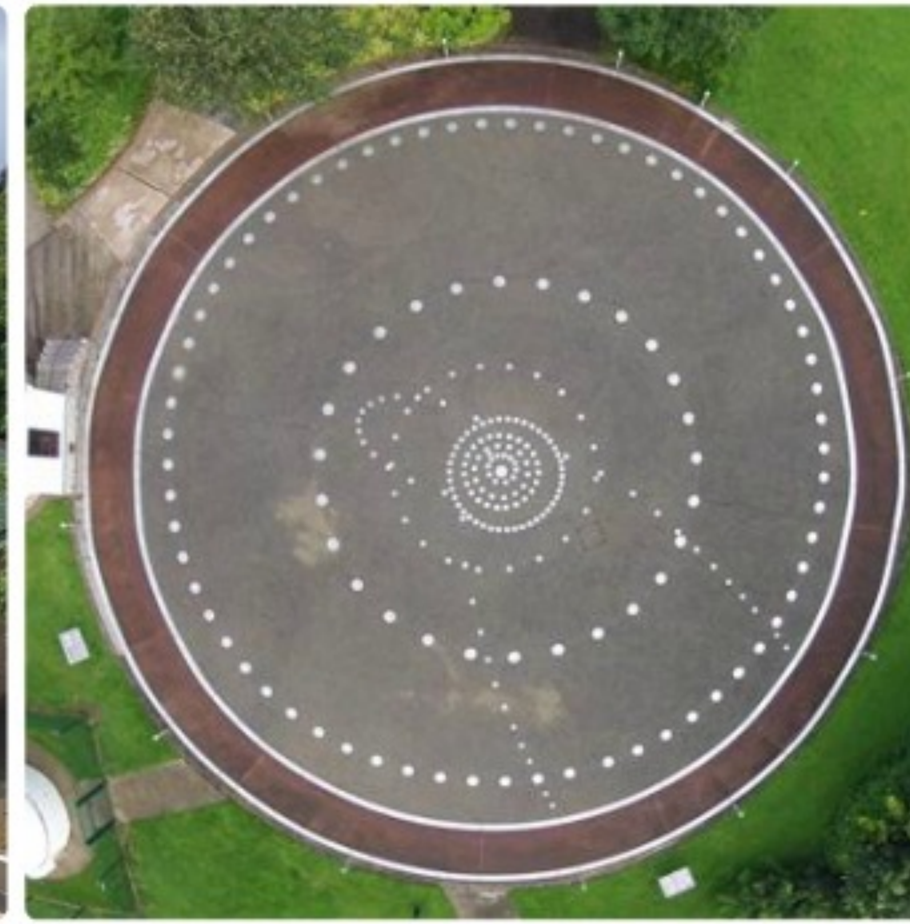
RApid Temporal Survey

RATS Arşivinde Yoğun Mavi Yıldız Avı

Onur ŞATIR

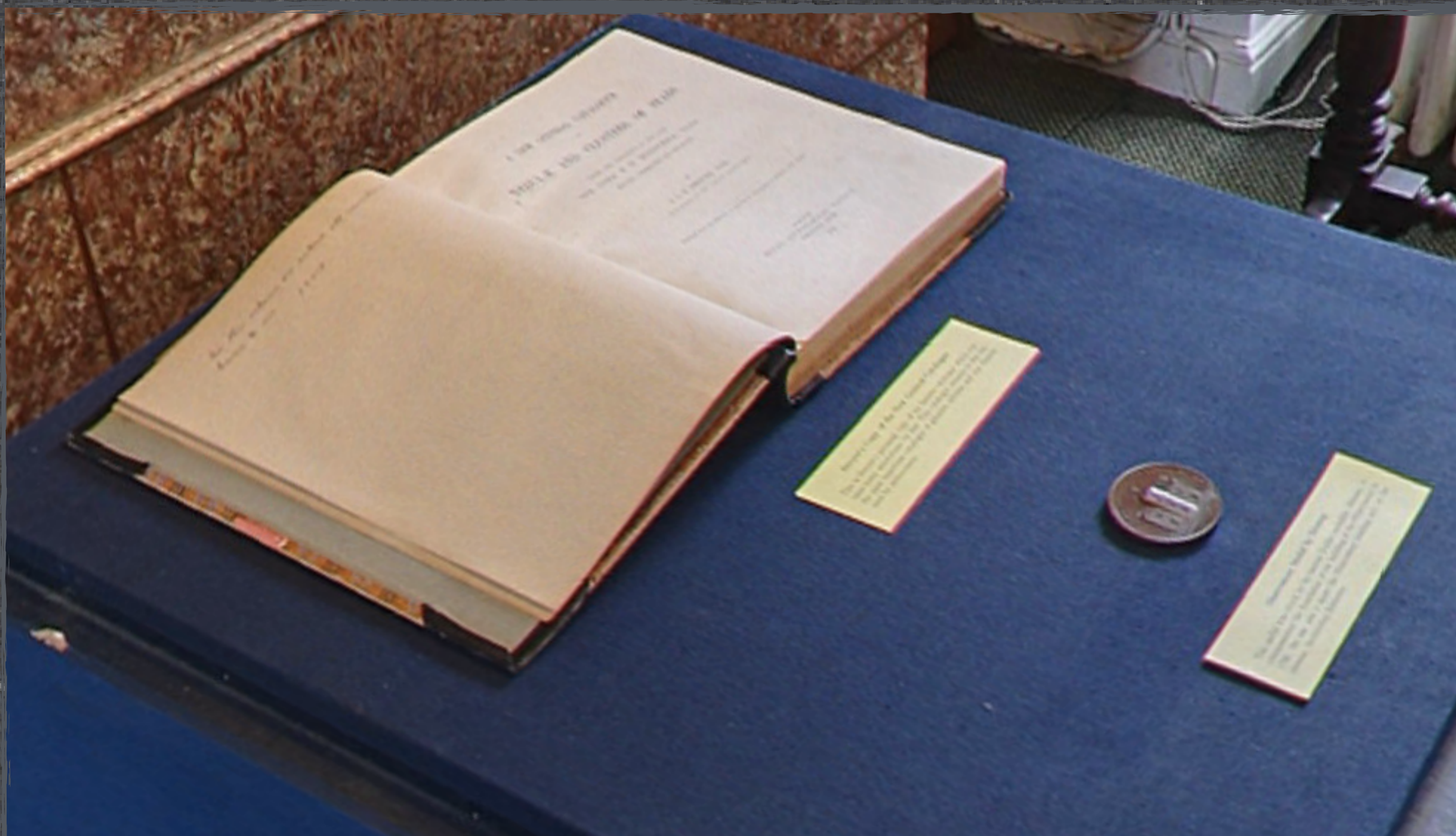



Ernst Julius Öpik

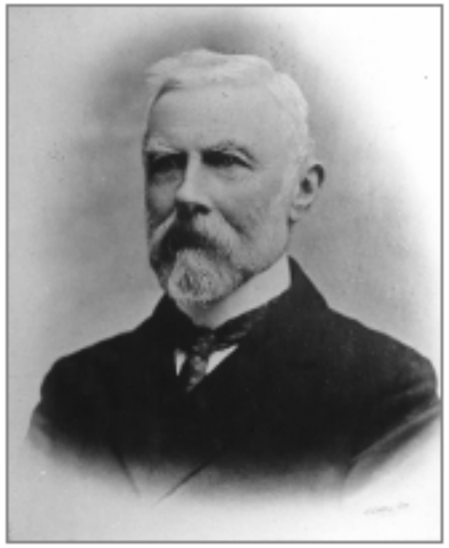
John Louis Emil Dreyer

Eric Lindsay

Ernst Julius Öpik   John Louis Emil Dreyer   Eric Lindsay



Ernst Julius Öpik



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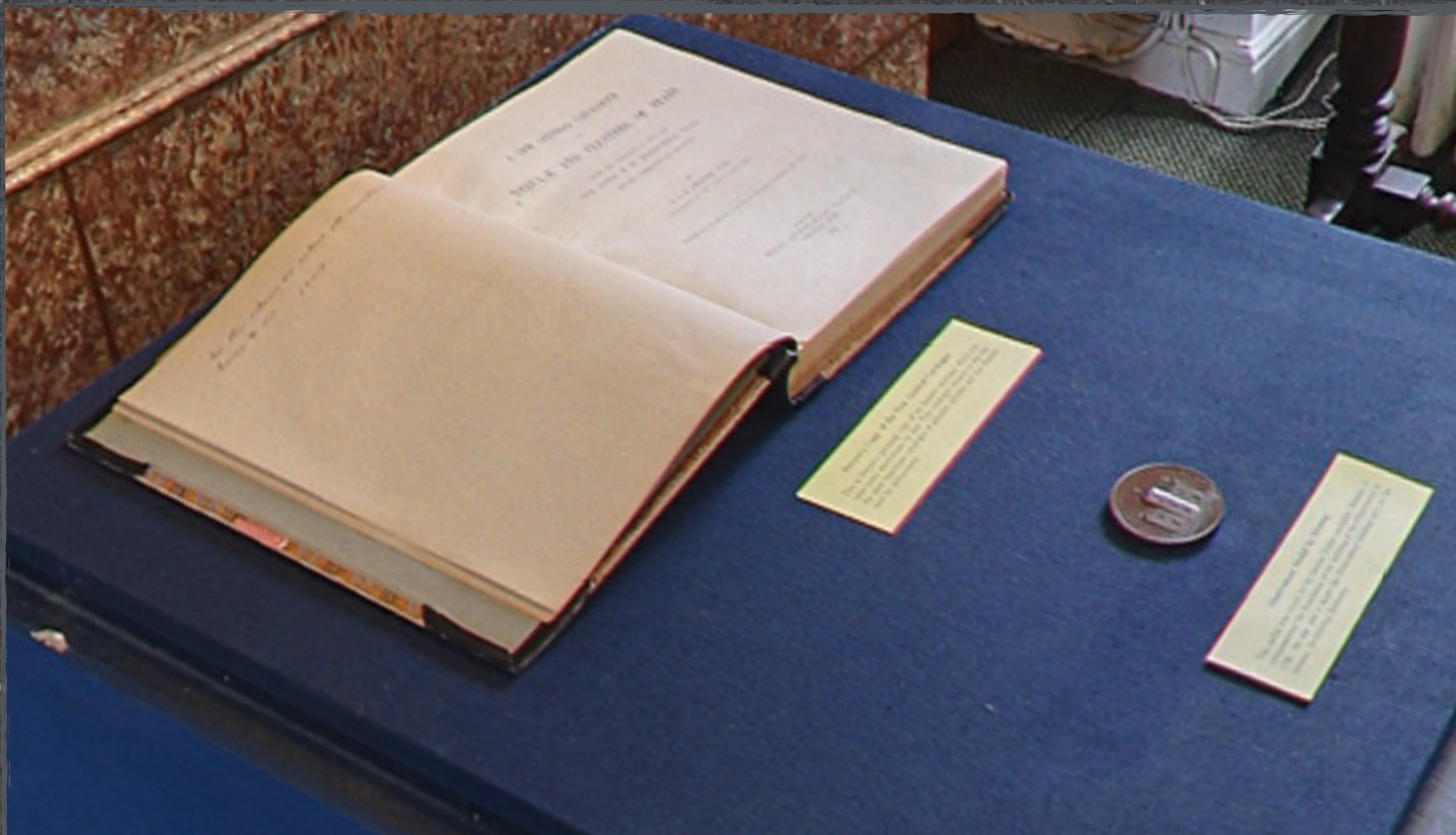

Astronomical Society of the Pacific

San Francisco, California

☆ ☆ ☆

Leaflet No. 436—October, 1965

☆ ☆ ☆

J. L. E. DREYER
and his
NEW GENERAL CATALOGUE OF NEBULAE AND CLUSTERS OF STARS

By E. M. Lindsay
Armagh Observatory, N. Ireland

In 1862 Argelander published his catalogue of 224,000 stars in the northern heavens which he and his coworkers had observed for position and magnitude during the preceding decade. This catalogue, known as the *BD (Bonner Durchmusterung)* is still in constant use, together with the corresponding charts, for the identification of stars brighter than about the 9th magnitude *(Leaflet* No. 271).

A somewhat similar catalogue of all known nebulous objects based upon John Herschel's *General Catalogue of Nebulae and Clusters of Stars* of 1864, but including later observations by many others, was published by J. L. E. Dreyer in 1888 and entitled "*A New General Catalogue of Nebulae and Clusters of Stars.*"

John Louis Emil Dreyer, the compiler of this most valuable catalogue, was born in Copenhagen on February 13, 1852. He came from a long line of military ancestors. His father, a Lieutenant-General in the Danish army, became Danish Minister of War. His grandfather was a staff officer in Napoleon's army. His great-grandfather was Quarter-Master-General in the Danish army.

In 1875 Dreyer married a member of a distinguished Irish family and his descendants reverted to the profession of his forebears. One son was a

- Nedir bu yoğun mavi yıldızlar?

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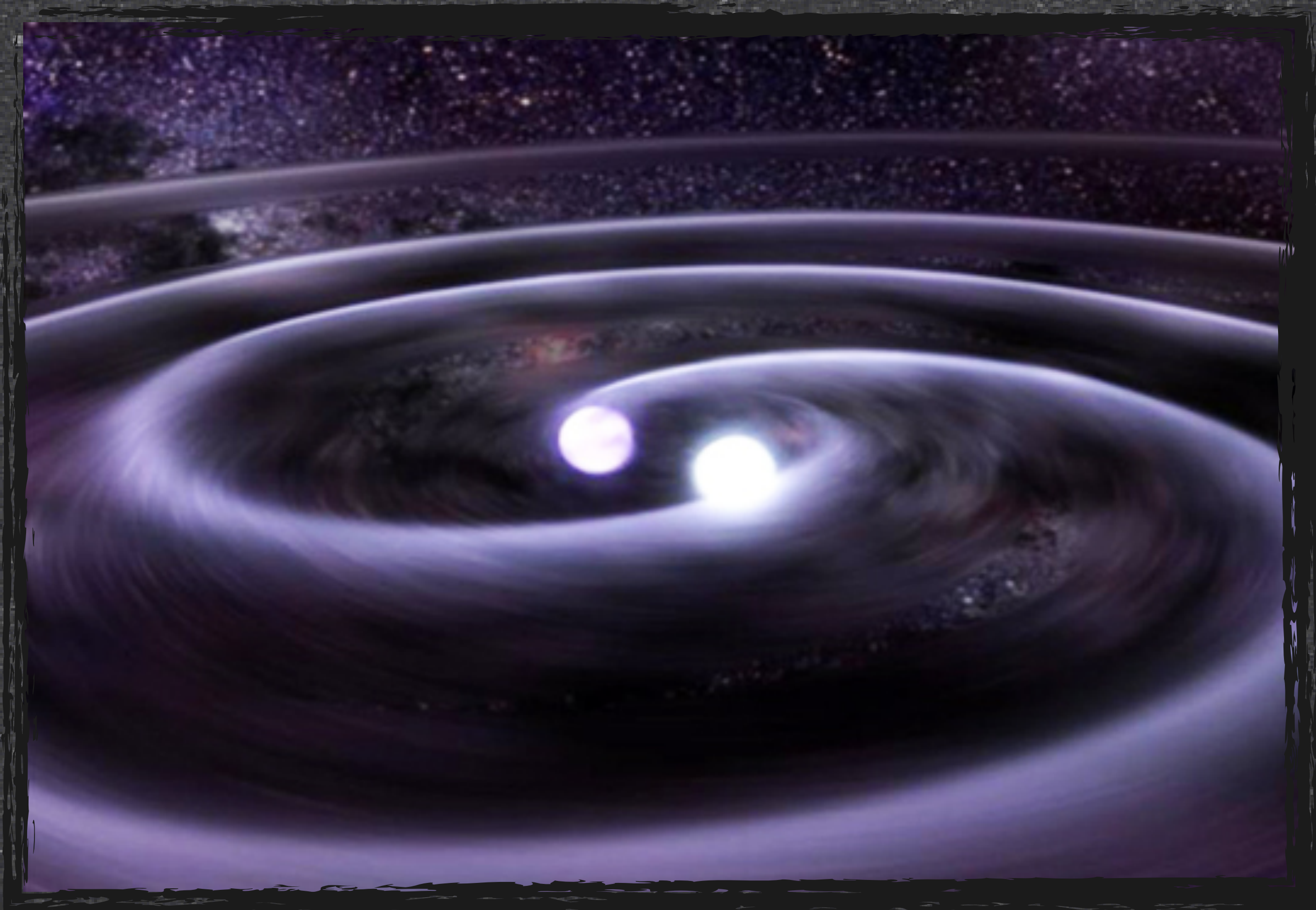
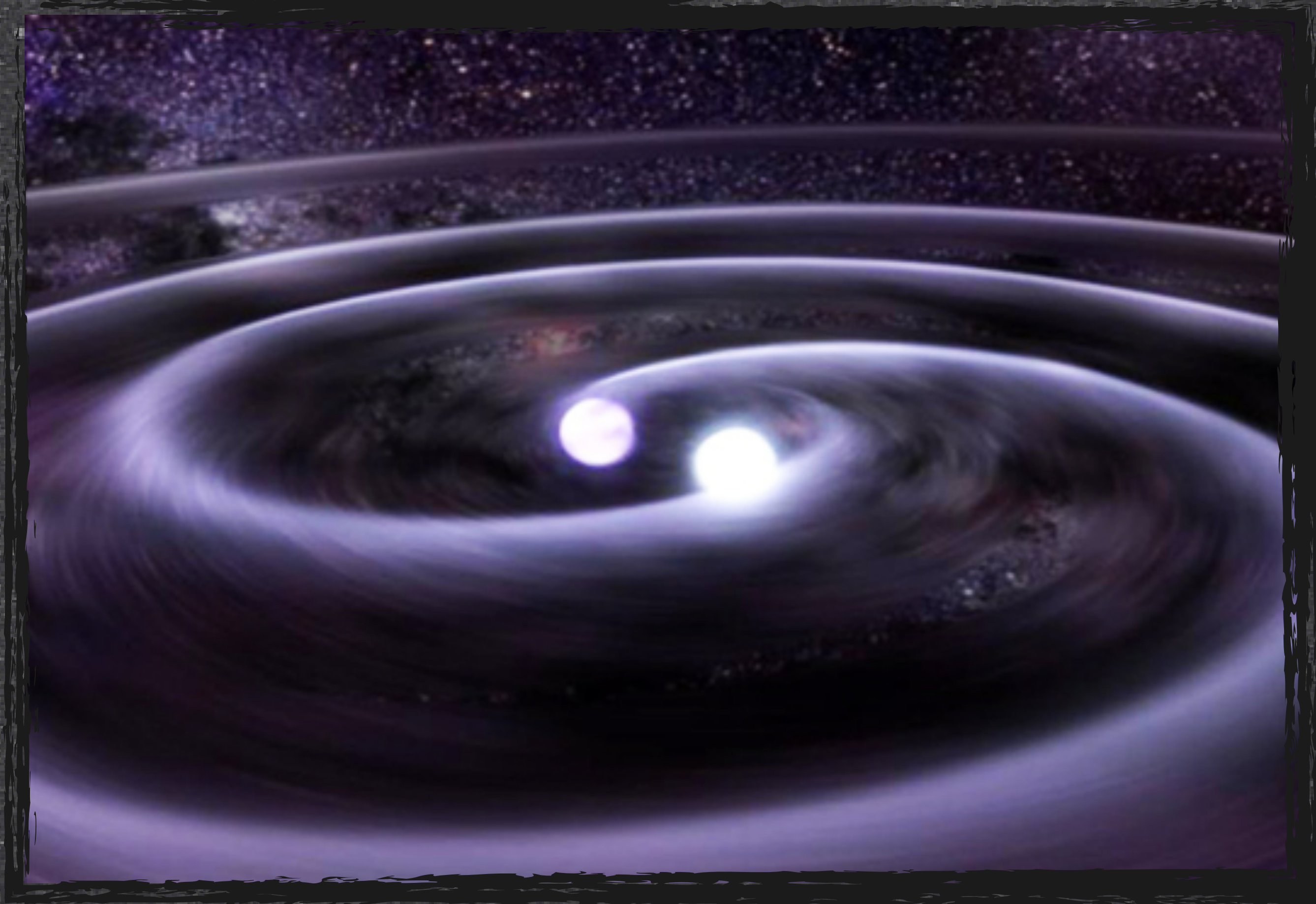


- Nedir bu yoğun mavi yıldızlar?



