v	170	0				A8IV/V	
WW And	SA	EA		10.92	0.67	0.16	V	23.2852		50	12				A0:+G5-K0III	
WX And		EA		12.10	1.70	0.00	V	3.0011	d	120	30				F5IV	
WZ And	CB	EB		11.60	0.40	0.01	V	0.6957	v		0		0		F5	
XZ And	SA	EA		9.91	2.54	0.25	V	1.3573	v	160	0	260			A1V+G5IV	
AA And	CB	EA		10.30	0.90	0.30	p	0.9351		210	0				B8V	
AB And	CWW	EW		9.49	0.97	0.83	V	0.3319	v		0		0		G5+G5V	
AD And		EB		11.20	0.62	0.58	V	0.9862	v		0		0	494	A0V	
AM And		EA		12.50	1.20	0.00	p	8.8505		80					—	
AN And	DM	EB		6.00	0.16	0.09	p	3.2196			0		0		A7Vm	

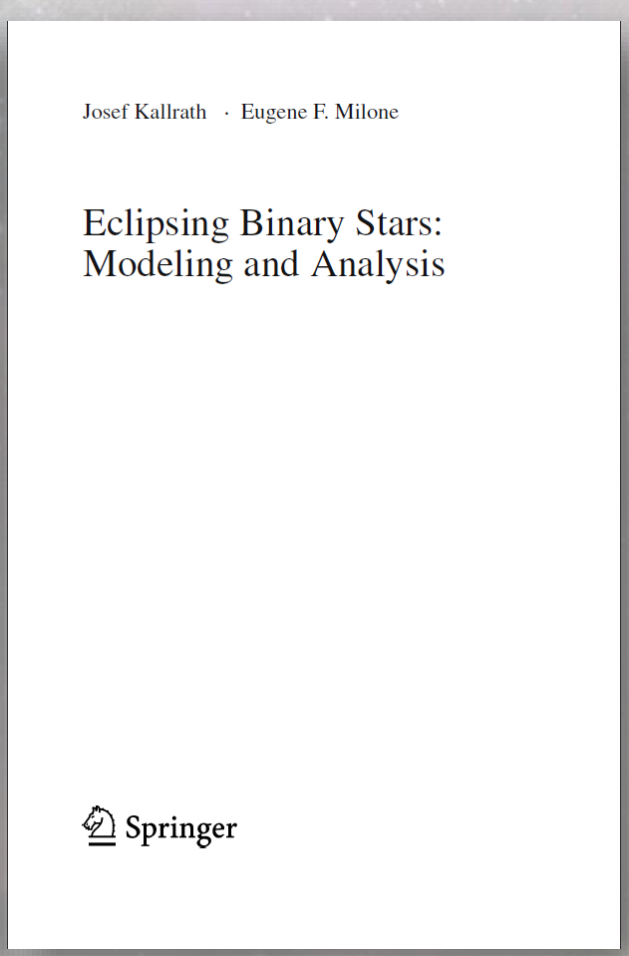
Identification and classification: (1) name of the star (as listed in the GCVS); (2) class of the system (the abbreviations are gi according to sections 2.1–2.3); (3) morphological type of the light curve (EA, EB, EW; as in the GCVS); (4) additional variability t from the GCVS. *Photometry*: (5) magnitude at maximum brightness; (6) depth of primary minimum, A_1, mag; (7) depth of second minimum (if known), A_2, mag; (8) the photometric system for magnitudes as in the GCVS. *Period*: (9) period of the variable star, days; (10) information on the sign of period variability (d: derivative is negative and period decreases, i: derivative is positive and per increases, v: derivative is non-zero and the sign varies, thus period increases and decreases, u: derivative is non-zero but the sig unknown, thus period increases or/and decreases). *Eclipses* (in phase × 1000 units): (11) duration of primary eclipse, DI; (12) durat of totality in primary eclipse, dI; (13) duration of secondary eclipse, DII; (14) duration of totality in secondary eclipse, dII; (15) ph of secondary minimum, MinII–MinI. *Spectra*: (16) spectral types and luminosity classes of the primary and secondary (if known); (information on chromospheric activity (a: chromospherically active system).