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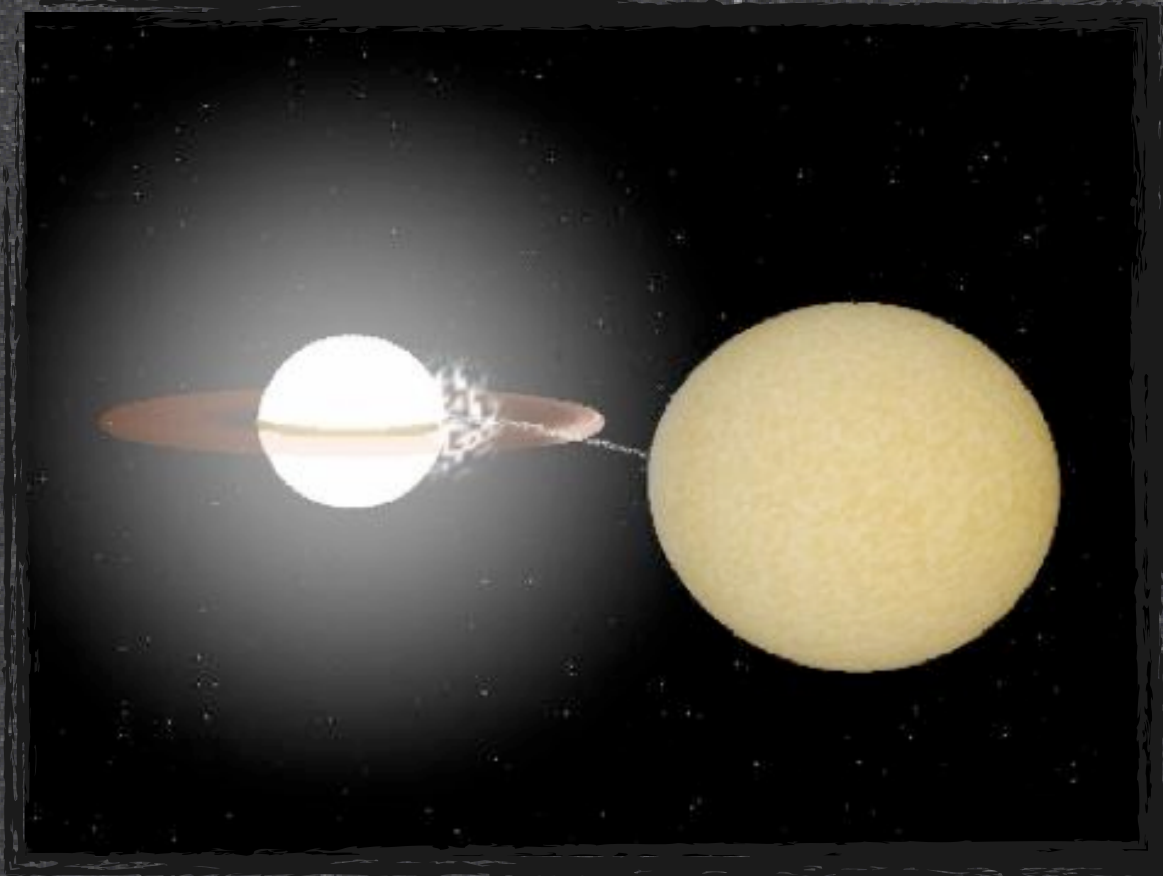

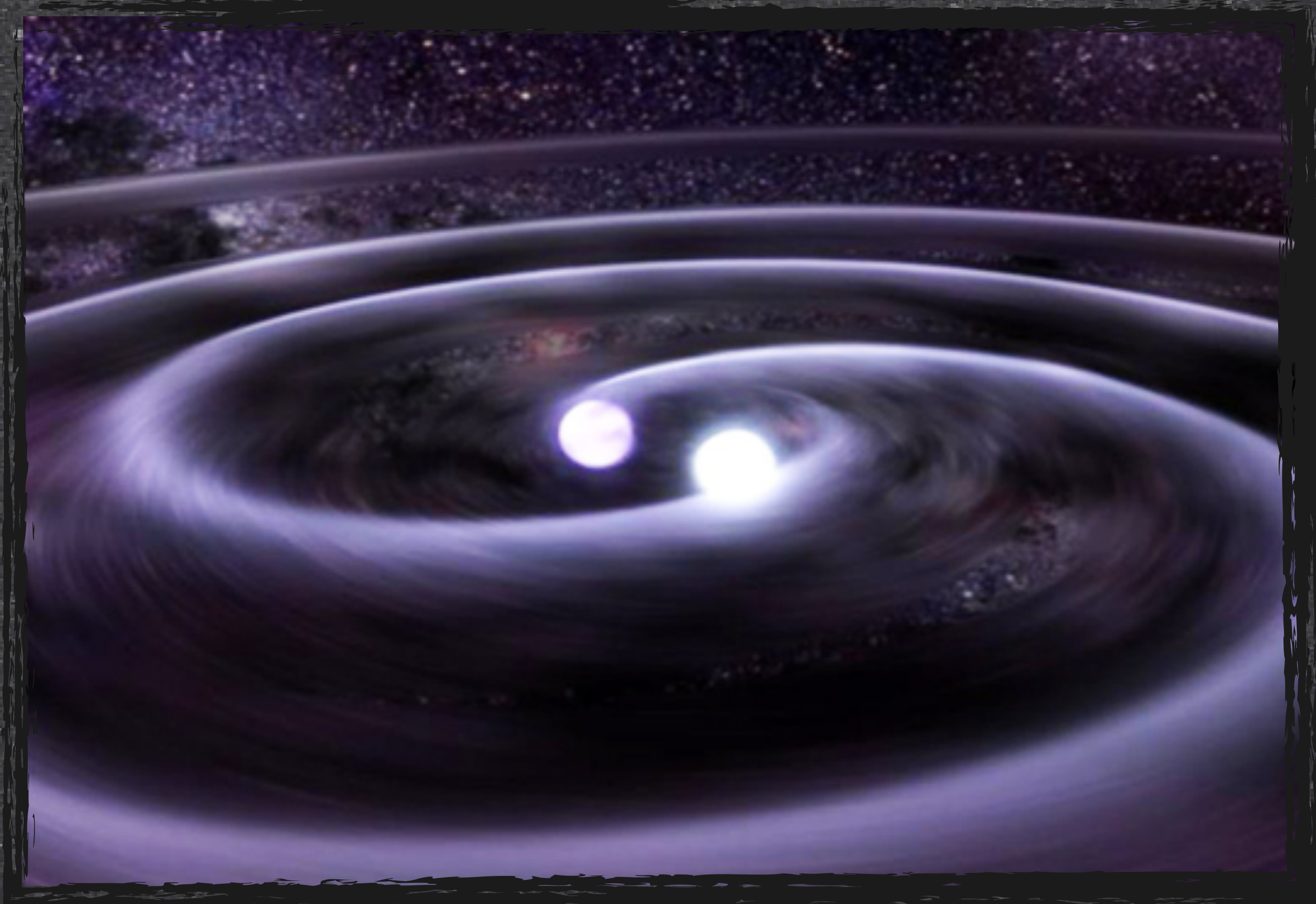

- Bu cisimler neden önemli?

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- AM CVn'leri bulmak
- Popülasyon yoğunlukları
- Kütleçekimsel ışınım

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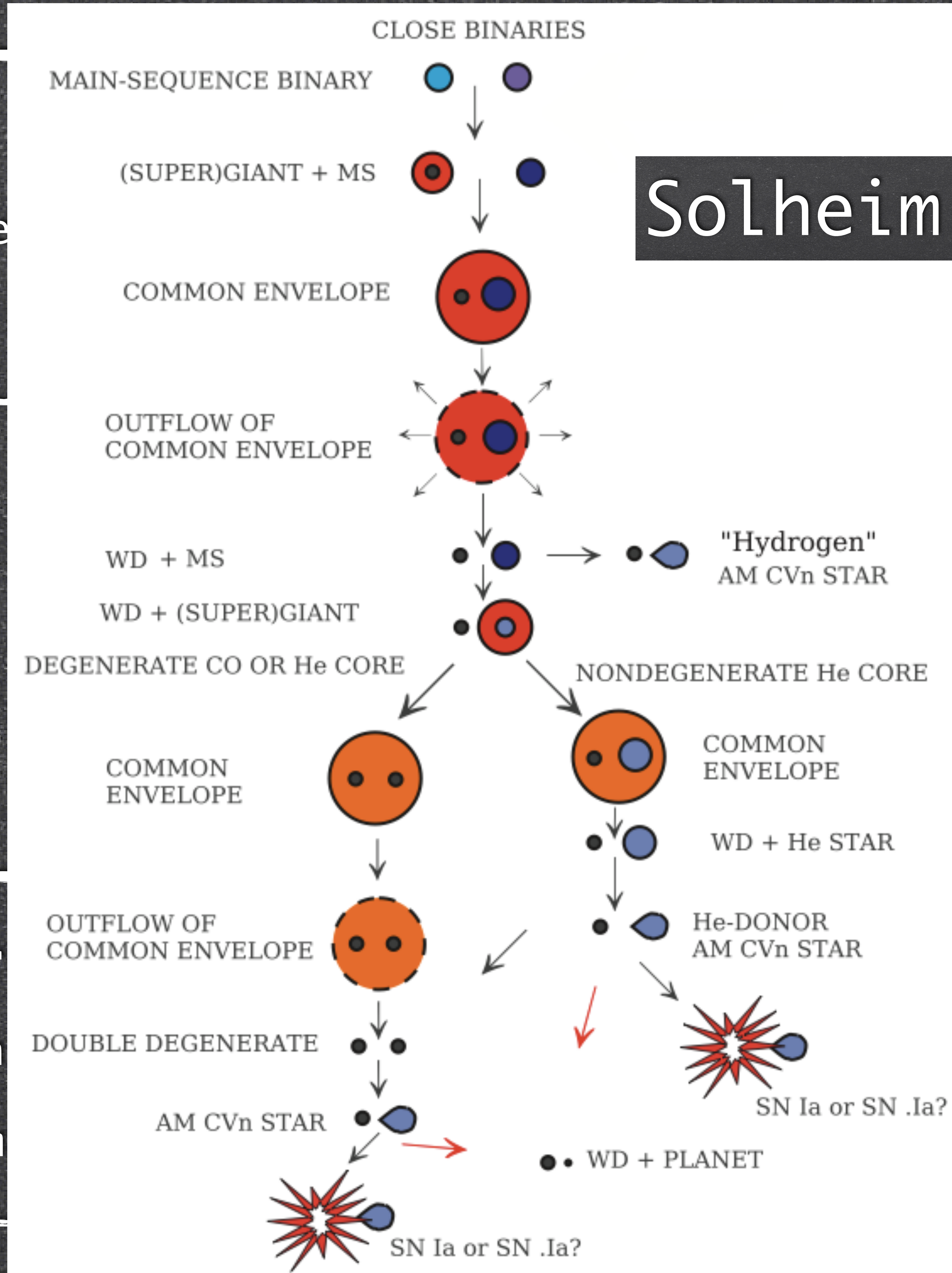
- Çift yıldızların evrimi
- Ortak zarf evresi

- AM CVn'leri bulmak
- Popülasyon yoğunlukları
- Kütleçekimsel ışınım

- Bu cisimle



Solheim 2010

vrimi

- AM CVn'ler
- Popülasyon
- Kütleçekim

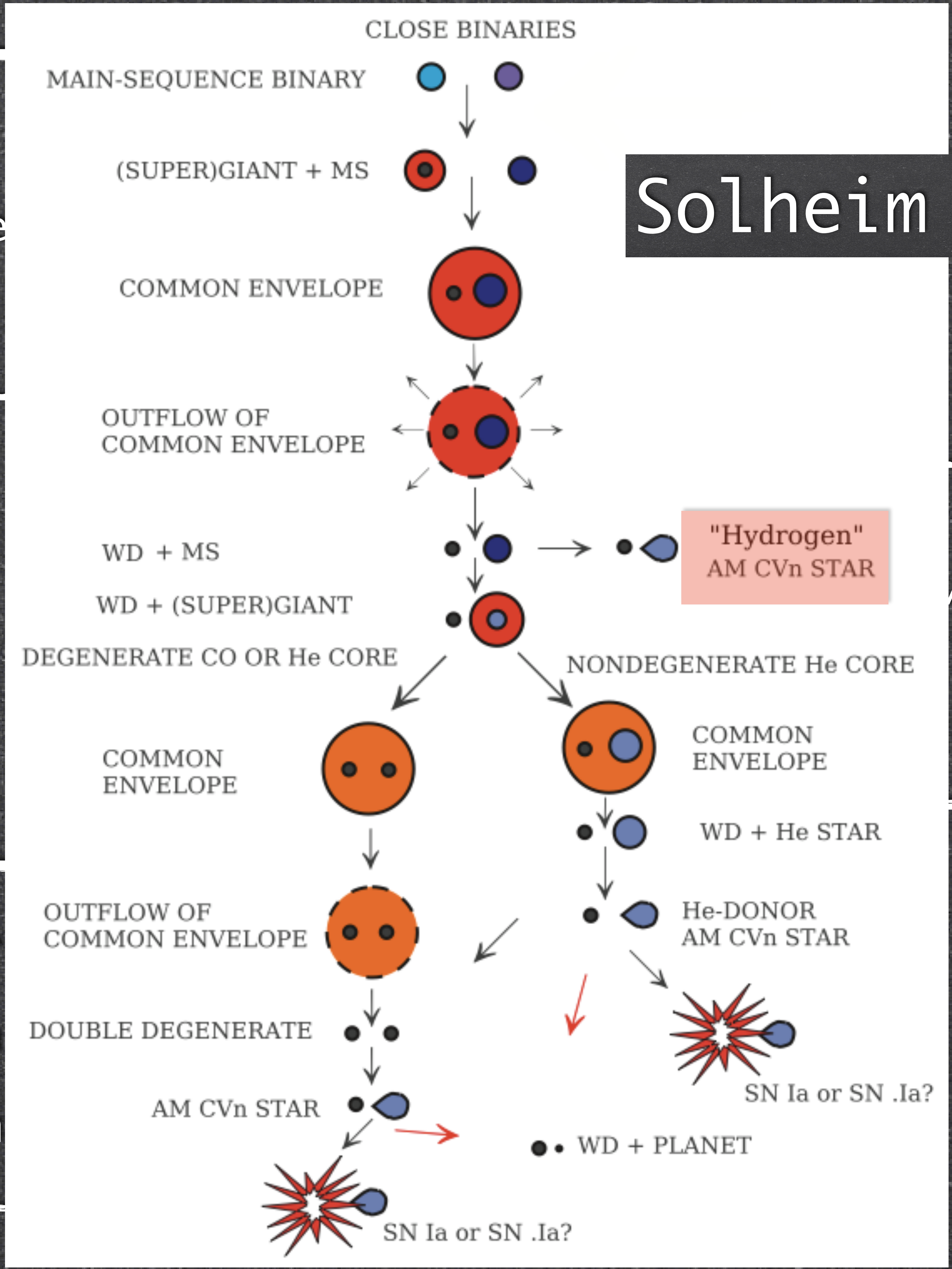
Bu cisimle

AM CVn’ler

Popülasyon

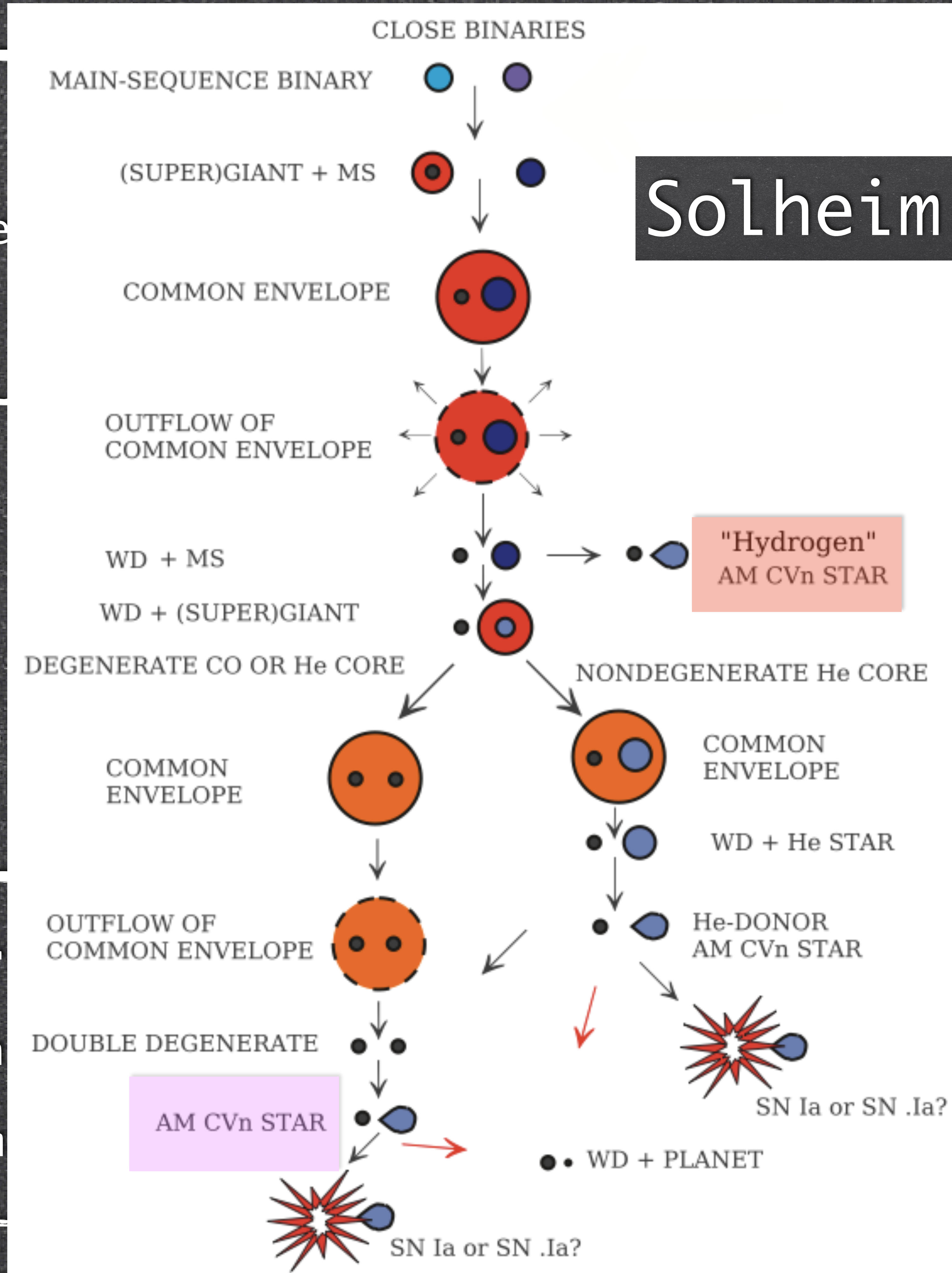
Kütleçekim

vrimi



Solheim 2010

- Bu cisimle



Solheim 2010

rimi

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Bu cisimle

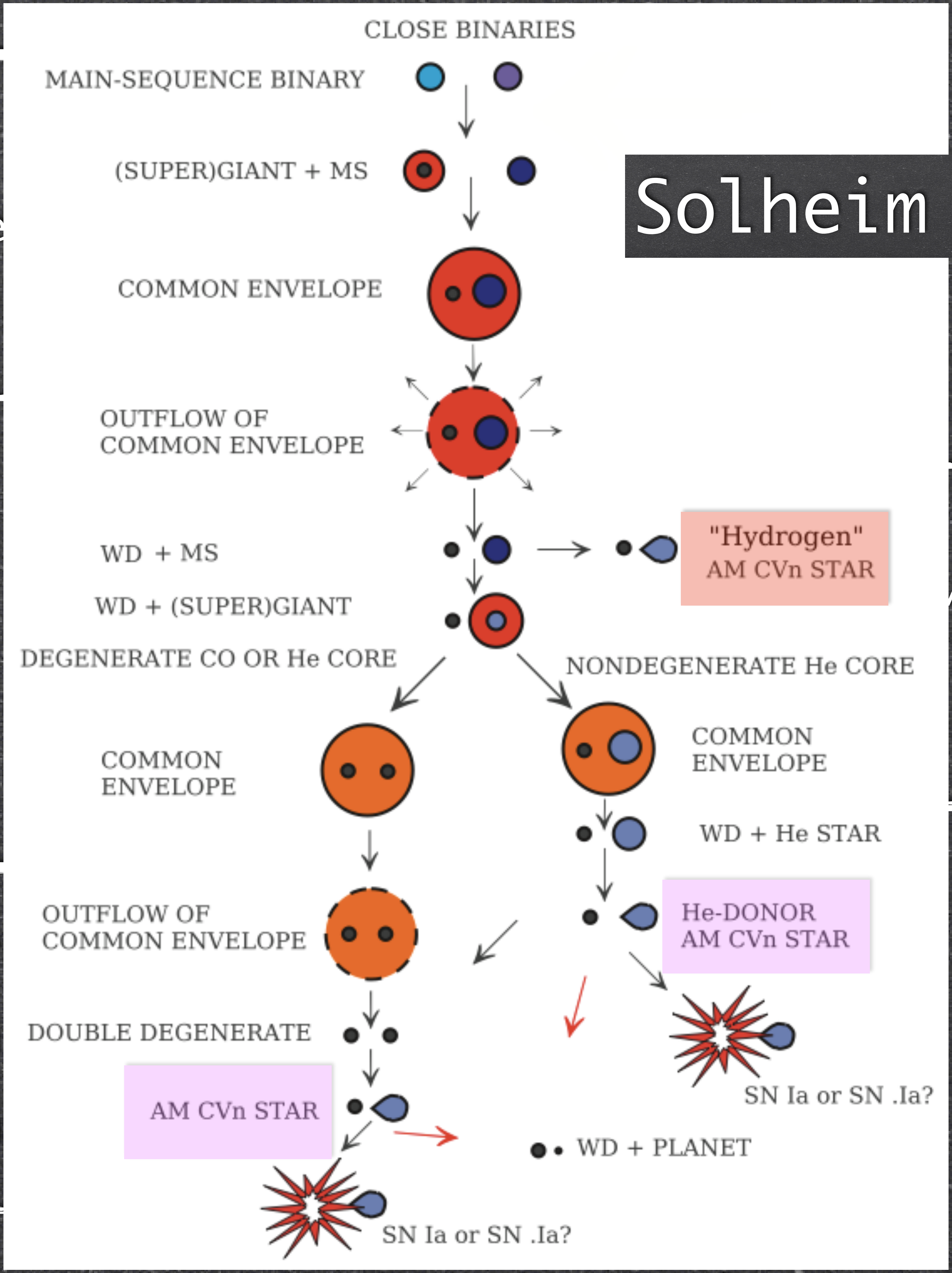
AM CVn'ler

Popülasyon

Kütleçekim

yrimi

Solheim 2010



- Nasıl buluyoruz bu cisimleri?