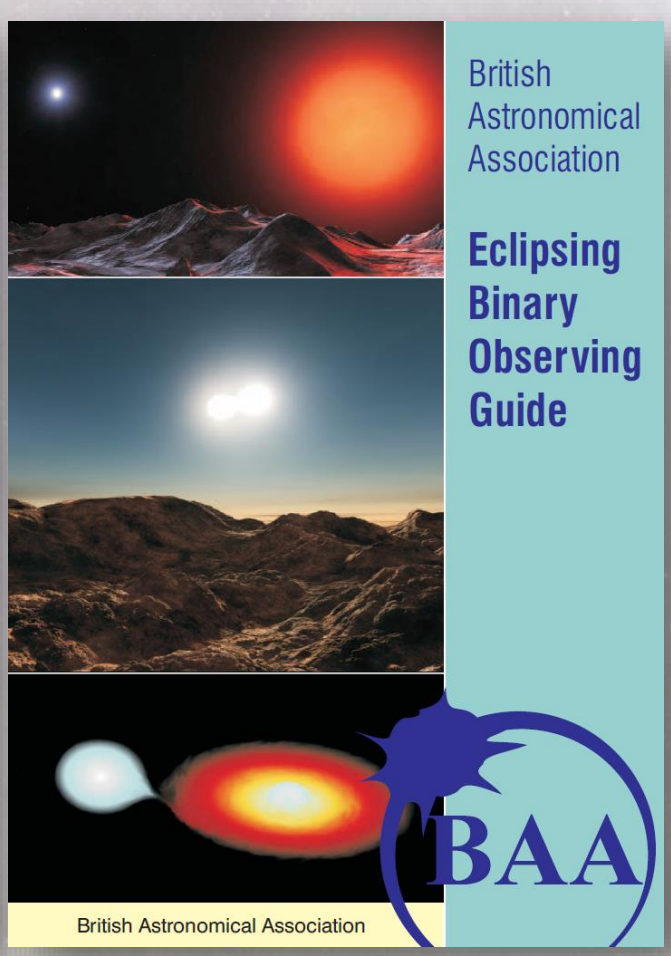
Acknowledgements. We are grateful to Nikolay Samus for reviewing this paper and for his very useful comments on the GCVS. We thank Dipen Bhattacharya for his careful reading of the manuscript and constructive remarks. We thank Laurent Corp for his observations of some interesting eclipsing binaries. This work has been supported by Russian Foundation for Basic Research grants 10-02-00426 and 12-07-00528, by the Federal Science and Innovations Agency under contract 02.740.11.0247, by the program "Leading Scientific Schools Support" of the Presidium of Russian Academy of Sciences (project 3602.2012.2), and by the Federal task program "Research and operations on priority directions of development of the science and technology complex of Russia for 2007–2013" (contract 14.518.11.7064). AYK acknowledges support from the National Research Foundation (NRF) of South Africa. This research has made use of the SIMBAD and VizieR databases, operated at the Centre de Données astronomiques de Strasbourg, of the International Variable Star Index (VSX) database, operated at AAVSO, Cambridge, Massachusetts, USA, and of NASA's Astrophysics Data System Bibliographic Services.

"Eclipsing variables: catalogue and classification", Avvakumova E.A., Malkov O.Yu., Kniazev A.Yu. 2013, Astronomische Nachrichten, 334, 859