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RATS projesi

RApid Temporal Survey

- Nasıl ~~buluyoruz~~ ARADIK bu cisimleri?

RATS projesi

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RATS projesi

RApid Temporal Survey

Neden?

- AM Cvn sistemlerinin uzay yoğunluğunu araştırmak

Ne?

- Yaklaşık 40 deg^2
- Beyaz ışık ve 5 filtre (WUBVg'r')
- ~3 milyon yıldız, %4 değişen, %1<40min

Nasıl?

- Her bir bölge, 2 saat boyunca 30snlik pozlarla

Ne zaman?

- Observations are taken between 2003-2010

See Barclay et al. (2011) for further details

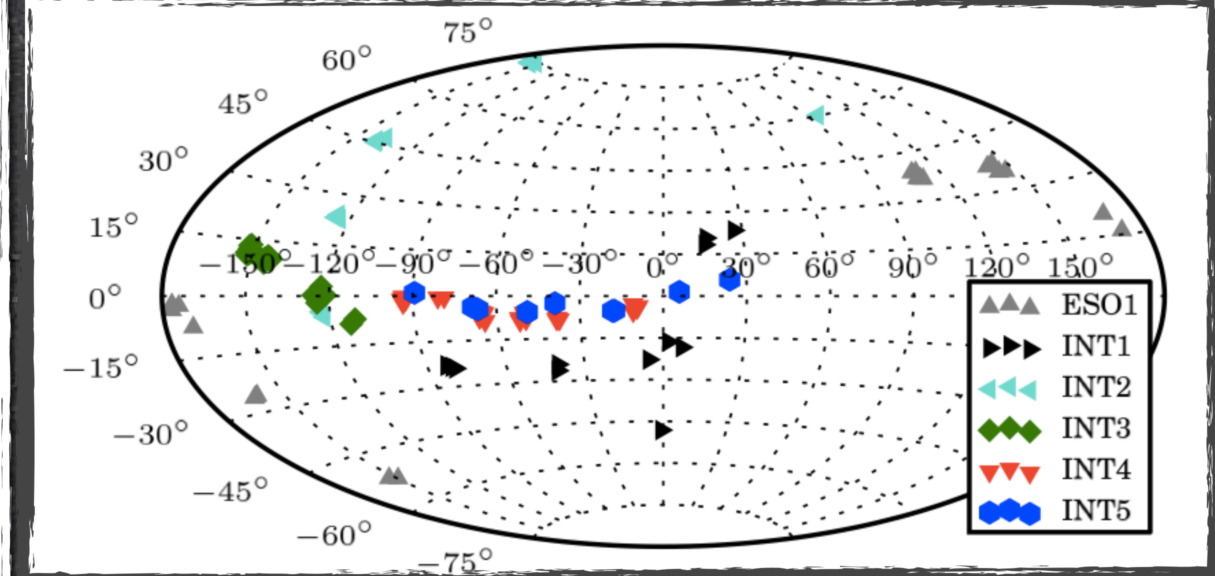

Figure 1. The position of the field centres of all the fields observed during the first five years of the RATS project. The fields are plotted in Galactic coordinates using an Aitoff projection. Many of the fields are spatially close and so appear as only a single point in this figure.

- Nasıl buluyoruz bu cisimleri?

RATS project

RApid Temporal Survey

Survey	Cadence	Limiting magnitude
RATS	~1 minute	g' = 23
SuperWASP	1 minute - 40 minutes	W = 15
Faint Sky Variability Survey	12 minutes	V = 24
Palomar Transient Factory	1 minute - 5 days	R = 21
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Run	Date	Sq Degrees	Filters	Stars
INT1	2003 Nov 28-30	4	WBVi'	46k
INT2	2005 May 28-31	3.5	WBVi'	234k
ESO1	2005 Jun 03-07	3	WBVi'	750k
INT3	2007 Jun 12-20	6.5	WUg'r'	1224k
INT4	2007 Oct 13-20	7.2	WUg'r'	679k
INT5	2008 Nov 03-09	2.1	WUg'r'	113k
INT6	2009 Oct 09–13	2.5	WUg'r'	384k
INT7	2009 Dec 08–12	2.5	WUg'r'	154k
ESO2	2010 Mar 18–24	4.5	WUBV	531k
INT8	2010 Jun 16–20	4.4	WUg'r'	369k

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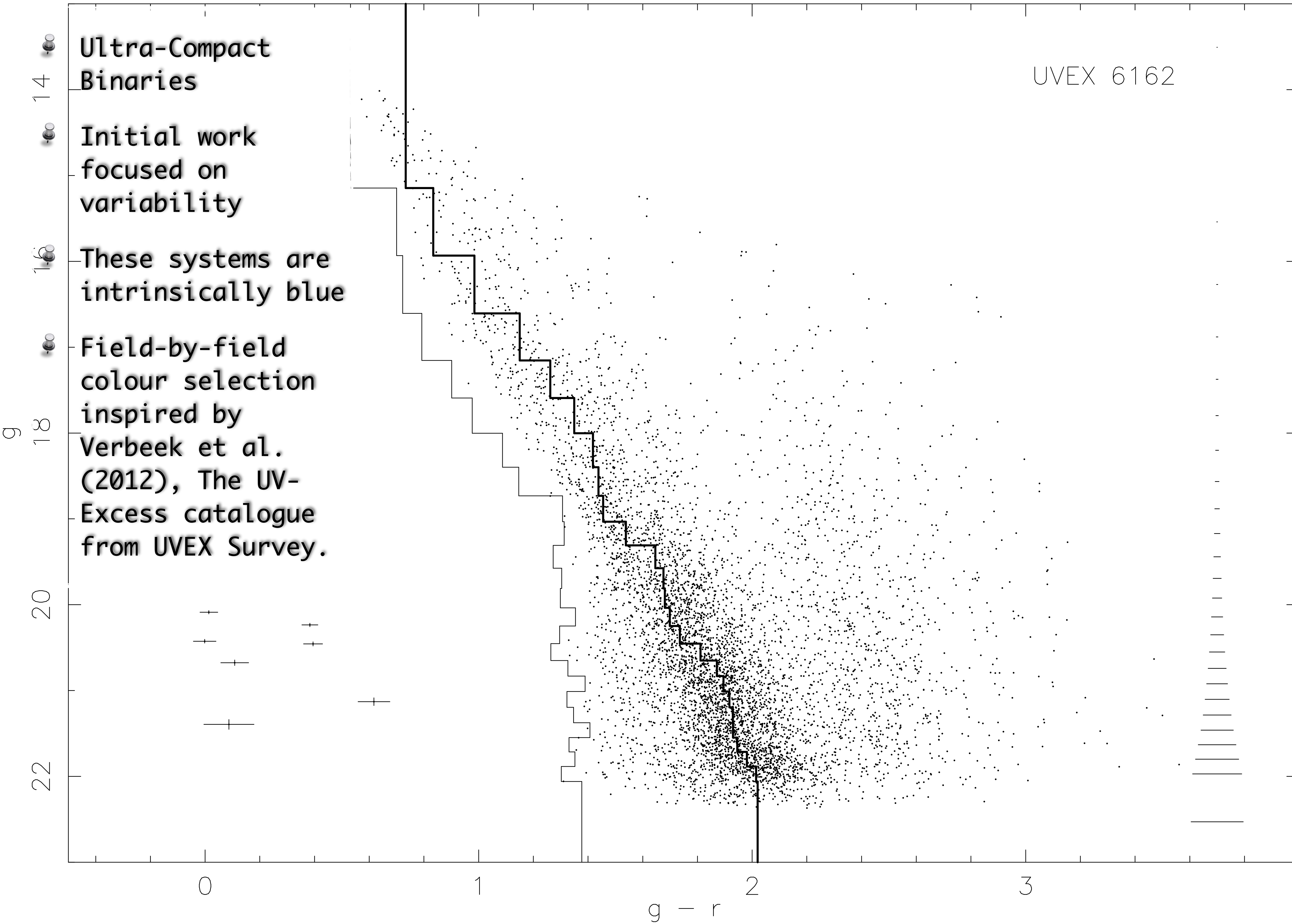
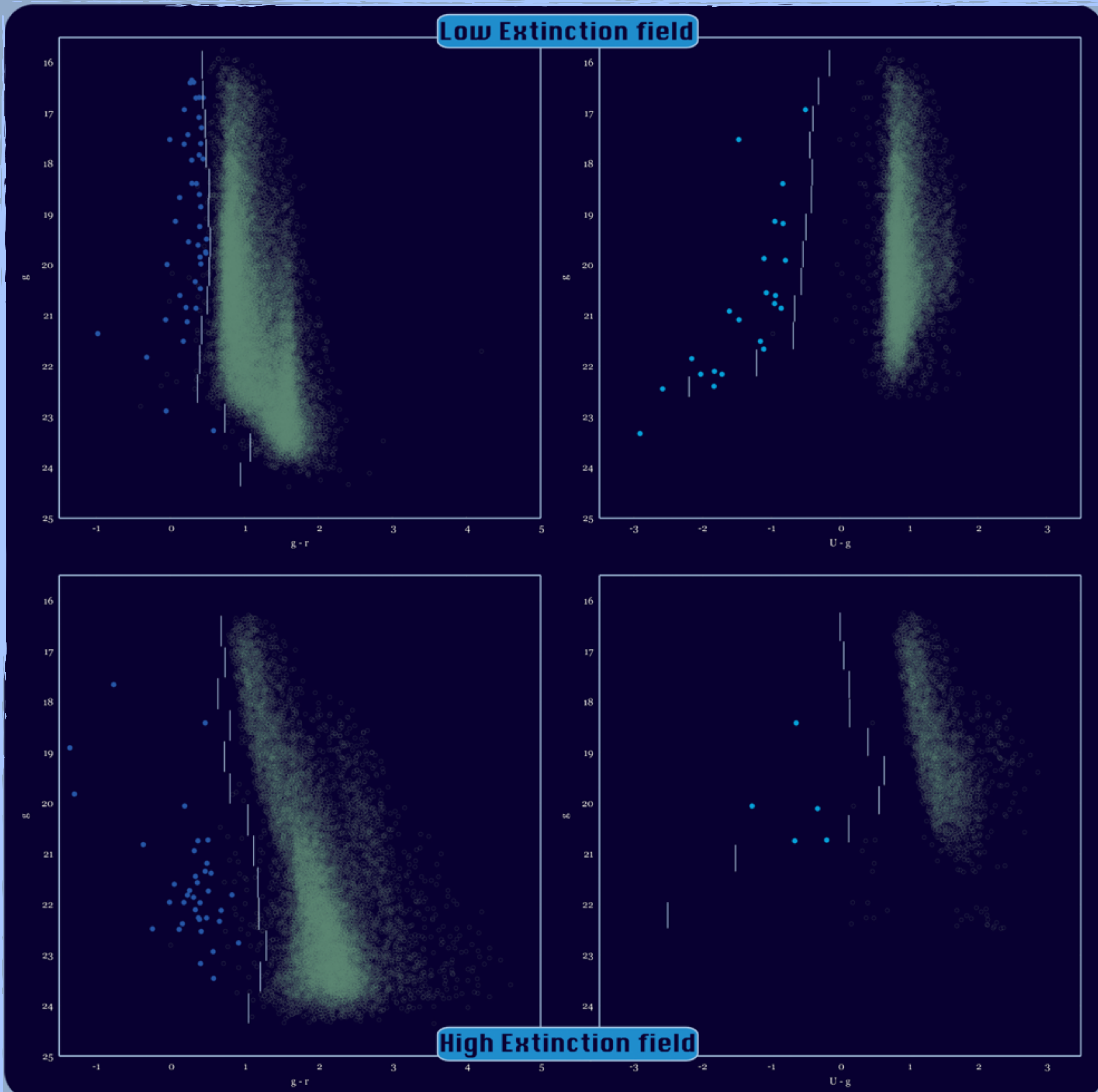
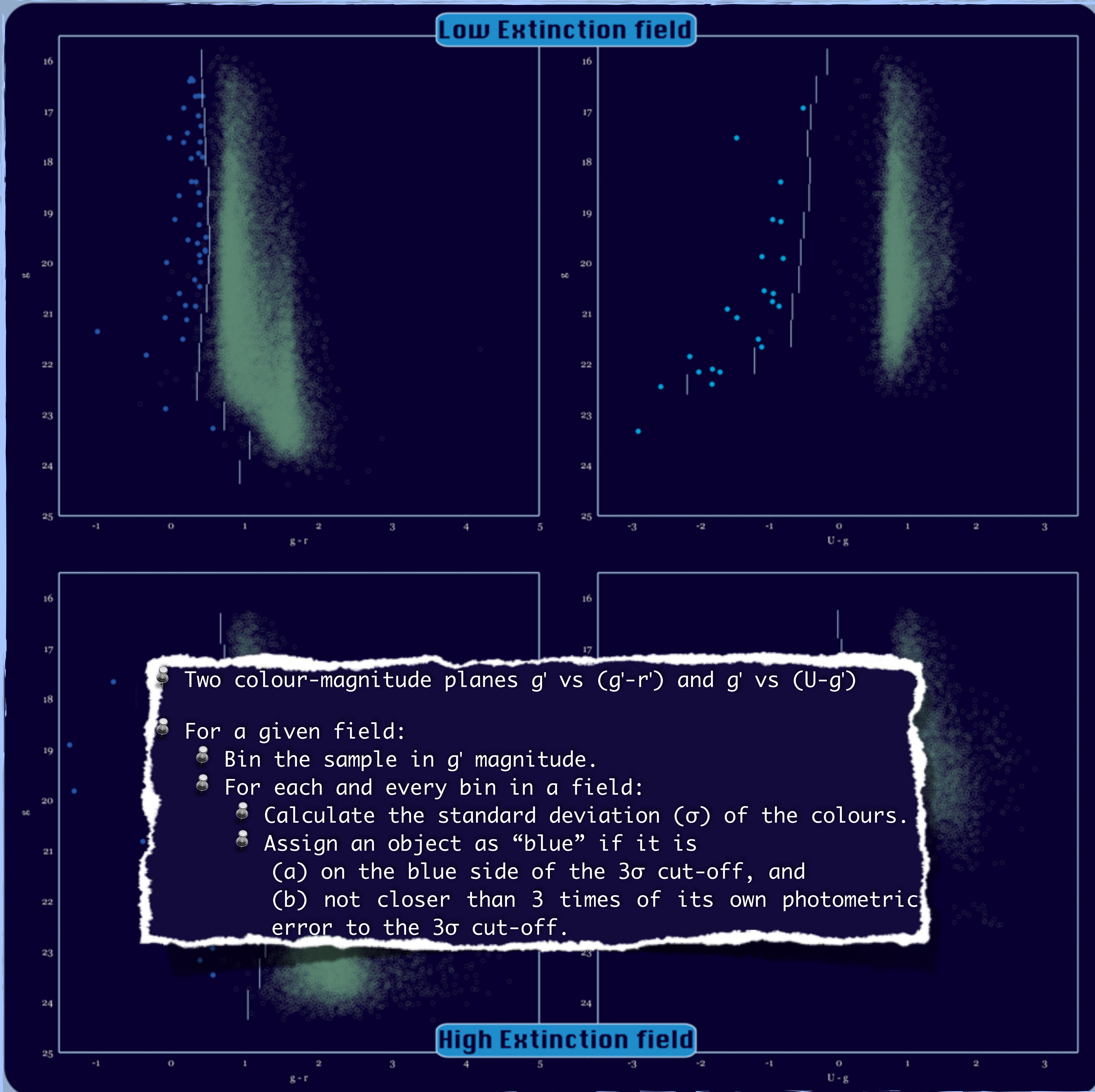
- Field-by-field colour selection inspired by Verbeek et al. (2012), The UV-Excess catalogue from UVEX Survey.