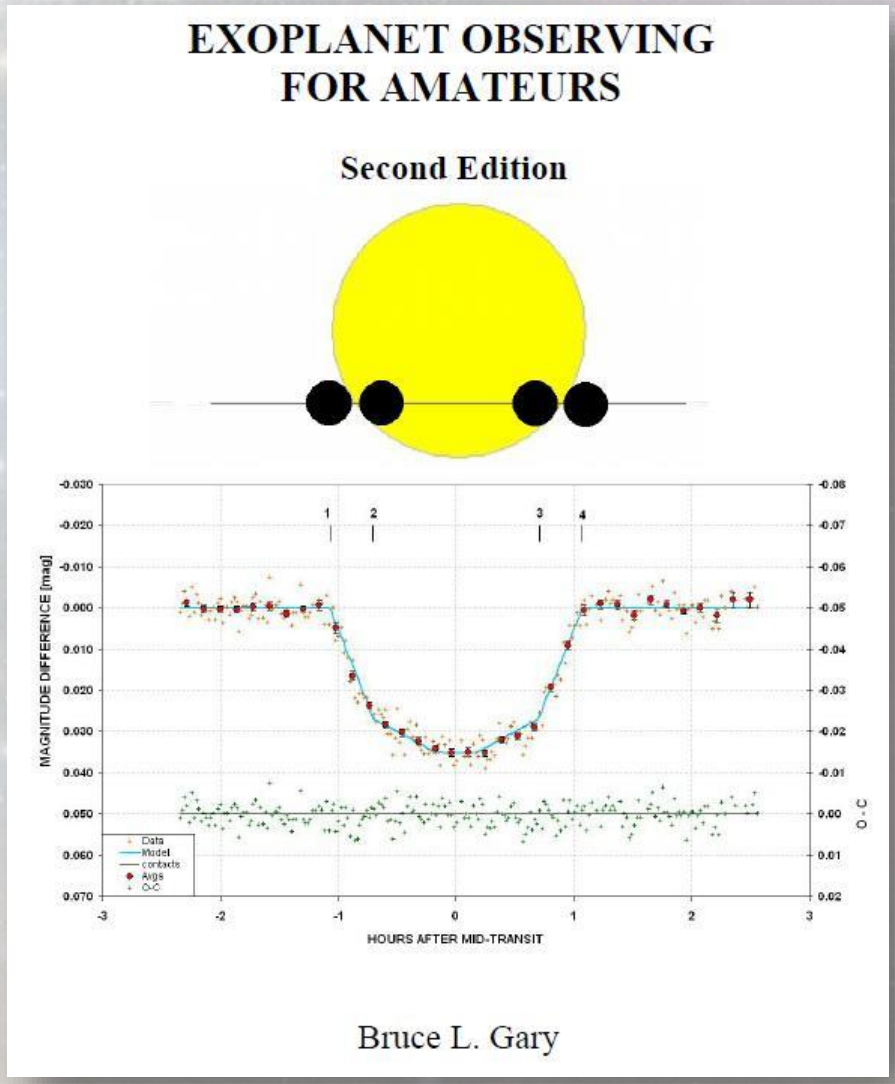
Ressources et questions

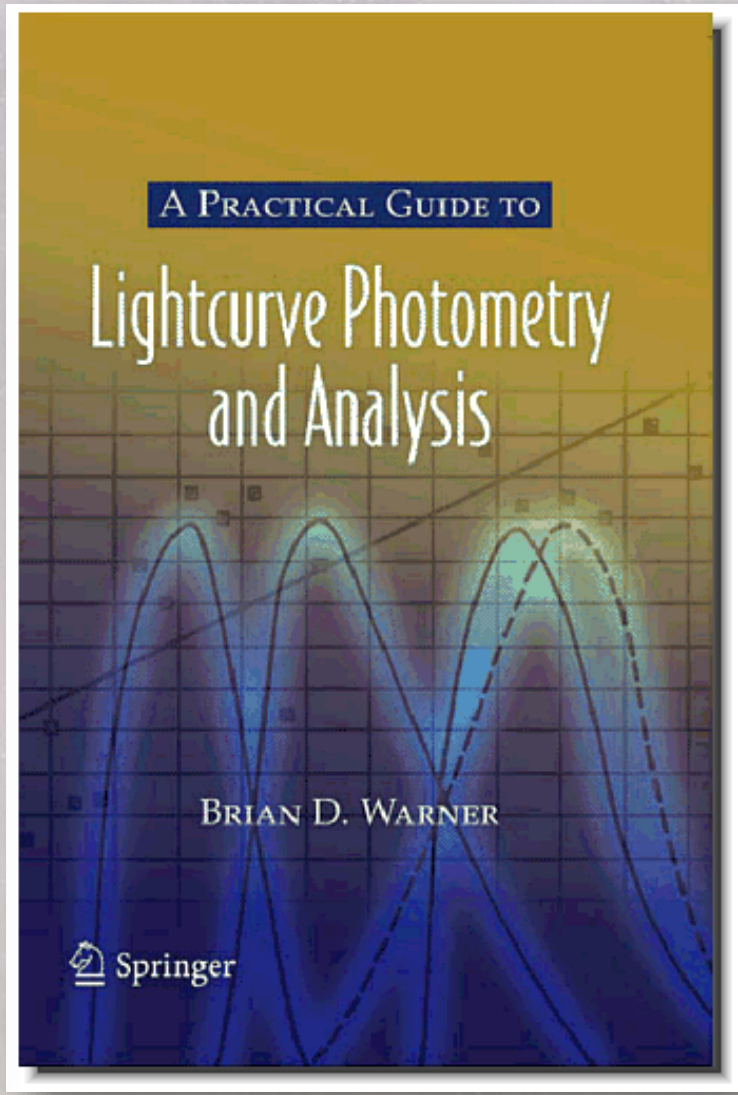

ASTROPHYSICS AND SPACE SCIENCE LIBRARY 352
Eugene F. Milone
Denis A. Leahy
David W. Hobill
Editors
Short-Period Binary Stars: Observations, Analyses, and Results
ASSL
Springer


Josef Kallrath · Eugene F. Milone
Eclipsing Binary Stars: Modeling and Analysis
Springer


British Astronomical Association
Eclipsing Binary Observing Guide
BAA
British Astronomical Association

Littérature (LES livres à lire)





Littérature

- *An Introduction to Astronomical Photometry Using CCDs*

  by W. Romanishin Universitiy of Oklahoma
  Livre de 175 pages reprenant un cours universitaire de niveau accessible sans trop de mathématiques, agréable à lire.
  http://observatory.ou.edu/wrccd22oct06.pdf

- http://www.astrosurf.com/luxorion/Documents/evolstar-bmauclaire.pdf en Français – 43 pages tout sur la vie des étoiles

- *Limites et lobes de Roche (SAF – collectif)*

Mes publications

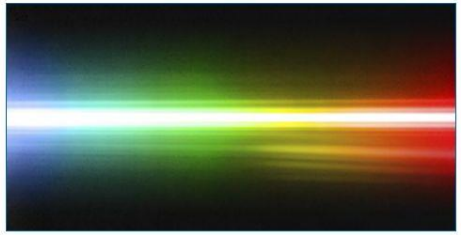
ENQUÊTE SUR LES SCIENCES PARTICIPATIVES EN ASTRONOMIE

Association française d'astronomie 2013

Enquête sur les sciences participatives en astronomie
avec le soutien du ministère de l'enseignement supérieur et de la recherche

Astronomie collaborative

Inventaire et analyse des programmes professionnels-amateurs en astronomie observationnelle identifiés en France