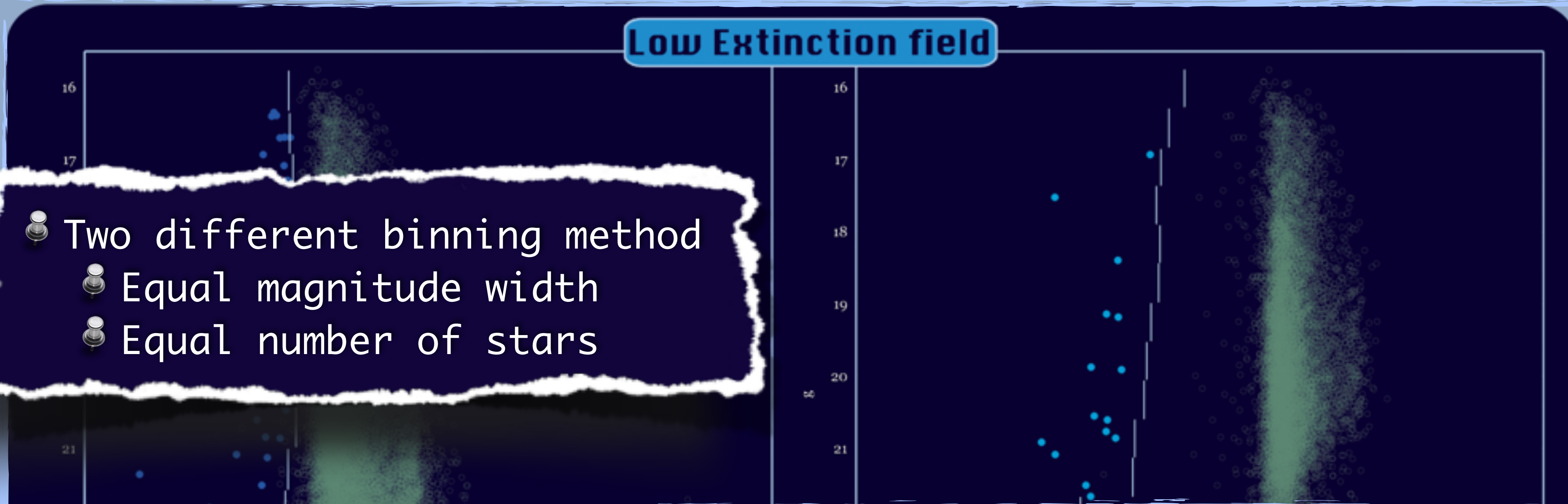




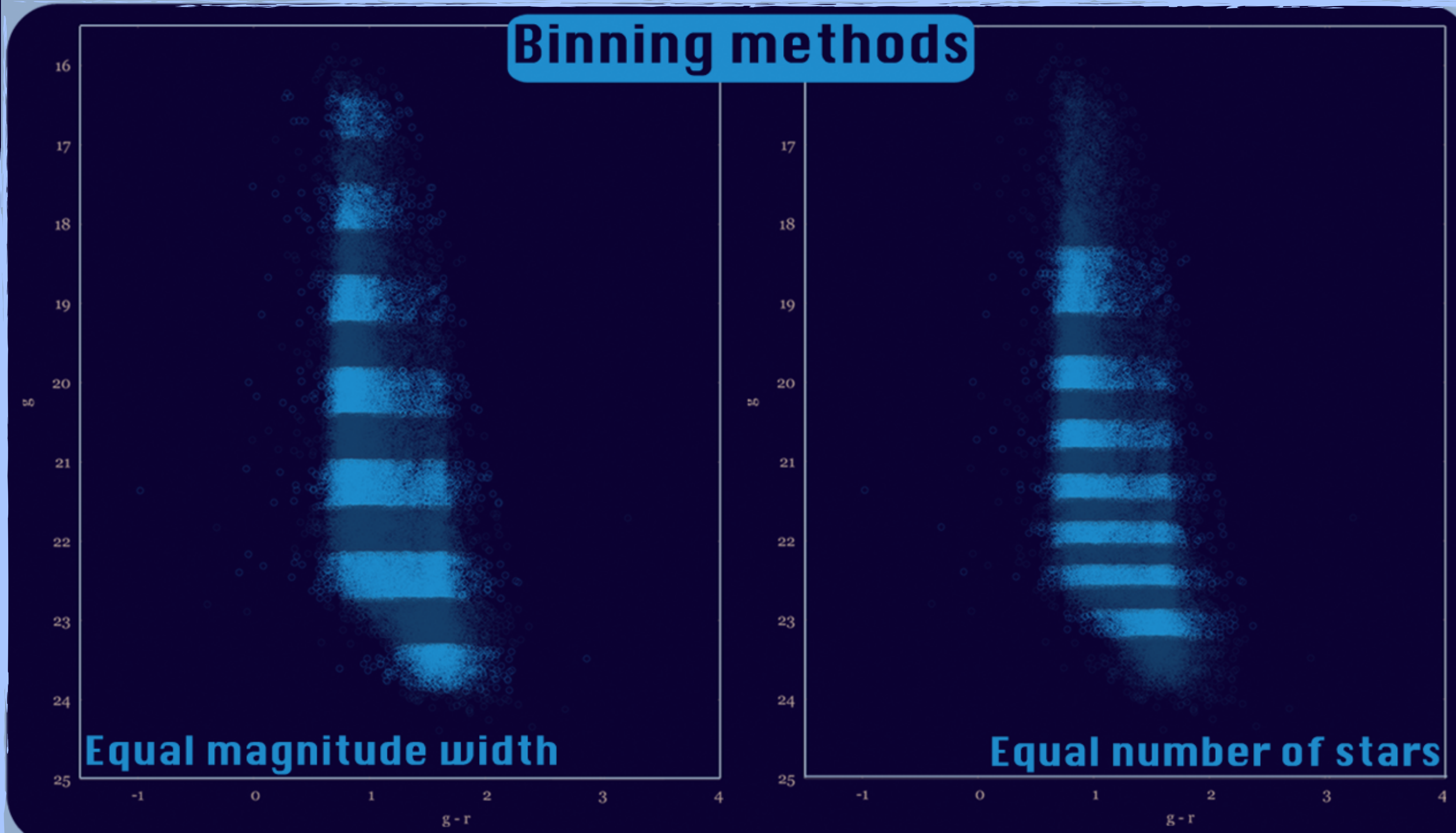
Low Extinction field
High Extinction field
g - r
U - g
g

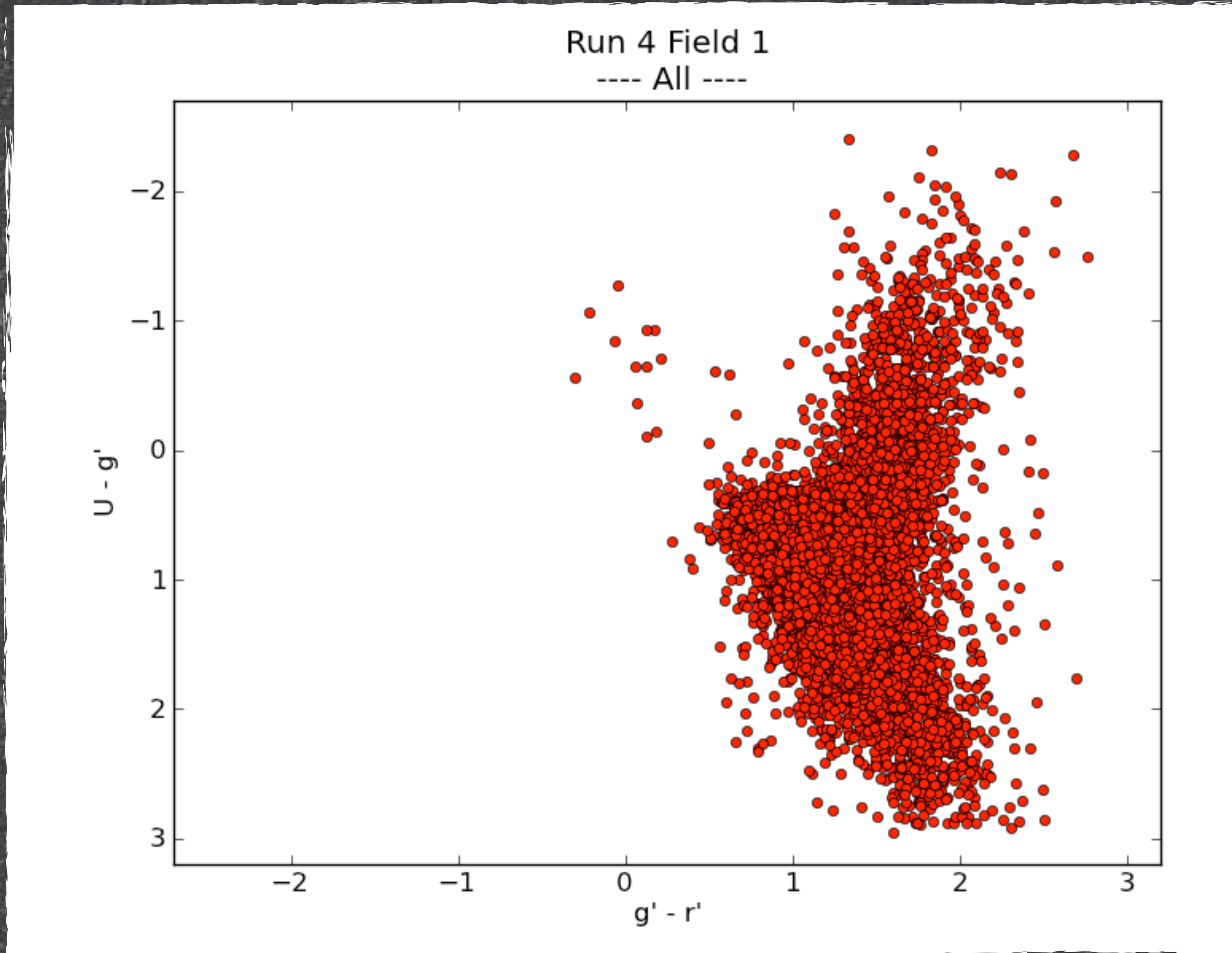


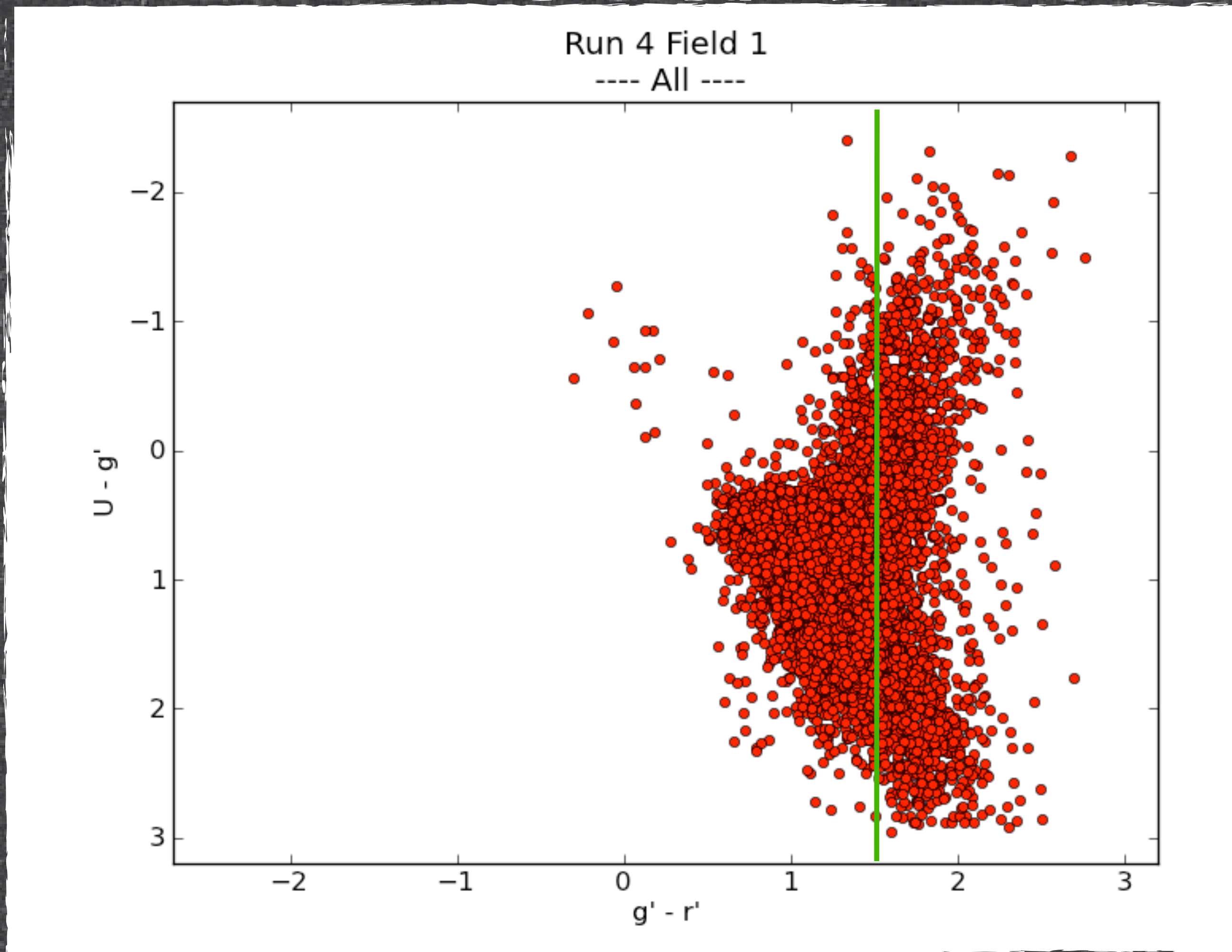
- Two colour-magnitude planes g' vs (g'-r') and g' vs (U-g')
- For a given field:
  - Bin the sample in g' magnitude.
  - For each and every bin in a field:
    - Calculate the standard deviation (σ) of the colours.
    - Assign an object as "blue" if it is
      (a) on the blue side of the 3σ cut-off, and
      (b) not closer than 3 times of its own photometric error to the 3σ cut-off.

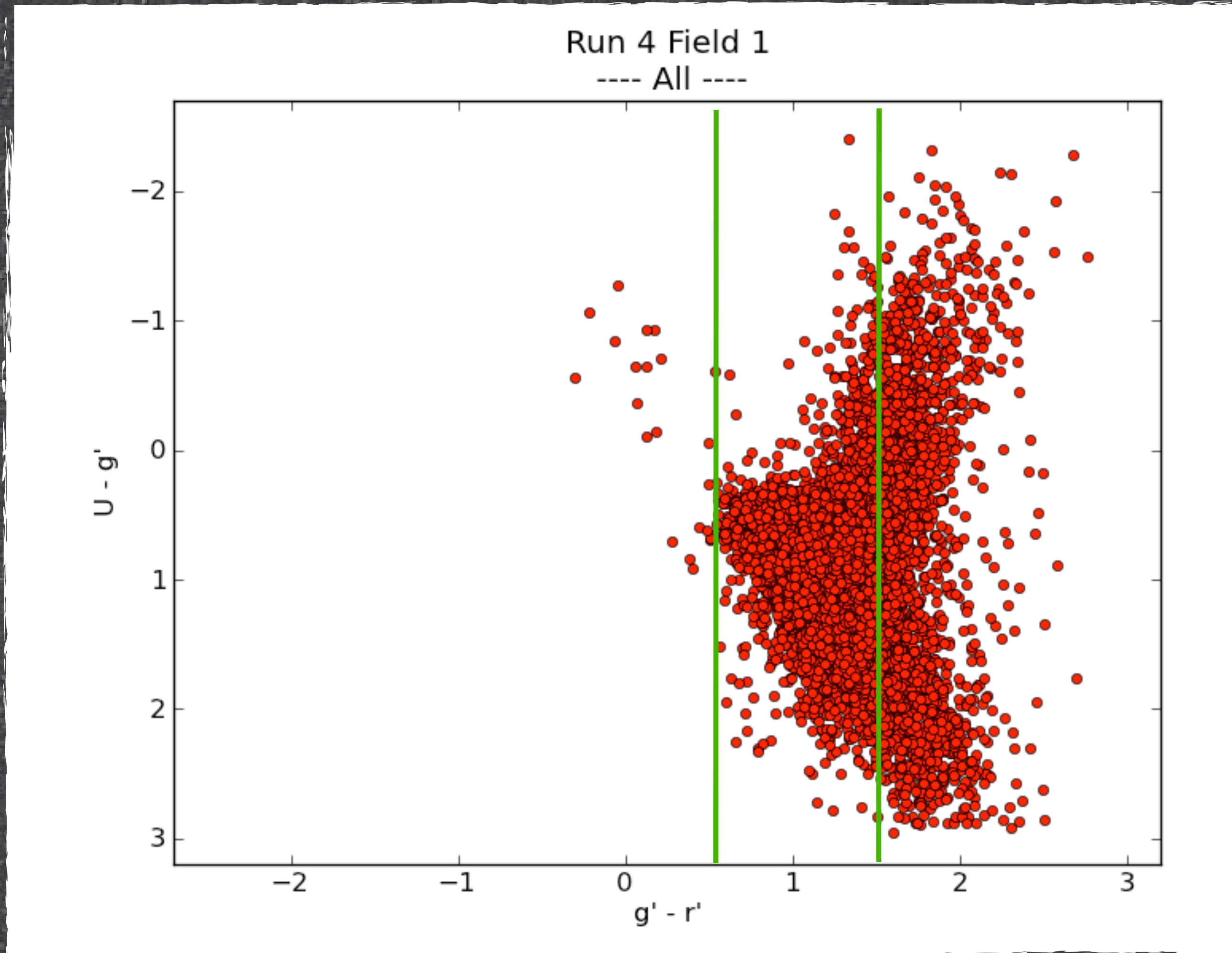


- Two different binning method
  - Equal magnitude width
  - Equal number of stars




Run 4 Field 1
---- All ----
U - g'
g' - r'
−2
−1
0
1
2
3
−2
−1
0
1
2
3


Run 4 Field 1
---- All ----
U - g'
g' - r'
−2
−1
0
1
2
3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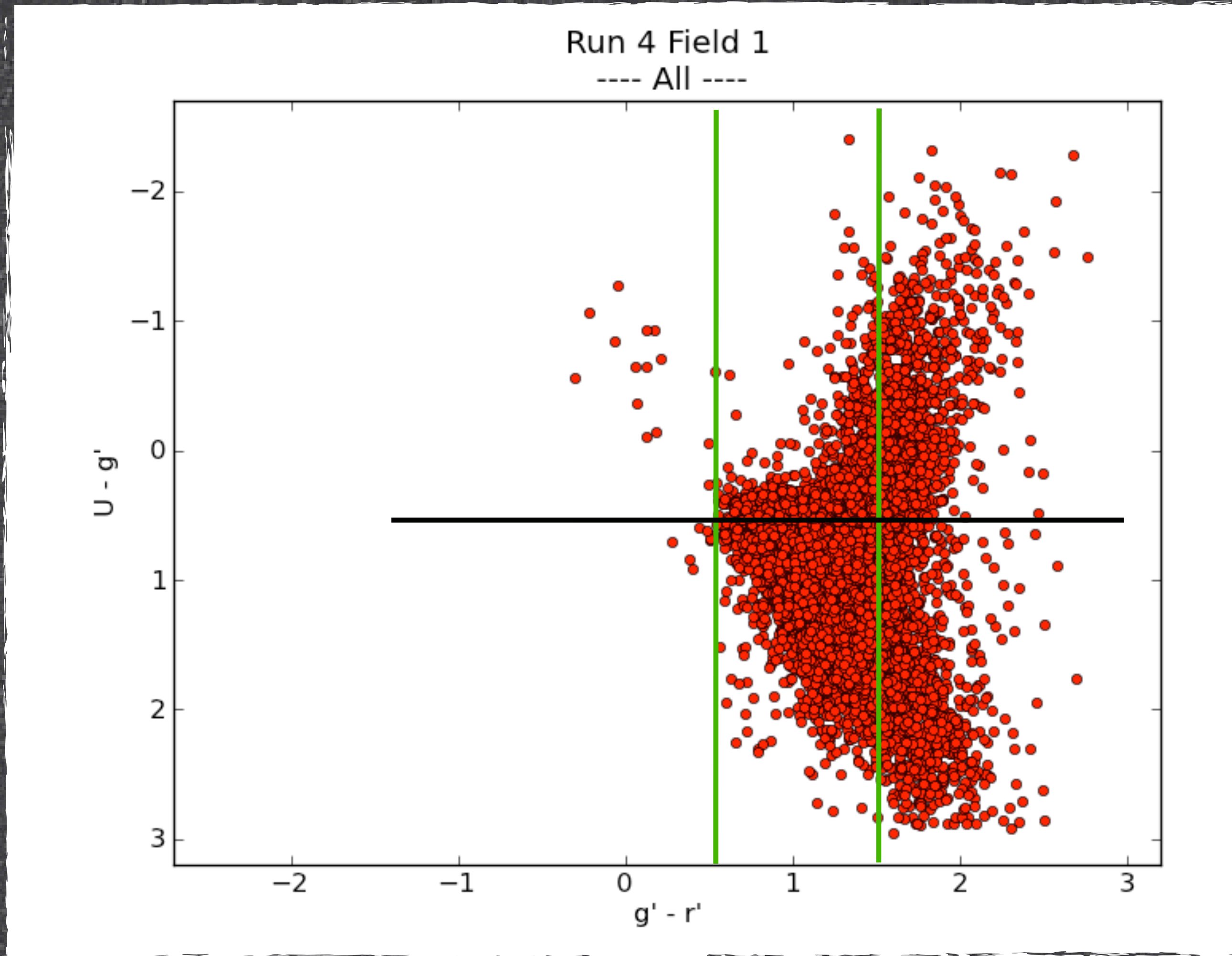
U - g'
g' - r'
−2
−1
0
1
2
3
−2
−1
0
1
2
3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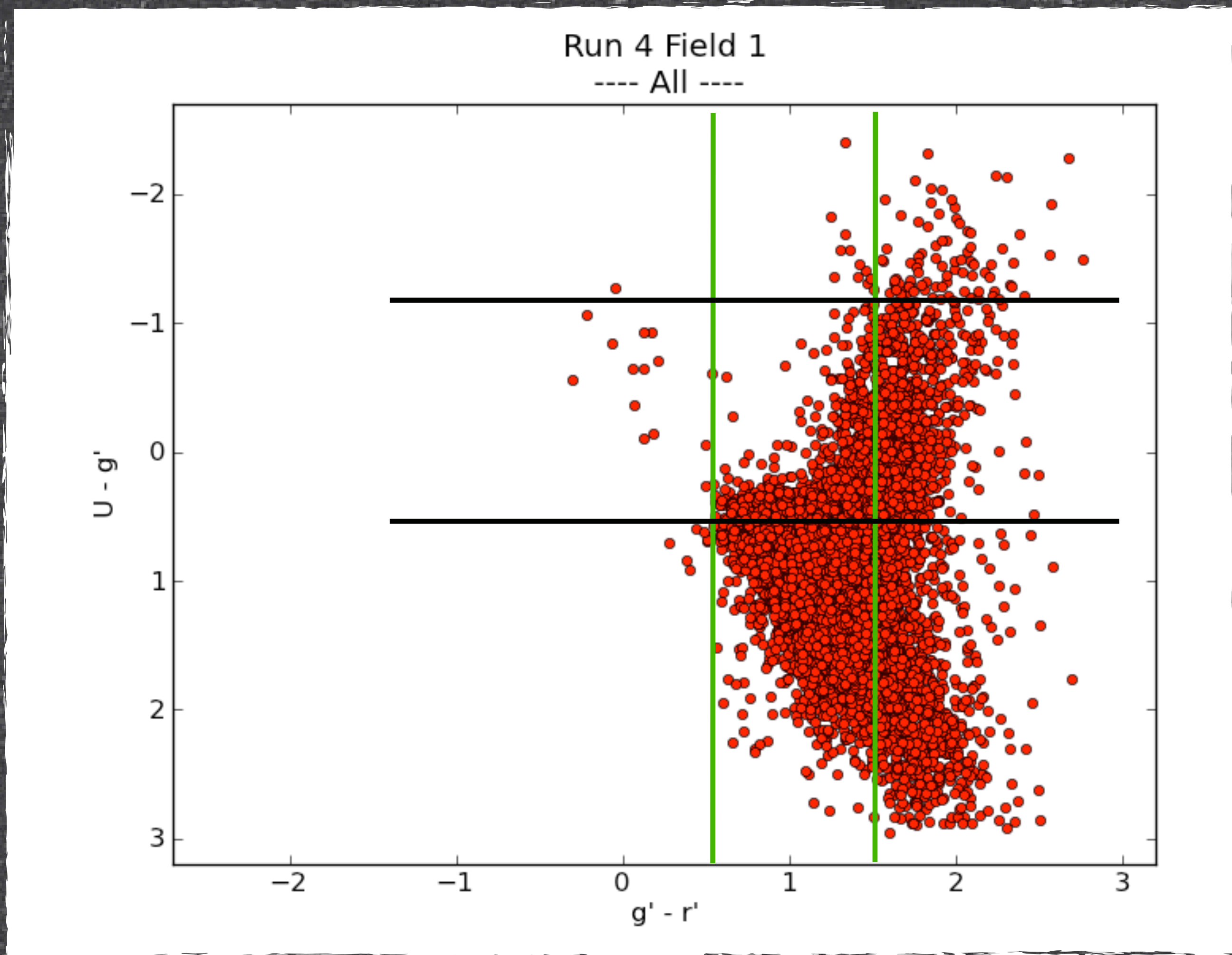
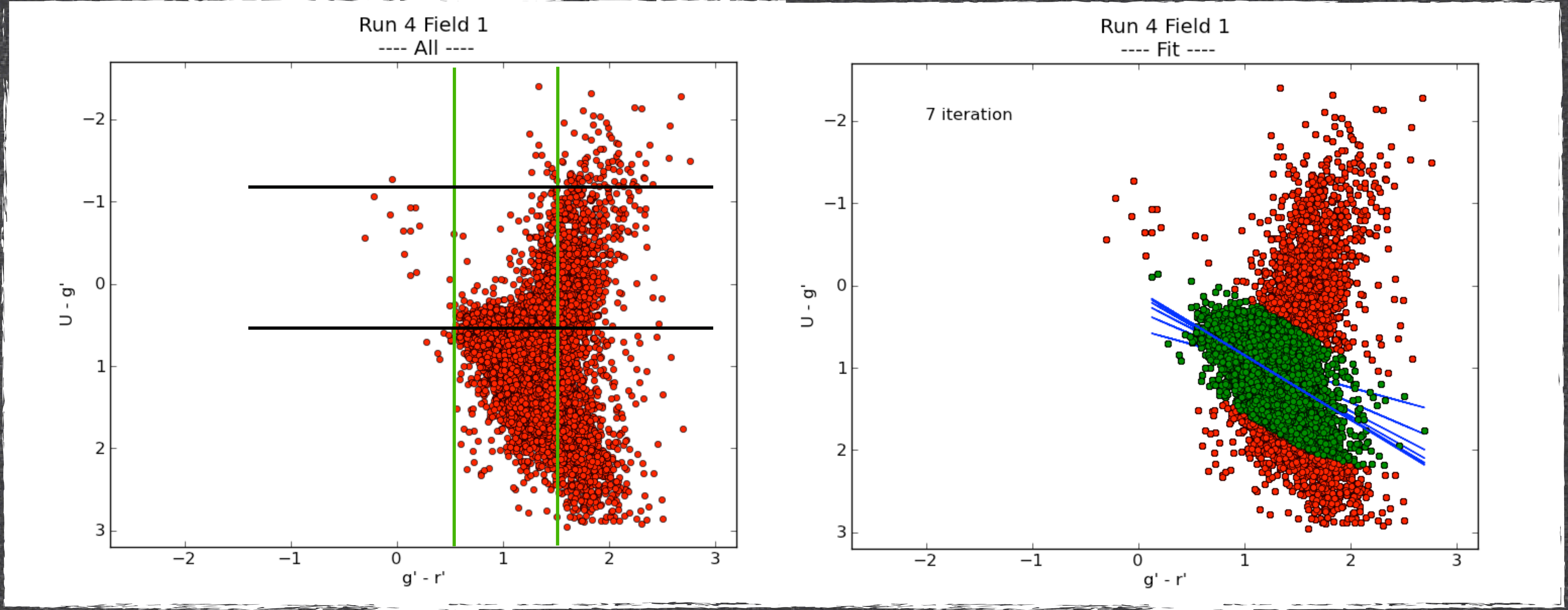
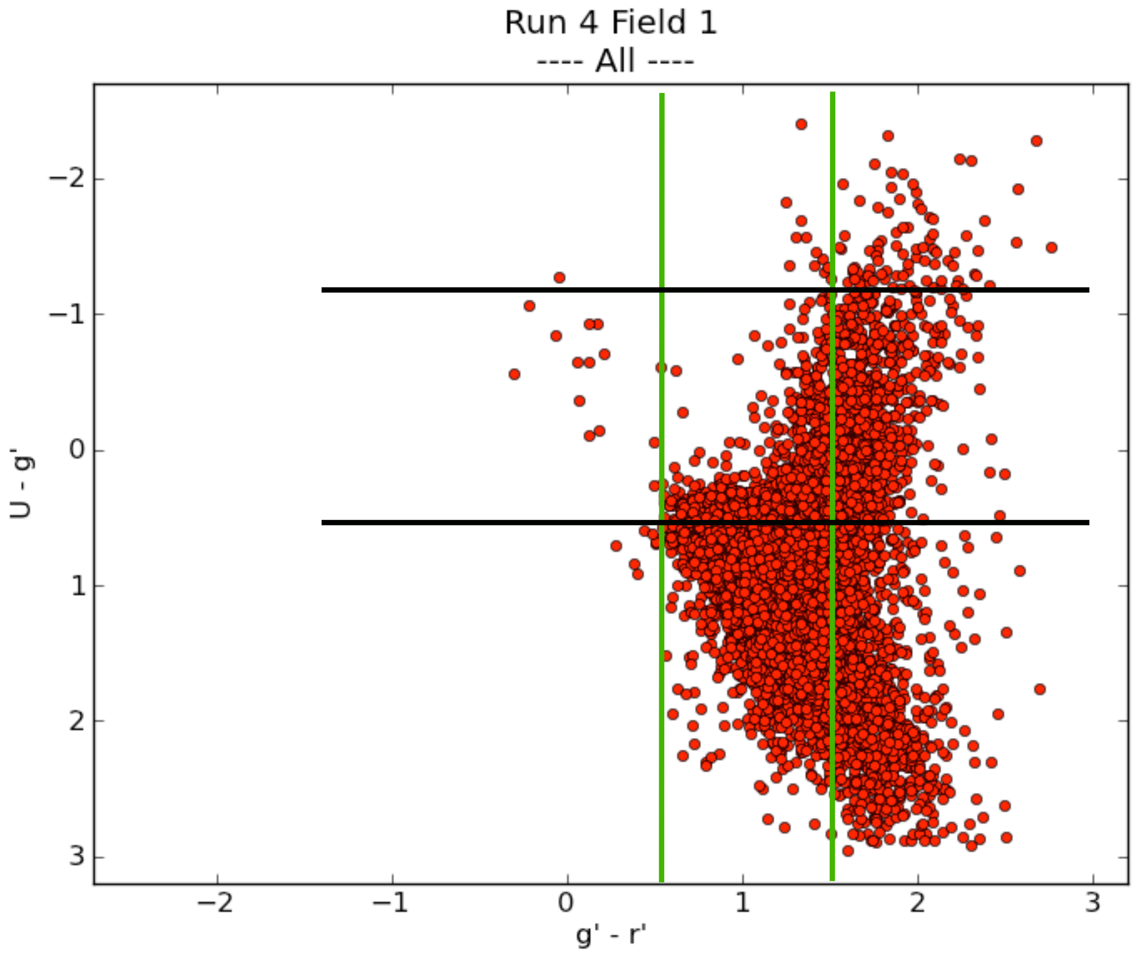
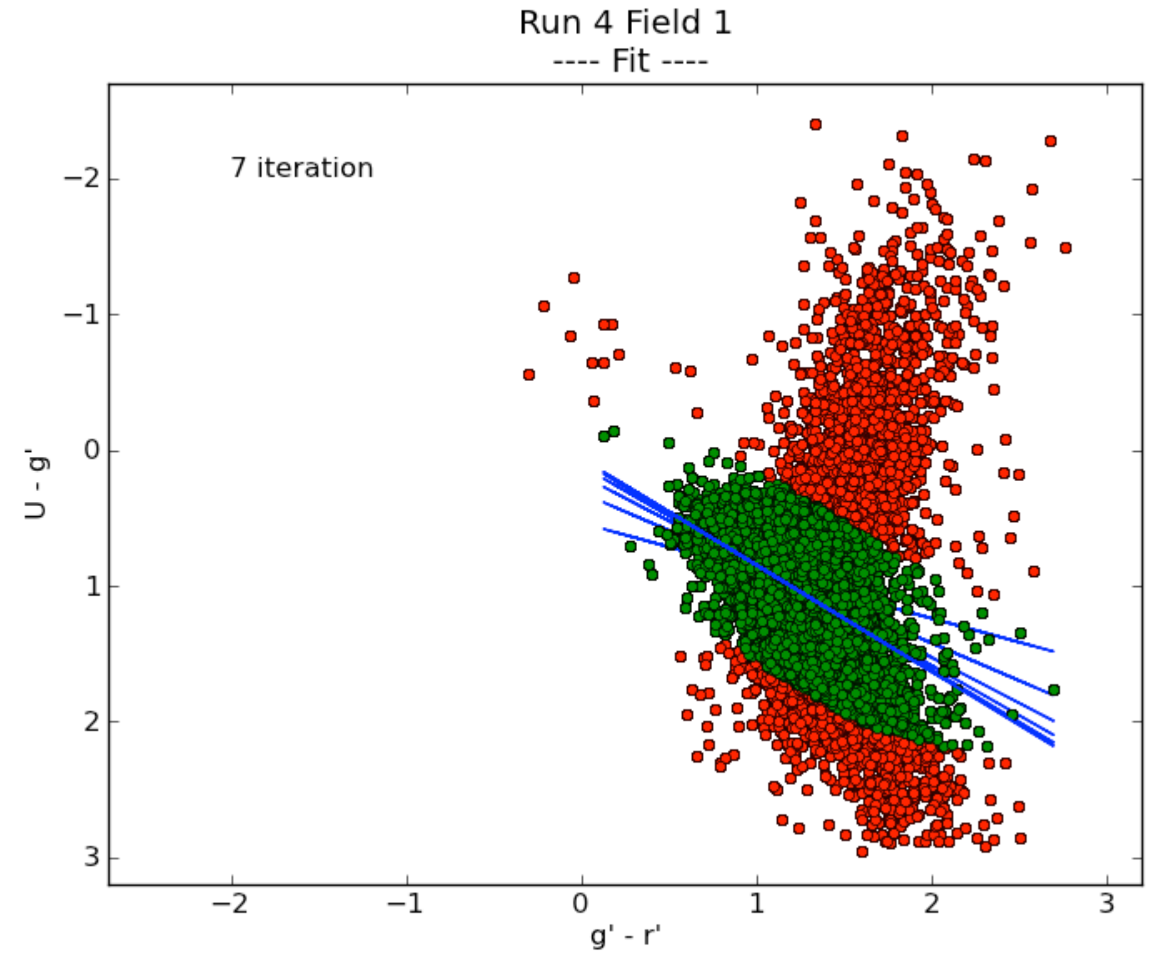
---- All ----
U - g'
g' - r'
−2
−1
0
1
2
3

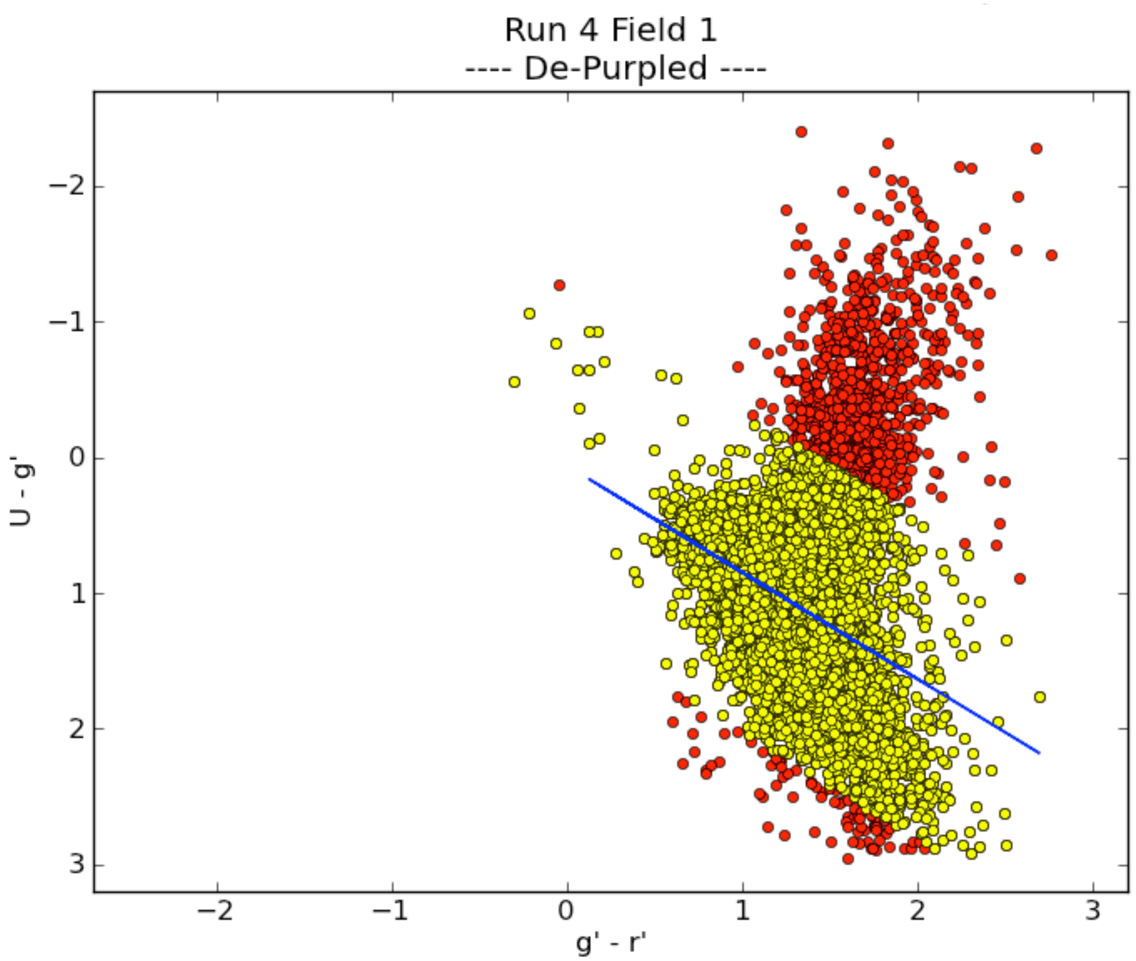

Run 4 Field 1
---- All ----
U - g'
g' - r'
−2
−1
0
1
2
3

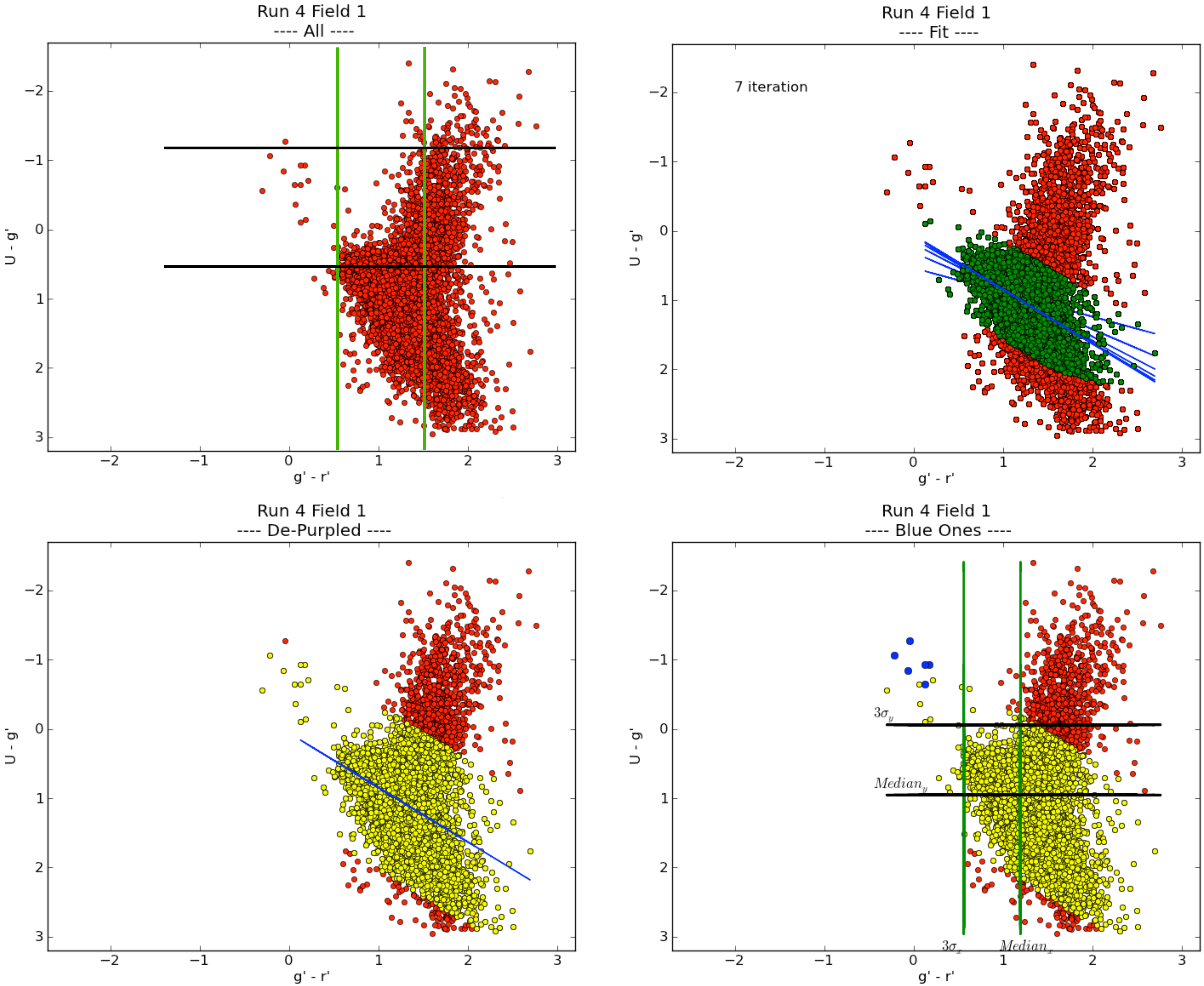


Run 4 Field 1
---- All ----
U - g'
g' - r'
Run 4 Field 1
---- Fit ----
7 iteration
U - g'
g' - r'


Run 4 Field 1
---- All ----
U - g'
g' - r'


Run 4 Field 1
---- Fit ----
7 iteration
U - g'
g' - r'


Run 4 Field 1
---- De-Purpled ----
U - g'
g' - r'


Run 4 Field 1
---- All ----
U - g'
g' - r'
Run 4 Field 1
---- Fit ----
7 iteration
U - g'
g' - r'
Run 4 Field 1
---- De-Purpled ----
U - g'
g' - r'
Run 4 Field 1
---- Blue Ones ----
$3\sigma_y$
$Median_y$
$3\sigma_x$
$Median_x$
U - g'
g' - r'