AVEC LE SOUTIEN DU MINISTERE DE L'ENSEIGNEMENT SUPERIEUR ET DE LA RECHERCHE

Association française d'astronomie

Binaires à éclipses

Connaître les heures des minima (et les maxima)

Coordination: CORP Laurent

Effectuer une multitude d'images CCD d'étoiles binaires à éclipses afin de déterminer des séries temporelles permettant de construire des courbes de lumière.

Réaliser des courbes de lumière sous forme de fichiers donnant les informations temporaires et lumineuses sur chaque saisie.

Les amateurs réalisent tout le protocole.

Nombre de personnes actuellement impliquées : 5

Échelle temporelle :

1 – Prédiction (logiciels et catalogues, recoupement.
2 – Observation d'une étoile pendant 4 h mini.
3 – Réduction des données (logiciels)

Systèmes solaire Stellaire Galactique Niveau de compétences : Informatiques Techniques Scientifiques

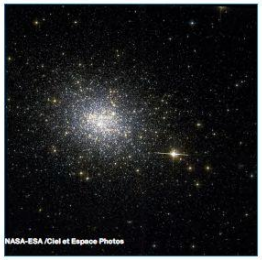
Fiche LaC1-I

Association française d'astronomie

RR Lyrae

Recherche des maxima

Coordination: CORP Laurent



Effectuer une multitude d'images CCD d'étoiles binaires à éclipses afin de déterminer des séries temporelles permettant de construire des courbes de lumière.
Réaliser des courbes de lumière sous forme de fichiers donnant les informations temporaires et lumineuses sur chaque saisie.
Les amateurs réalisent tout le protocole