Eye-balling

Eye-balling

```
import os
import subprocess as s
import sys

run    = sys.argv[1].split(" ")[0]
field  = sys.argv[1].split(" ")[1]
chip   = sys.argv[2]
x      = sys.argv[3].split(" ")[0]
y      = sys.argv[3].split(" ")[1]

# run '3' --> '03'
# No worries, these are strings :)
if len(run)==1:
    run='0'+run

# field '7' --> '07'
if len(field)==1:
    field='0'+field

img_list = s.check_output(['ls -r /home/osa/Work/wcs-images/r%sfield%s-*_%s-wcs.fits' %(run,field,chip)], shell=True).splitlines()

ds9_cmd = 'ds9 -geometry 780x960 -tile -scale linear -scale mode zscale'

opts = '-pan to %s %s -regions command "circle %s %s 15 # color=green"' %(x,y,x,y)

for img in img_list:
    ds9_cmd = ds9_cmd + ' ' + img + ' ' + opts

#ds9_cmd = ds9_cmd + ' -mode crosshair -crosshair lock wcs'

print '''

+++%s


=====================================================
''' %ds9_cmd

os.system('%s &' %ds9_cmd) #using & gives you the freedom keep going
                           #without closing ds9 window, compare two
                           #(or how many you want) star for example.
                           #This way it doesn't block topcat.
```

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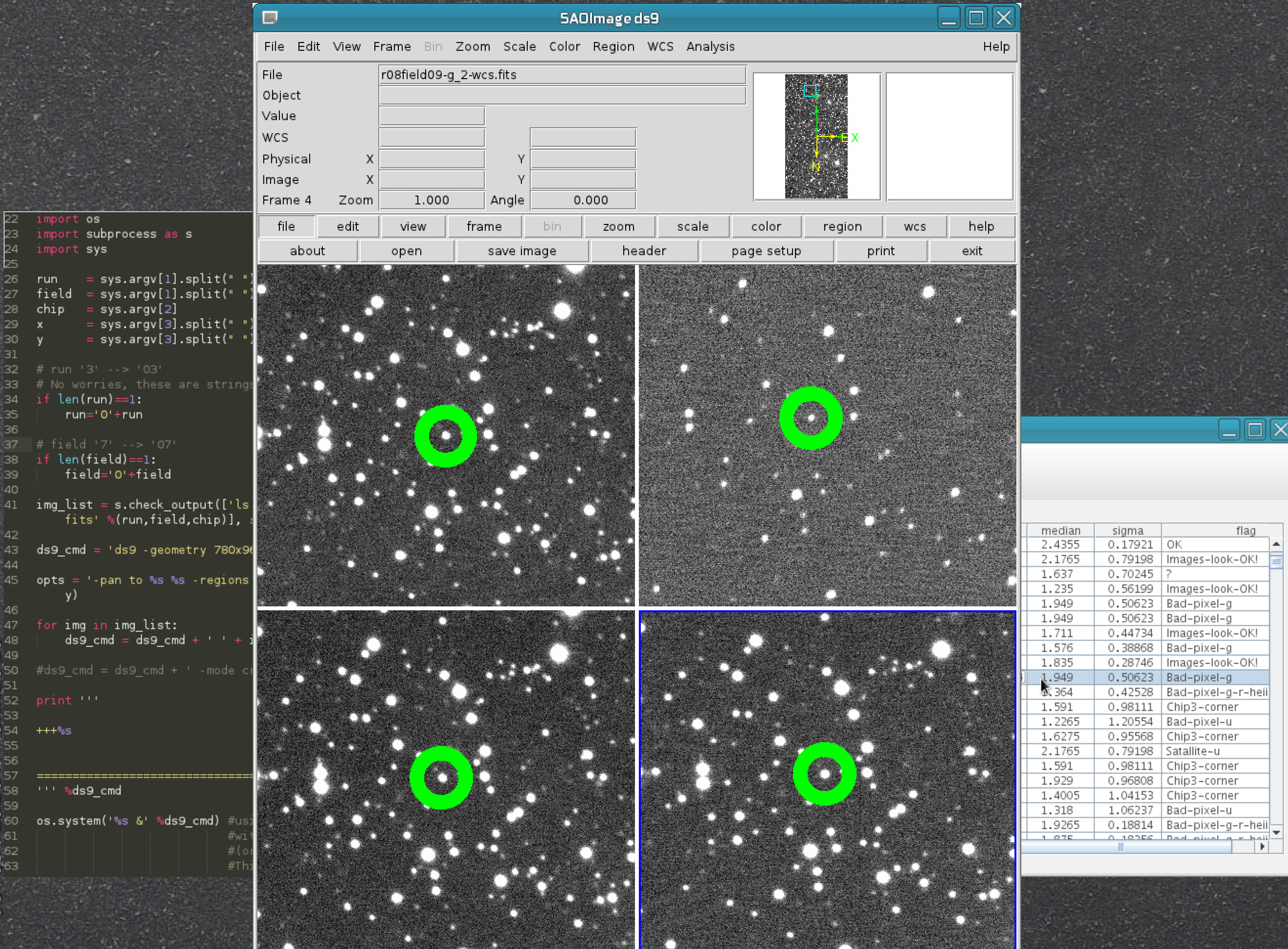
```

TOPCAT(1): Table Browser

File Subsets Help

Table Browser for 1: int6-8_all_blues.csv

	gerr	rmag	rerr	uming	gminr	median	sigma	flag
16	0.002			1.793		2.4355	0.17921	OK
17	0.198	16.928	0.007	-2.707	5.929	2.1765	0.79198	Images-look-OK!
18	0.149	16.926	0.067	-2.065	5.373	1.637	0.70245	?
19	0.199	18.342	0.009	-1.529	4.54	1.235	0.56199	Images-look-OK!
20	0.138	16.088	0.003	-0.802	3.903	1.949	0.50623	Bad-pixel-g
21	0.142	15.824	0.007	-1.618	3.854	1.949	0.50623	Bad-pixel-g
22	0.025	17.087	0.016	-0.375	3.64	1.711	0.44734	Images-look-OK!
23	0.219	17.723	0.005	-1.119	3.252	1.576	0.38868	Bad-pixel-g
24	0.013	17.104	0.014	-0.101	2.737	1.835	0.28746	Images-look-OK!
25	0.139	17.245	0.006	-0.334	)99915314	1.949	0.50623	Bad-pixel-g
26	0.245	19.337	0.137	-1.244	2.014	[illegible].364	0.42528	Bad-pixel-g-r-heii
27	0.22	21.525	0.083	-2.255	1.979	1.591	0.98111	Chip3-corner
28	0.072	20.381	0.018	-3.192	1.924	1.2265	1.20554	Bad-pixel-u
29	0.524	22.25	0.169	-2.867	1.907	1.6275	0.95568	Chip3-corner
30	0.127	21.907	0.055	-1.463	1.821	2.1765	0.79198	Satallite-u
31	0.315	21.94	0.1	-3.714	1.763	1.591	0.98111	Chip3-corner
32	0.123	20.757	0.063	-1.603	1.758	1.929	0.96808	Chip3-corner
33	0.205	20.252	0.057	-2.489	1.697	1.4005	1.04153	Chip3-corner
34	0.036	19.983	0.015	-3.525	1.68	1.318	1.06237	Bad-pixel-u
35	0.178	18.229	0.099	0.543	1.625	1.9265	0.18814	Bad-pixel-g-r-heii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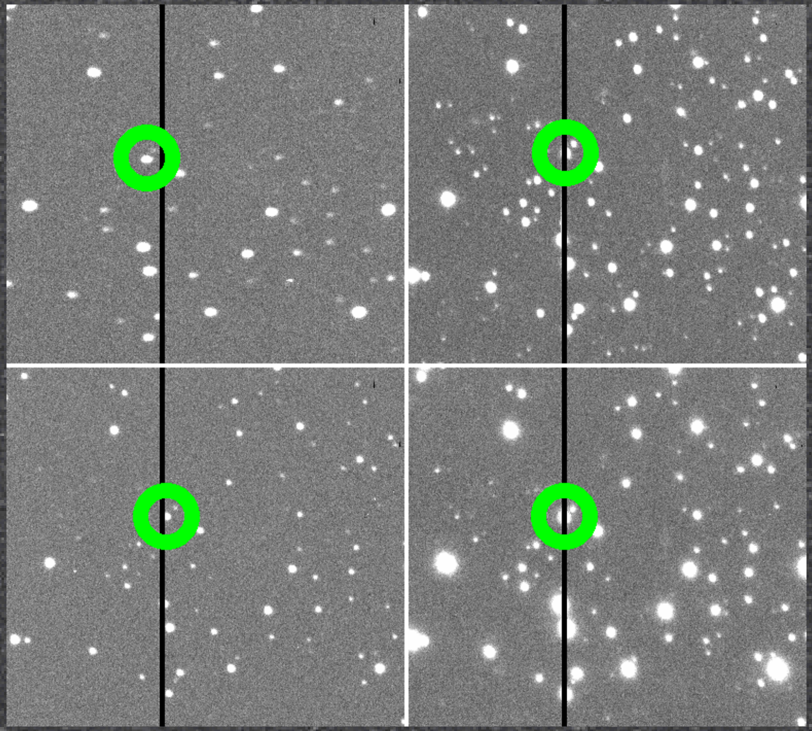
opts = '-pan to %s %s -regions
y)
for img in img_list:
ds9_cmd = ds9_cmd + ' ' + i
#ds9_cmd = ds9_cmd + ' -mode c
print '''
+++%s
==============================
''' %ds9_cmd
os.system('%s &' %ds9_cmd) #us
SAOImage ds9
File Edit View Frame Bin Zoom Scale Color Region WCS Analysis Help
File r08field09-g_2-wcs.fits
Object
Value
WCS
Physical X Y
Image X Y
Frame 4 Zoom 1.000 Angle 0.000
file edit view frame bin zoom scale color region wcs help
about open save image header page setup print exit
median sigma flag
2.4355 0.17921 OK
2.1765 0.79198 Images-look-OK!
1.637 0.70245 ?
1.235 0.56199 Images-look-OK!
1.949 0.50623 Bad-pixel-g
1.949 0.50623 Bad-pixel-g
1.711 0.44734 Images-look-OK!
1.576 0.38868 Bad-pixel-g
1.835 0.28746 Images-look-OK!
1.949 0.50623 Bad-pixel-g
.364 0.42528 Bad-pixel-g-r-heii
1.591 0.98111 Chip3-corner
1.2265 1.20554 Bad-pixel-u
1.6275 0.95568 Chip3-corner
2.1765 0.79198 Satallite-u
1.591 0.98111 Chip3-corner
1.929 0.96808 Chip3-corner
1.4005 1.04153 Chip3-corner
1.318 1.06237 Bad-pixel-u
1.9265 0.18814 Bad-pixel-g-r-heii

Eye-balling

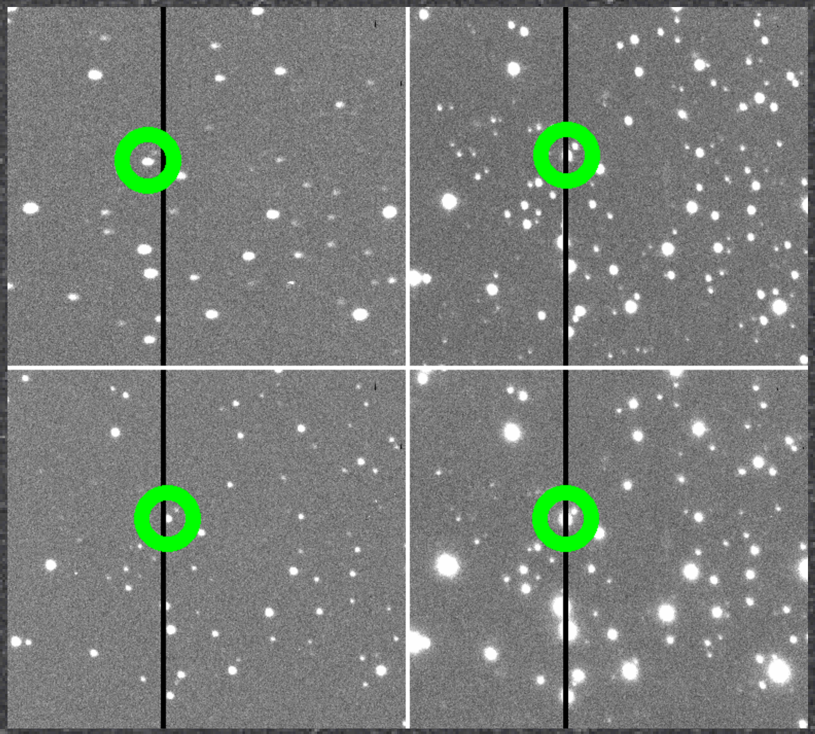
Eye-balling

Bad pixel

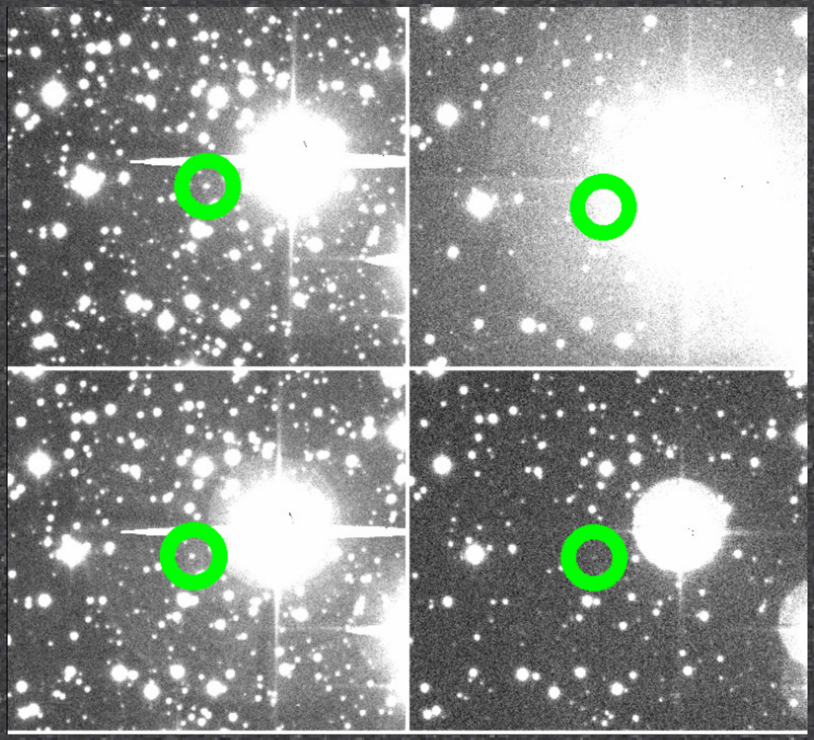


Eye-balling

Bad pixel

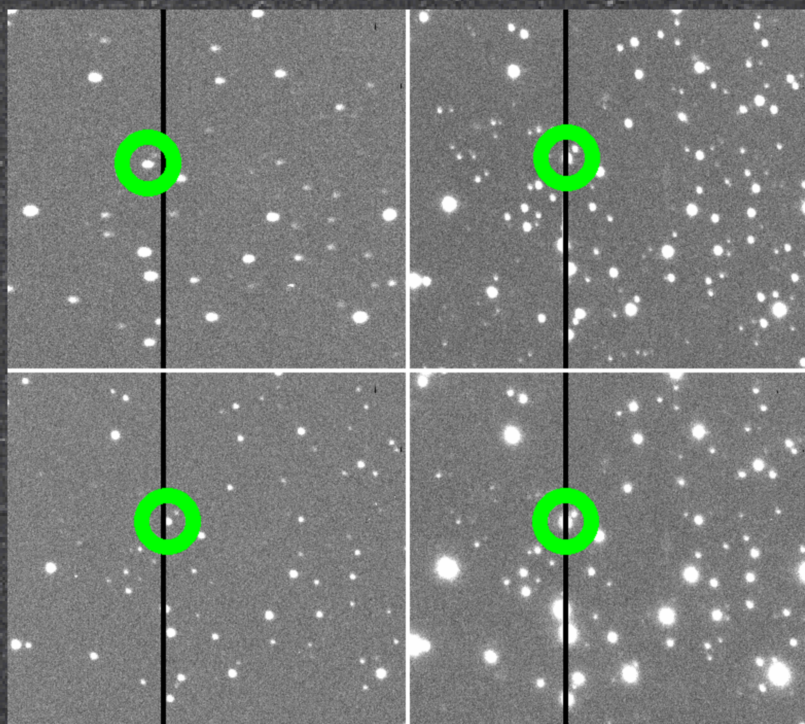


Nearby saturated star

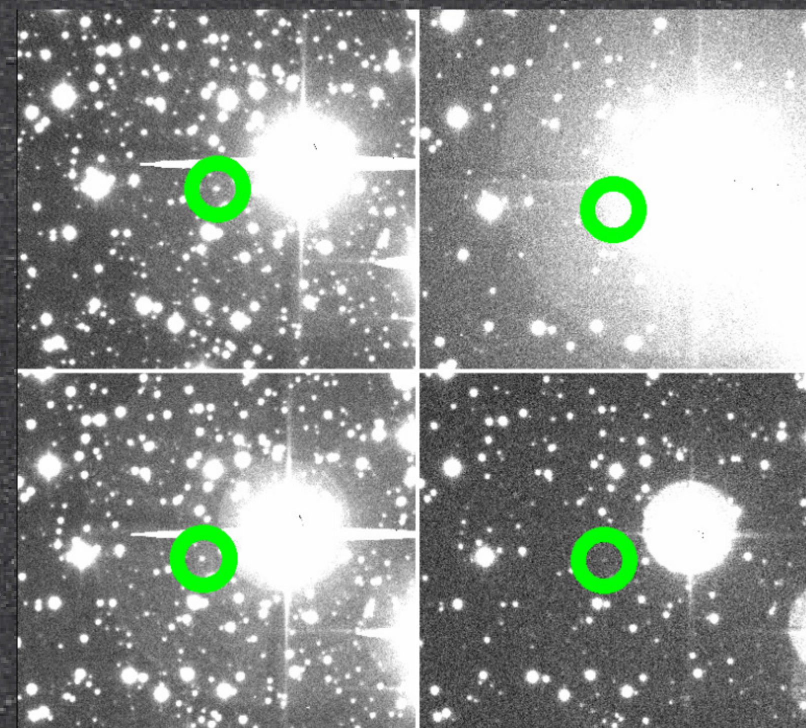