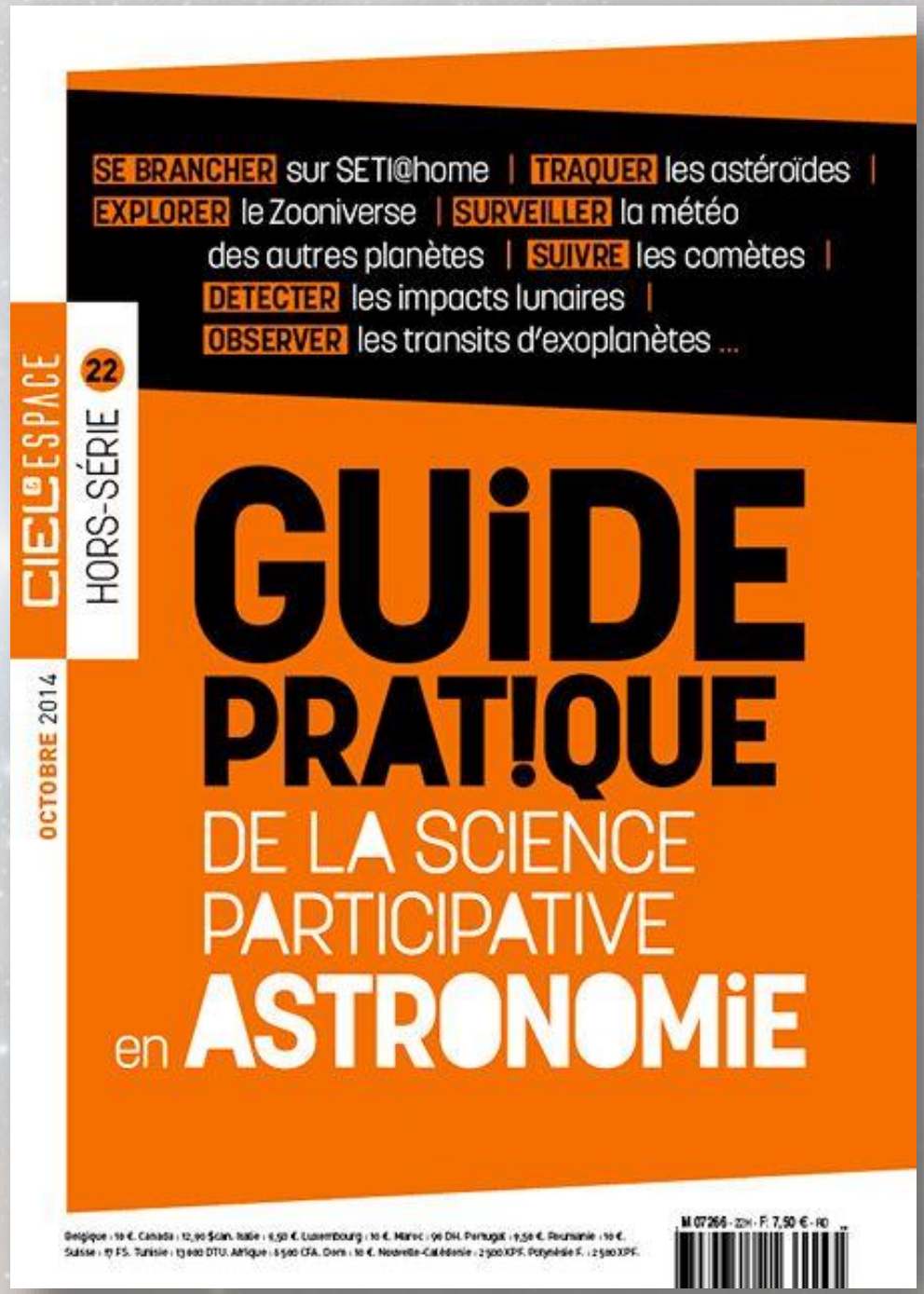
Nombre de personnes actuellement impliquées : 5

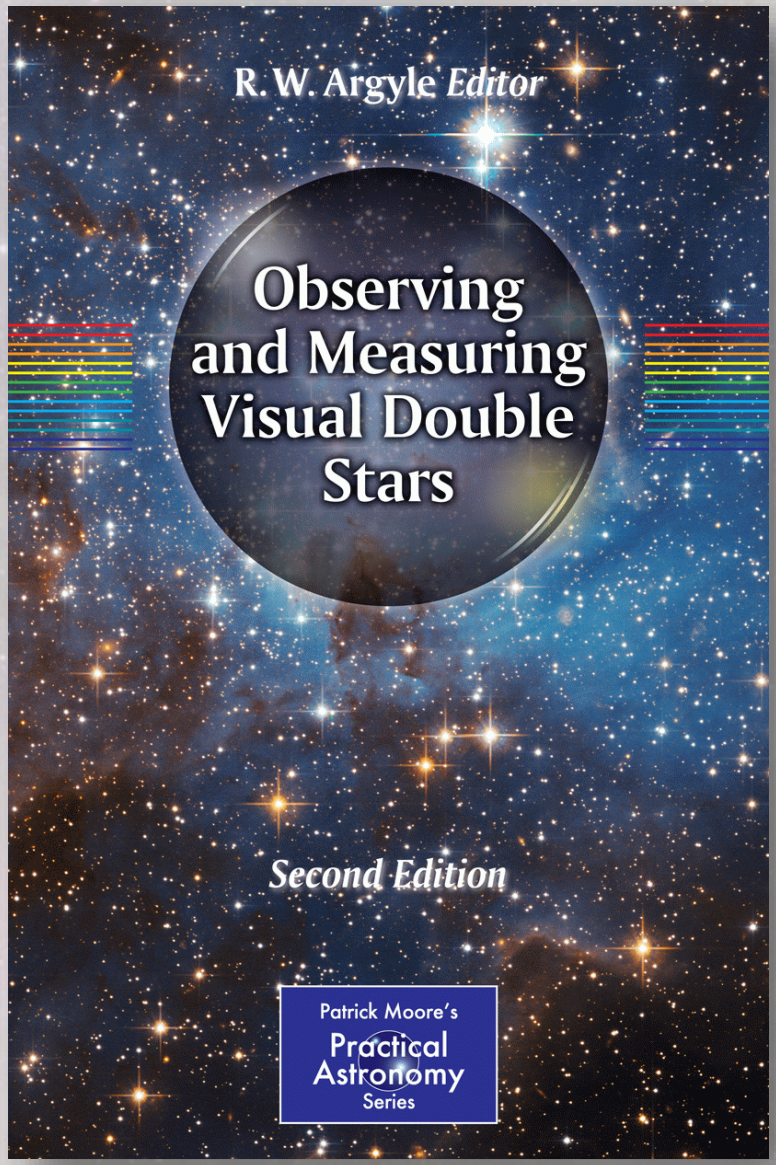
Échelle temporelle :

1 – Prédiction (logiciels et catalogues, recoupement.
2 – Observation d'une étoile pendant 4 h mini.
3 – Réduction des données (logiciels)

Systèmes solaire Stellaire Galactique Niveau de compétences : Informatiques Techniques Scientifiques

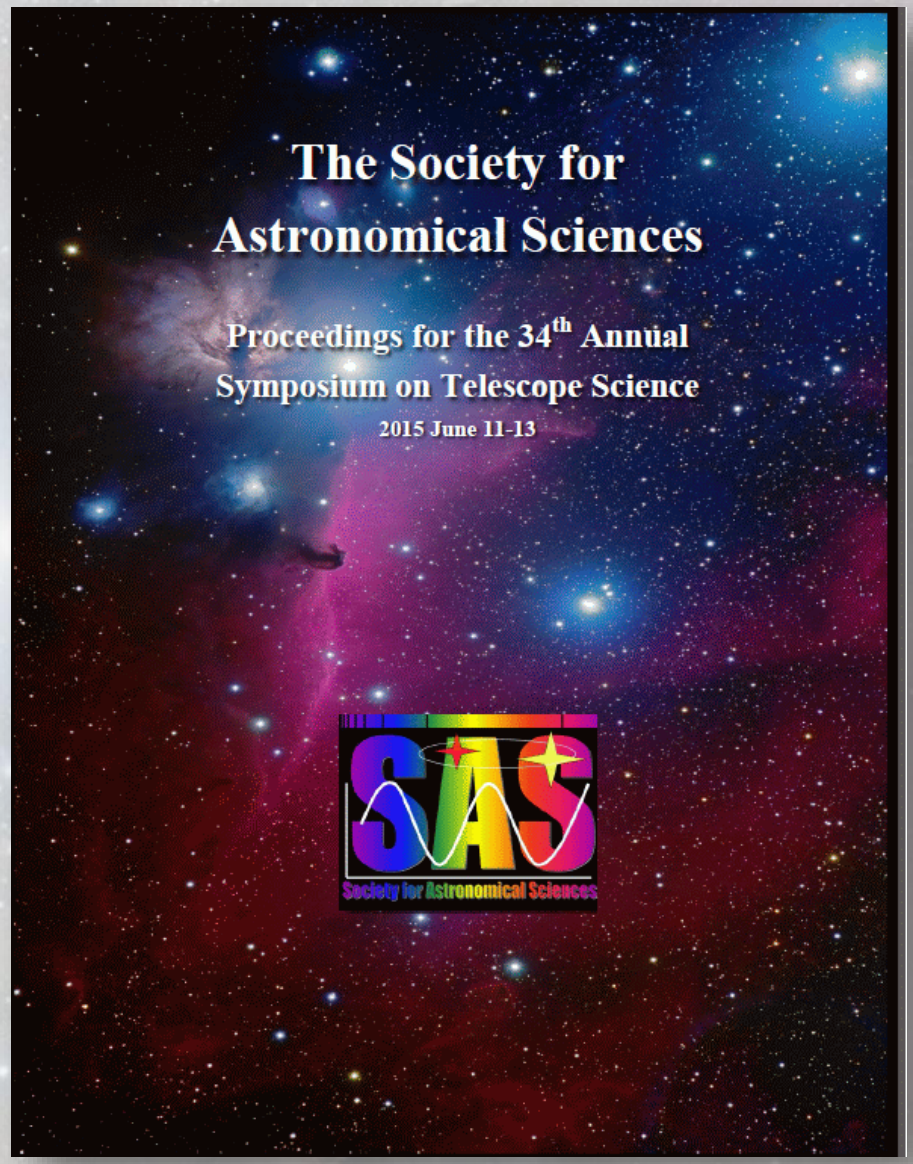
Fiche LaC2-I



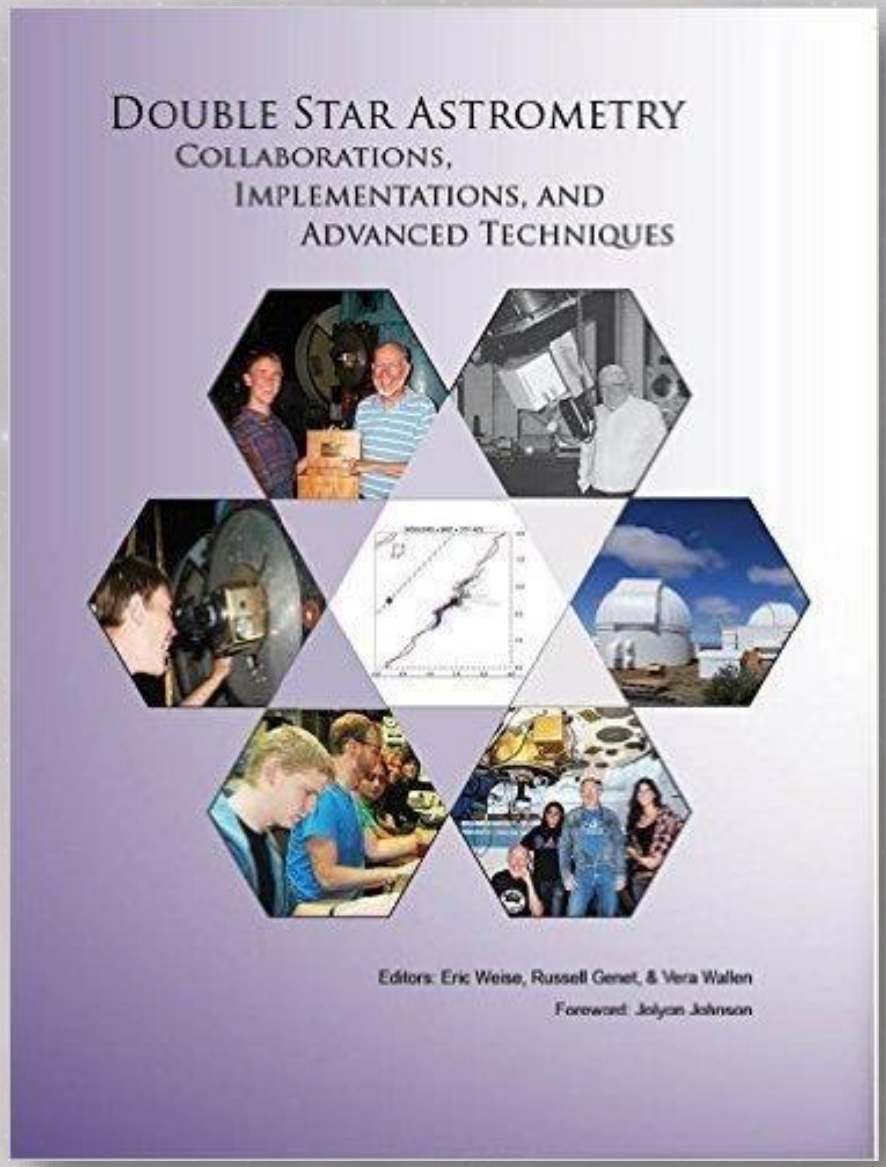


16 auteurs – 423 pages – voir chapitre 20

http://www.springer.com

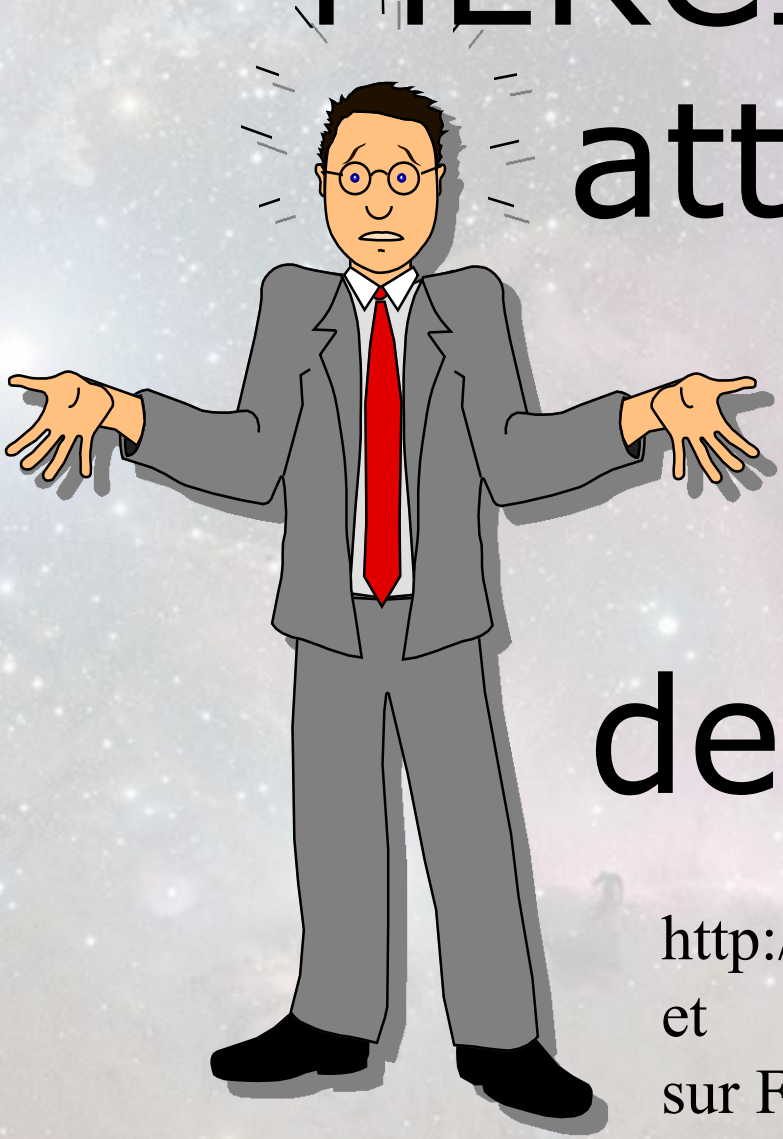


Pages 199-202



Pages 139-141

MERCI de votre attention



des questions ?

http://astrosurf.com/lcorp
et
sur Facebook