Eye-balling

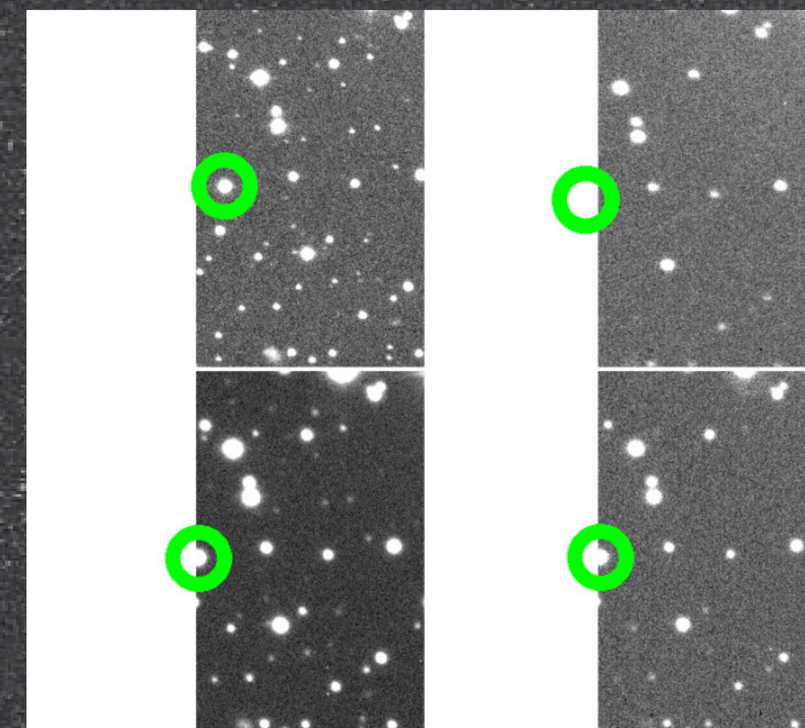
Bad pixel



Nearby saturated star

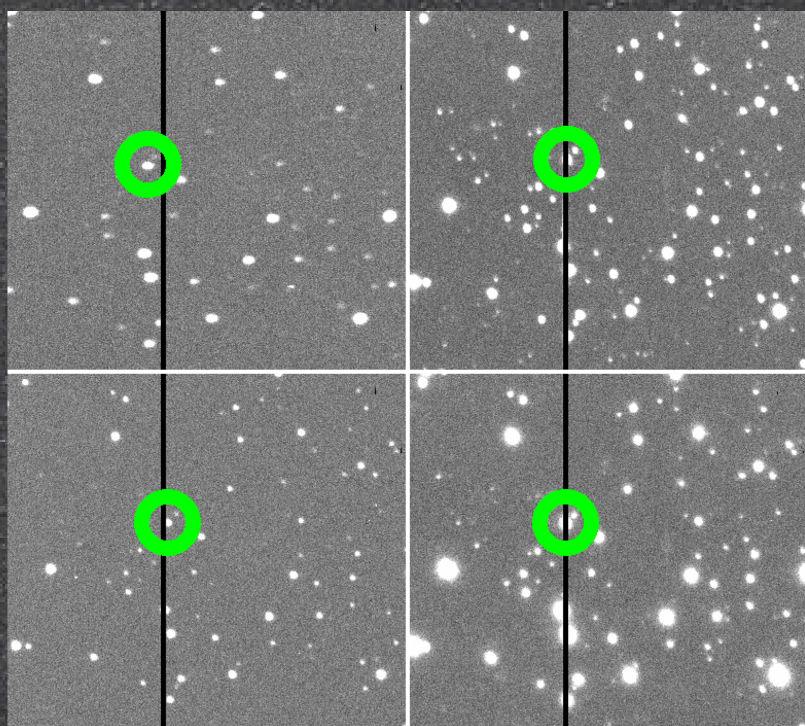


Out of the CCD

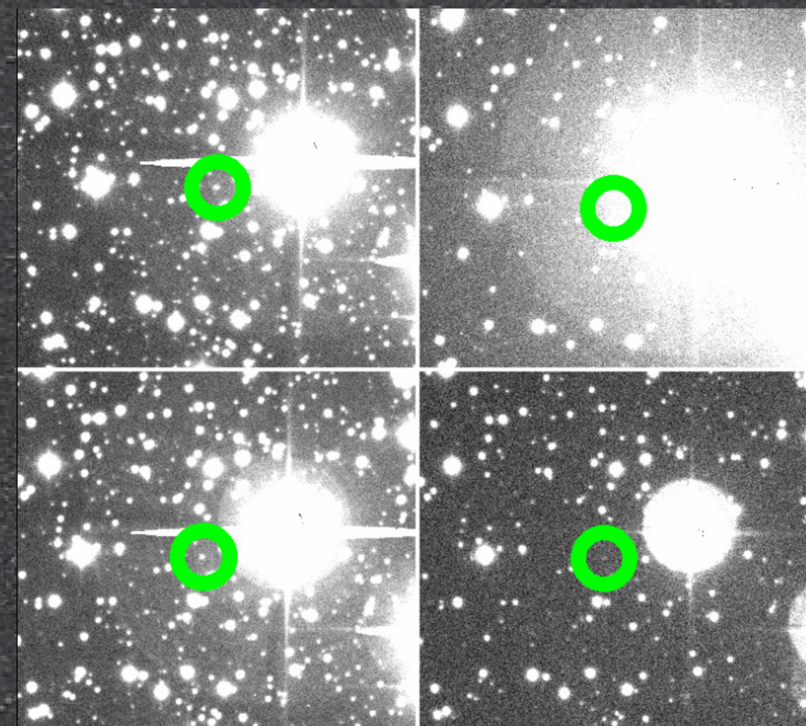


Eye-balling

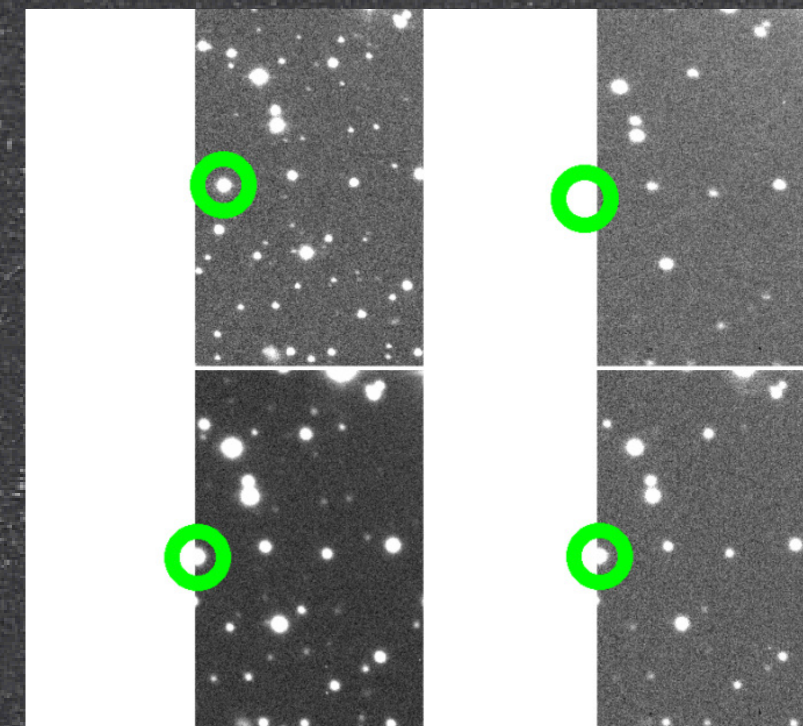
Bad pixel



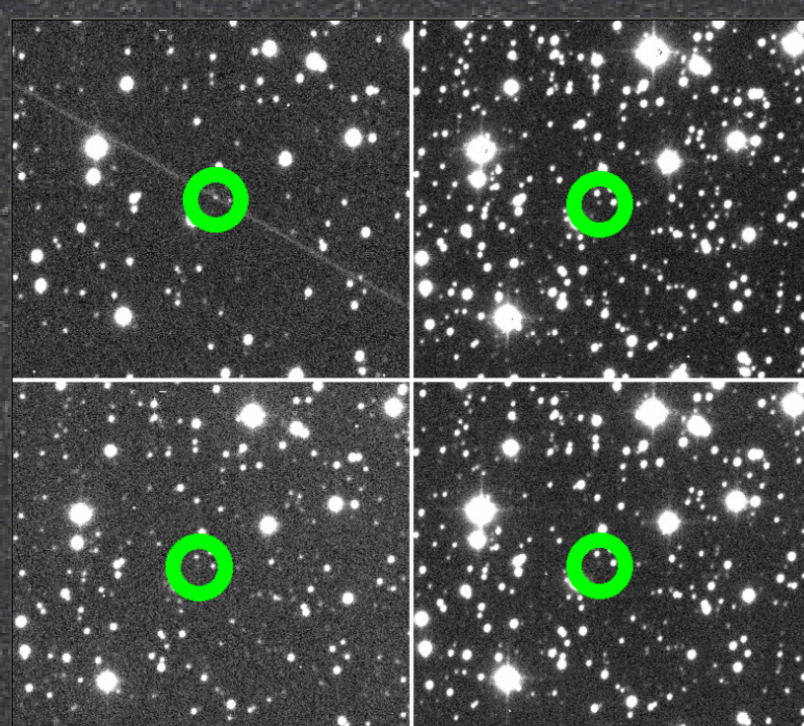
Nearby saturated star



Out of the CCD

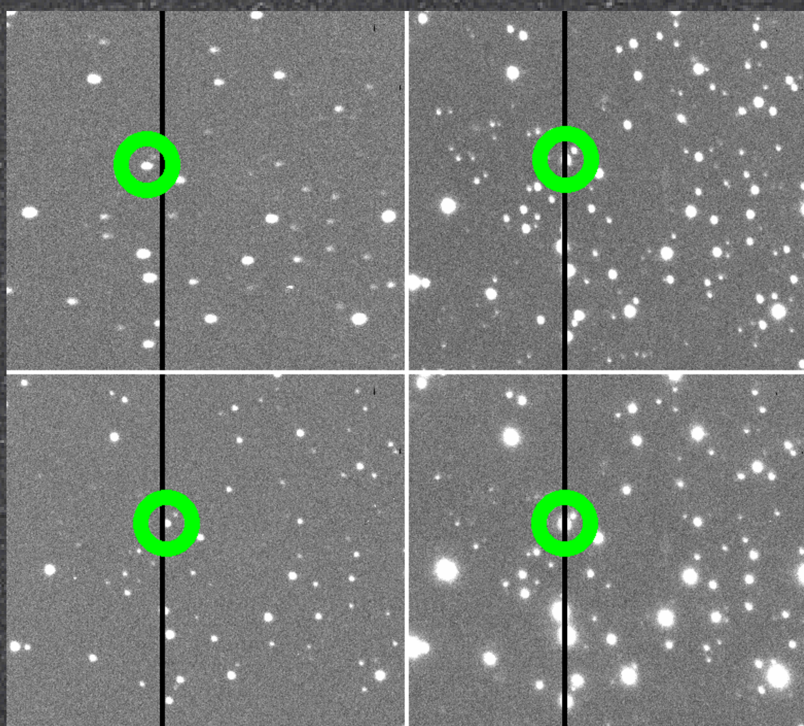


Satellite

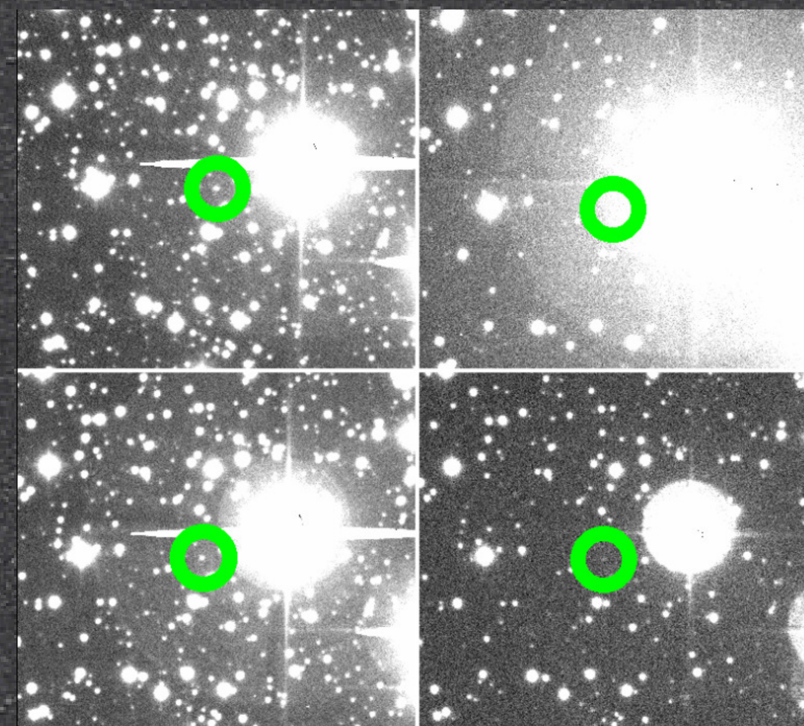


Eye-balling

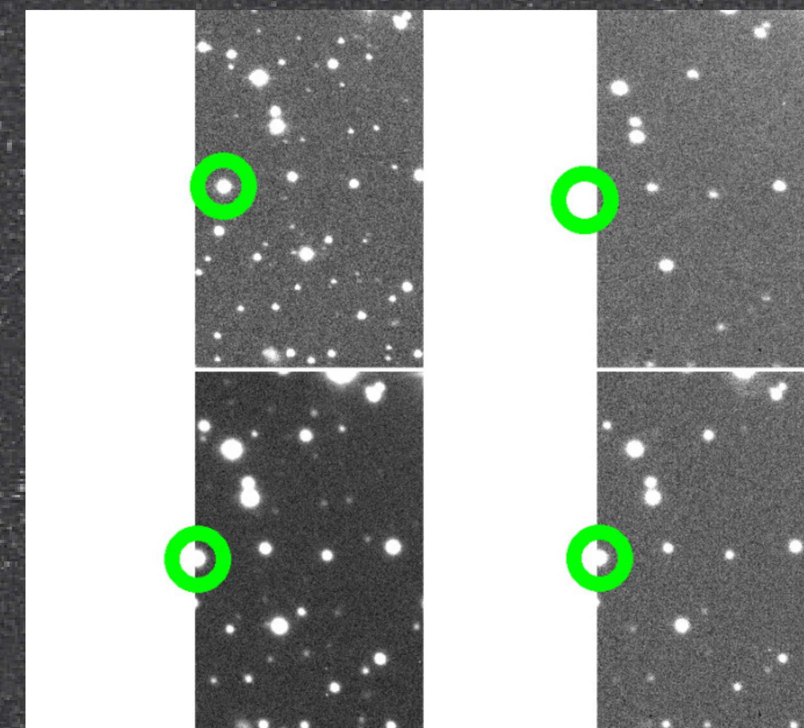
Bad pixel



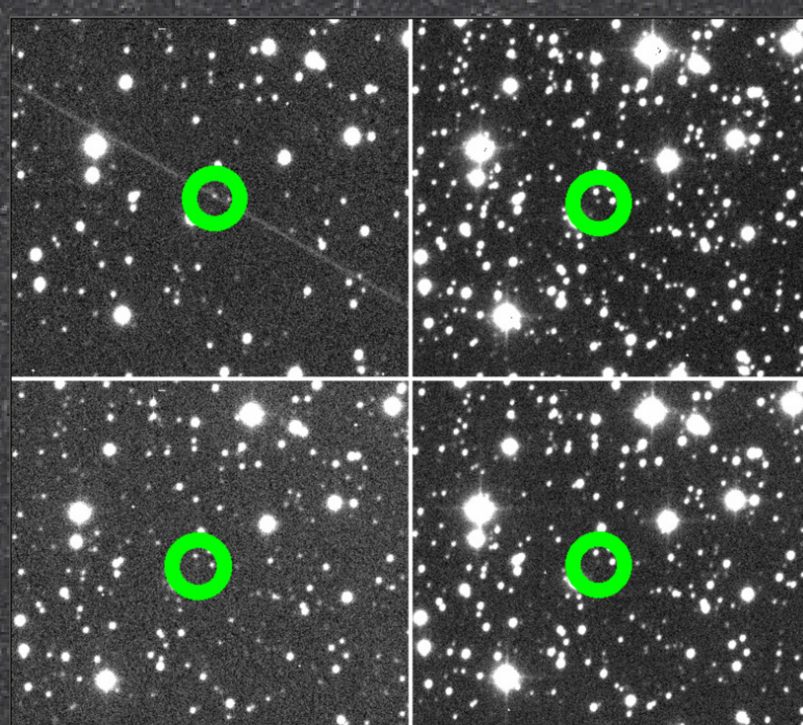
Nearby saturated star



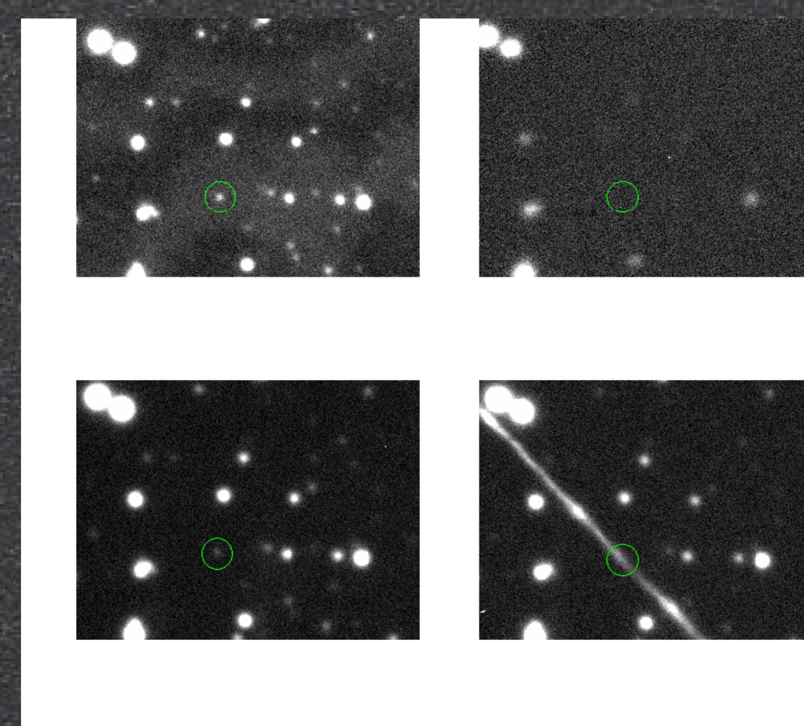
Out of the CCD

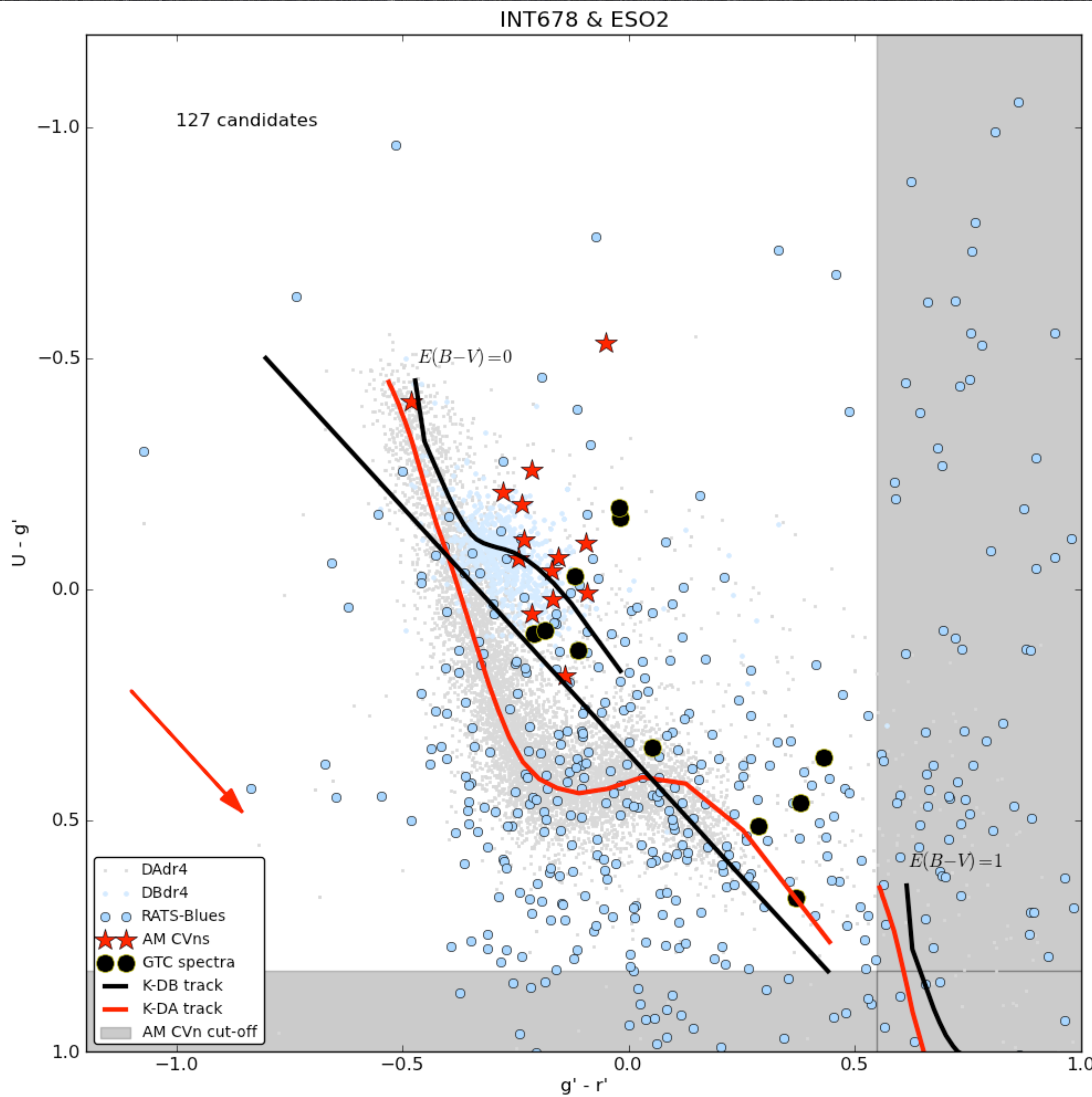


Satellite

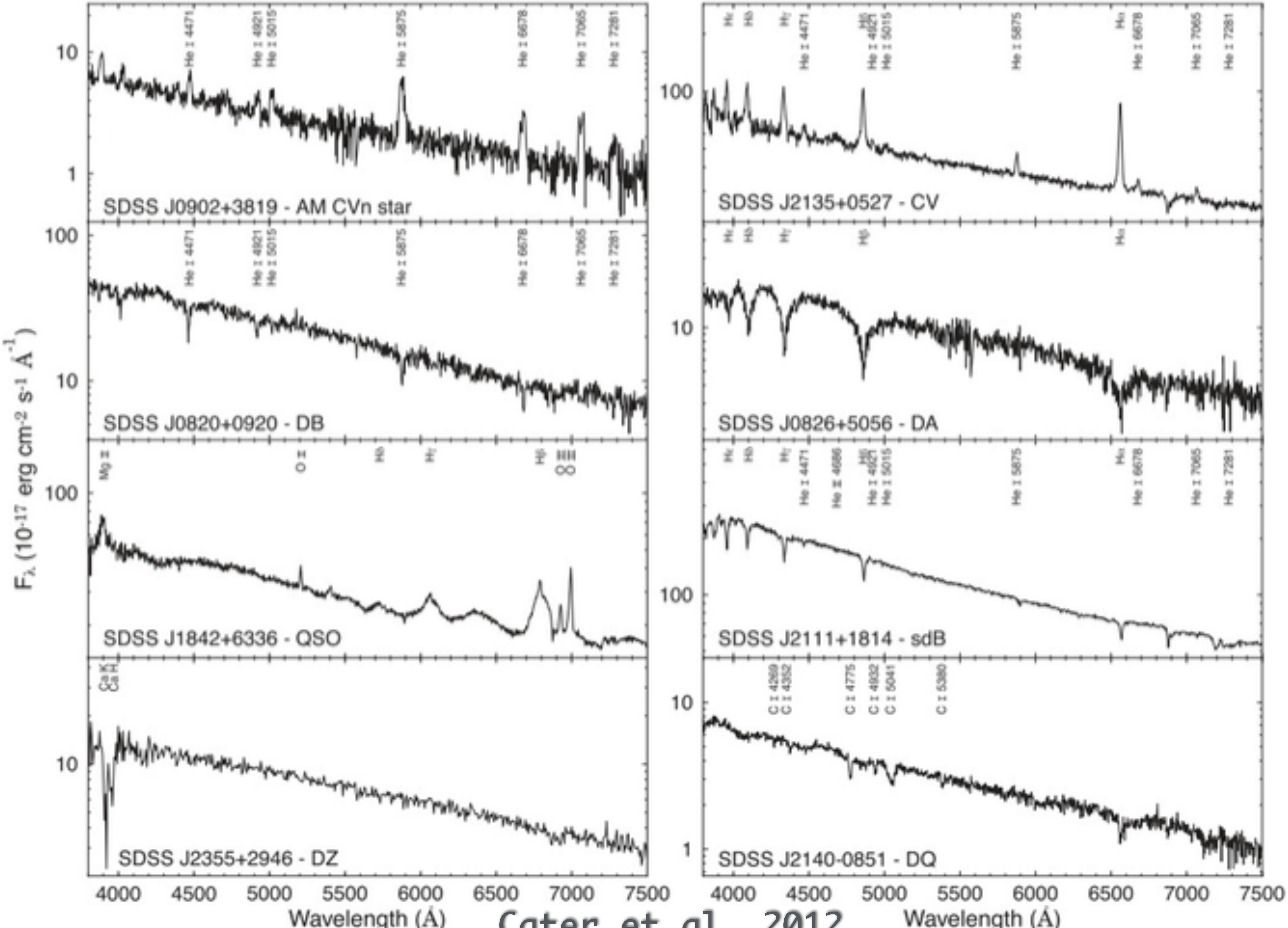


Plane



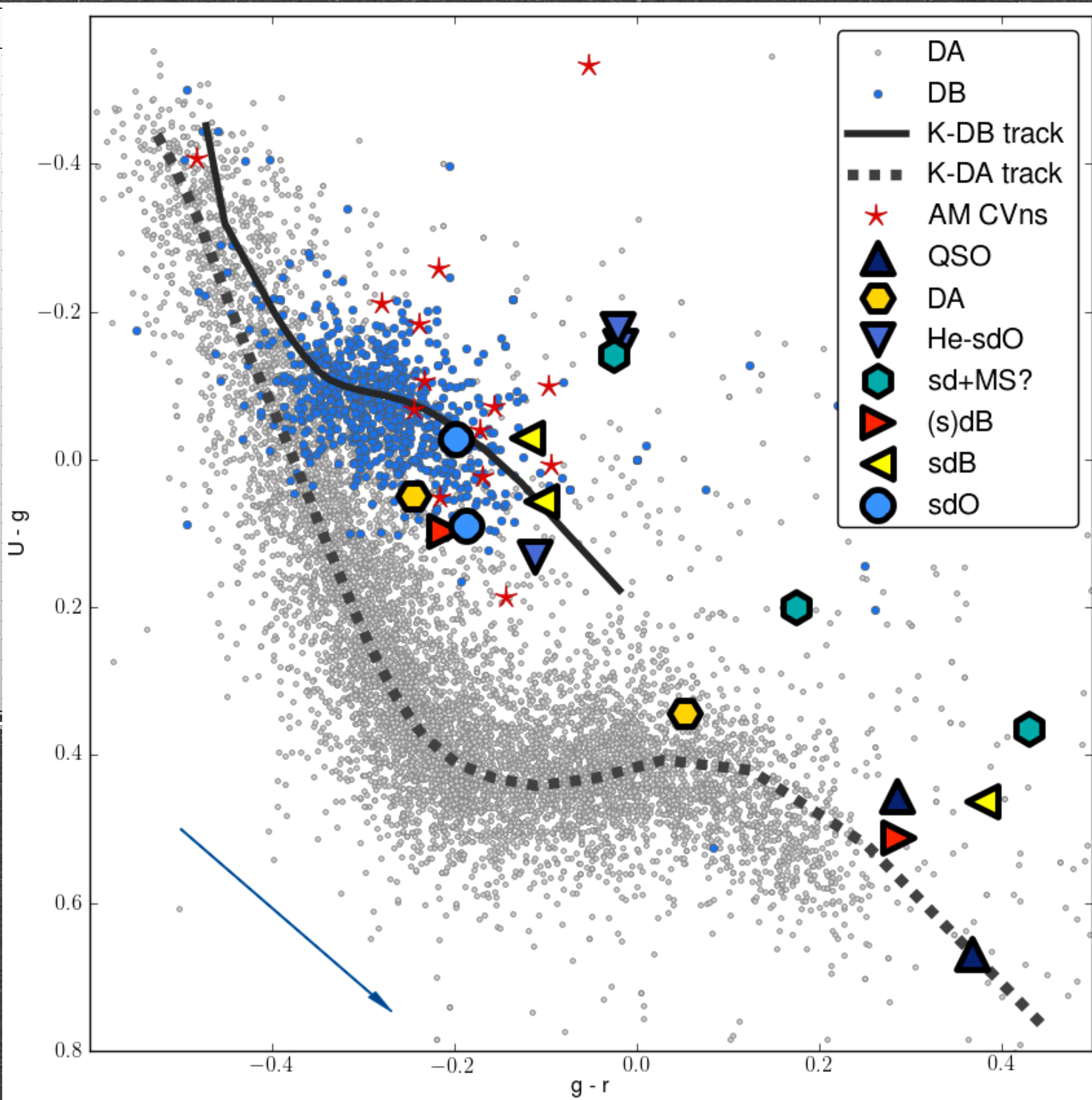


INT678 & ESO2
127 candidates
$E(B-V)=0$
$E(B-V)=1$
U - g'
g' - r'
−1.0
−0.5
0.0
0.5
1.0
DAdr4
DBdr4
RATS-Blues
AM CVns
GTC spectra
K-DB track
K-DA track
AM CVn cut-off

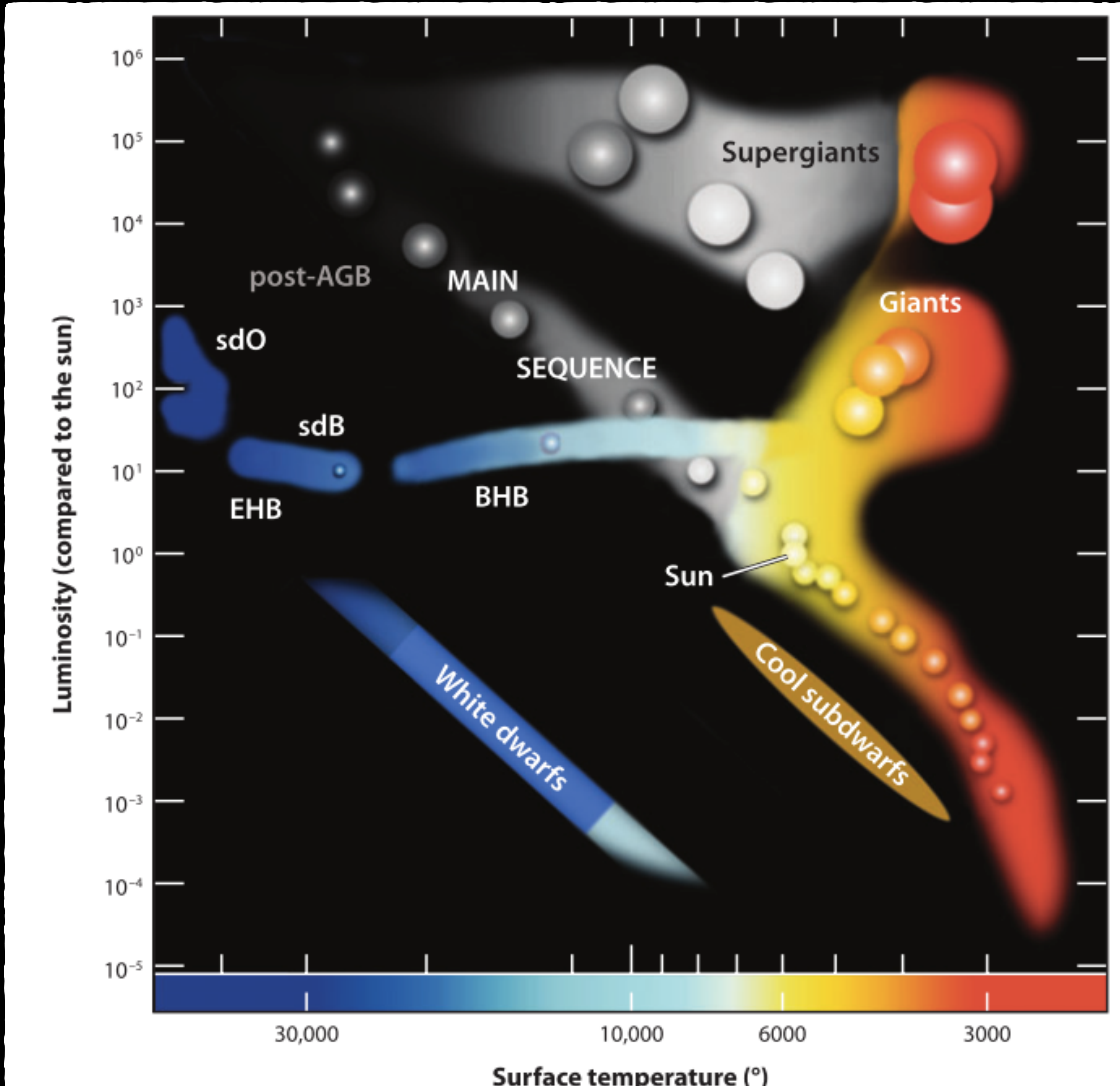


Cater et al. 2012

ID	GTC ID	Obs. Date	Exposure	g'	$U-g'$	$g'-r'$	Type
RATJ175431.29+013753.2	OB0050	20130514	3 x 600 sec	17.41	−0.15	−0.02	He-sdO
RATJ175914.97+011906.4	OB0055	20130514	2 x 600 sec	16.85	0.13	−0.11	He-sdO
RATJ180054.43+003232.0	OB0056	20130514	2 x 600 sec	16.12	−0.18	−0.02	He-sdO
RATJ175526.97+013207.3	OB0052	20130514	2 x 1200 sec	18.34	0.46	0.38	sdB
RATJ180036.57+022358.0	OB0057	20130514	2 x 600 sec	17.56	−0.03	−0.12	sdB
RATJ181931.29+053751.0	OB0069	20130701	2 x 400 sec	18.03	0.06	−0.11	sdB
RATJ180441.91+013832.9	OB0059	20130517	3 x 300 sec	17.26	0.51	0.29	(s)dB
RATJ181752.11+074008.6	OB0068	20130520	2 x 400 sec	18.03	0.10	−0.21	(s)dB
RATJ182318.33+082437.5	OB0060	20130520	3 x 300 sec	17.38	0.09	−0.19	sdO
RATJ180438.61+022226.8	OB0066	20130620	2 x 500 sec	18.68	−0.03	−0.20	sdO
RATJ175436.44+013339.1	OB0051	20130514	2 x 900 sec	19.06	0.34	0.05	DA
RATJ180324.64+013853.1	OB0064	20130620	2 x 400 sec	18.09	0.05	−0.25	DA
RATJ175738.28+013816.7	OB0053	20130514	2 x 600 sec	18.70	0.67	0.37	QSO
RATJ183350.57+282156.0	OB0070	20130620	2 x 450 sec	18.65	0.46	0.29	QSO
RATJ181746.01+072117.8	OB0067	20130520	2 x 400 sec	18.10	0.37	0.43	sd+CoolMS?
RATJ180025.28+012127.4	OB0063	20130620	2 x 400 sec	18.32	−0.14	−0.03	sd+CoolMS?
RATJ175917.90+022516.5	OB0061	20130605	2 x 400 sec	18.59	0.20	0.18	sd+CoolMS?

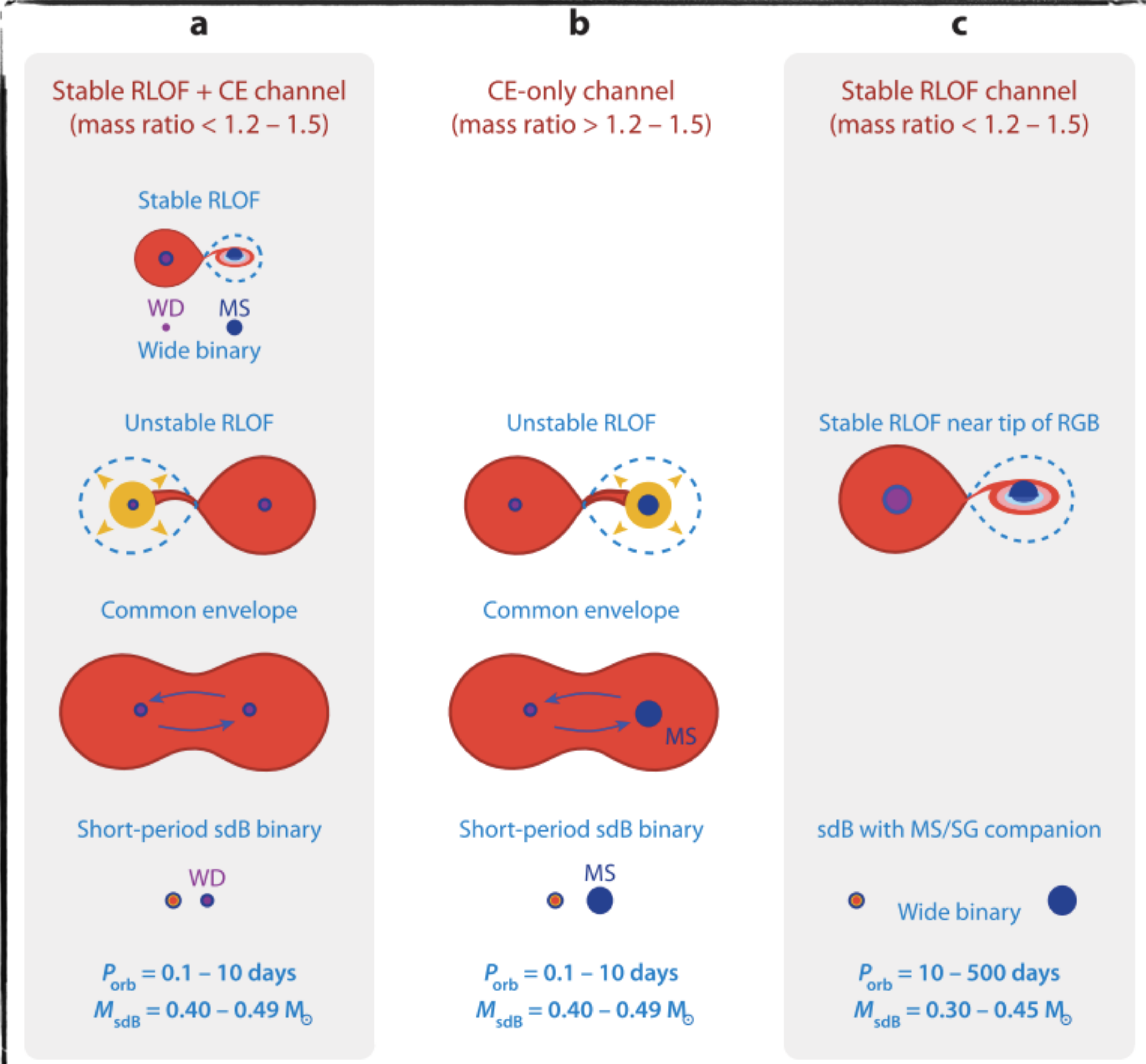


$g' - r'$	Type
-0.02	He-sdO
-0.11	He-sdO
-0.02	He-sdO
0.38	sdB
-0.12	sdB
-0.11	sdB
0.29	(s)dB
-0.21	(s)dB
-0.19	sdO
-0.20	sdO
0.05	DA
-0.25	DA
0.37	QSO
0.29	QSO
0.43	sd+CoolMS?
-0.03	sd+CoolMS?
0.18	sd+CoolMS?



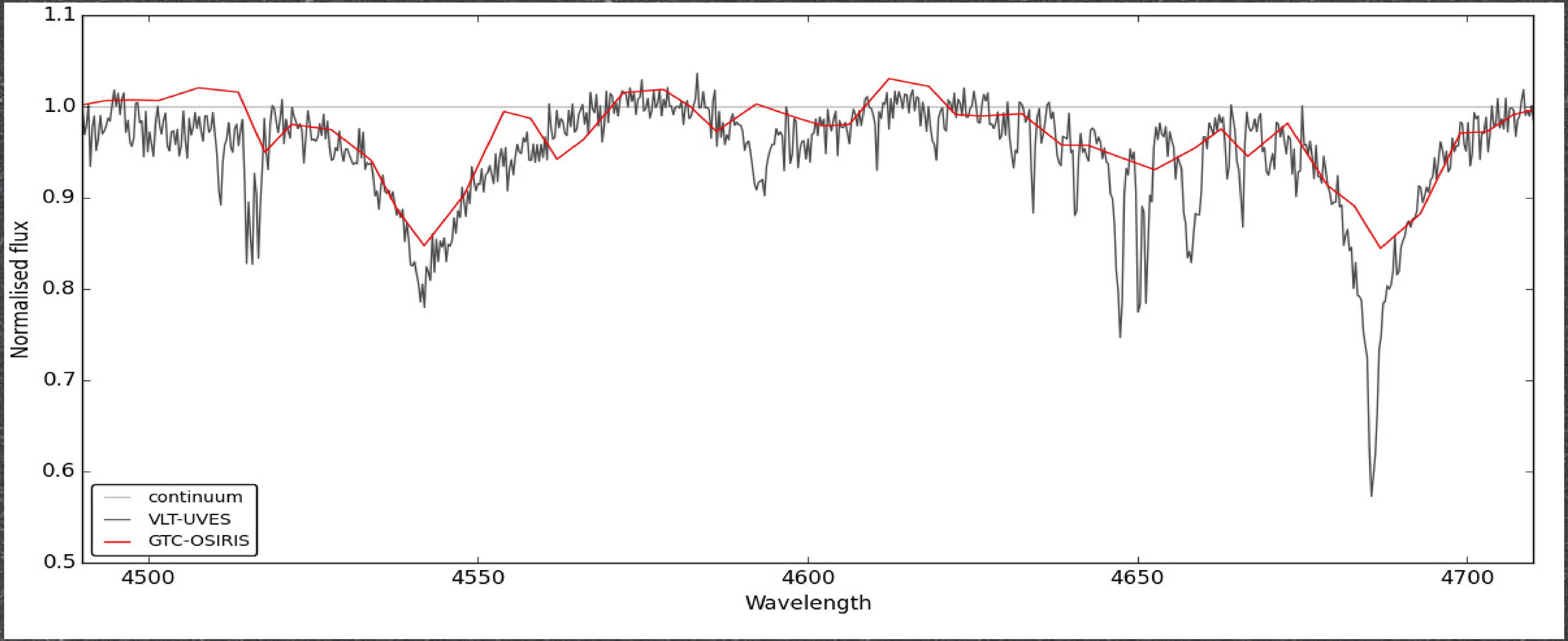
Supergiants
Giants
post-AGB
MAIN
SEQUENCE
sdO
sdB
EHB
BHB
Sun
White dwarfs
Cool subdwarfs
Luminosity (compared to the sun)
10^6
10^5
10^4
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
30,000
10,000
6000
3000
Surface temperature (°)

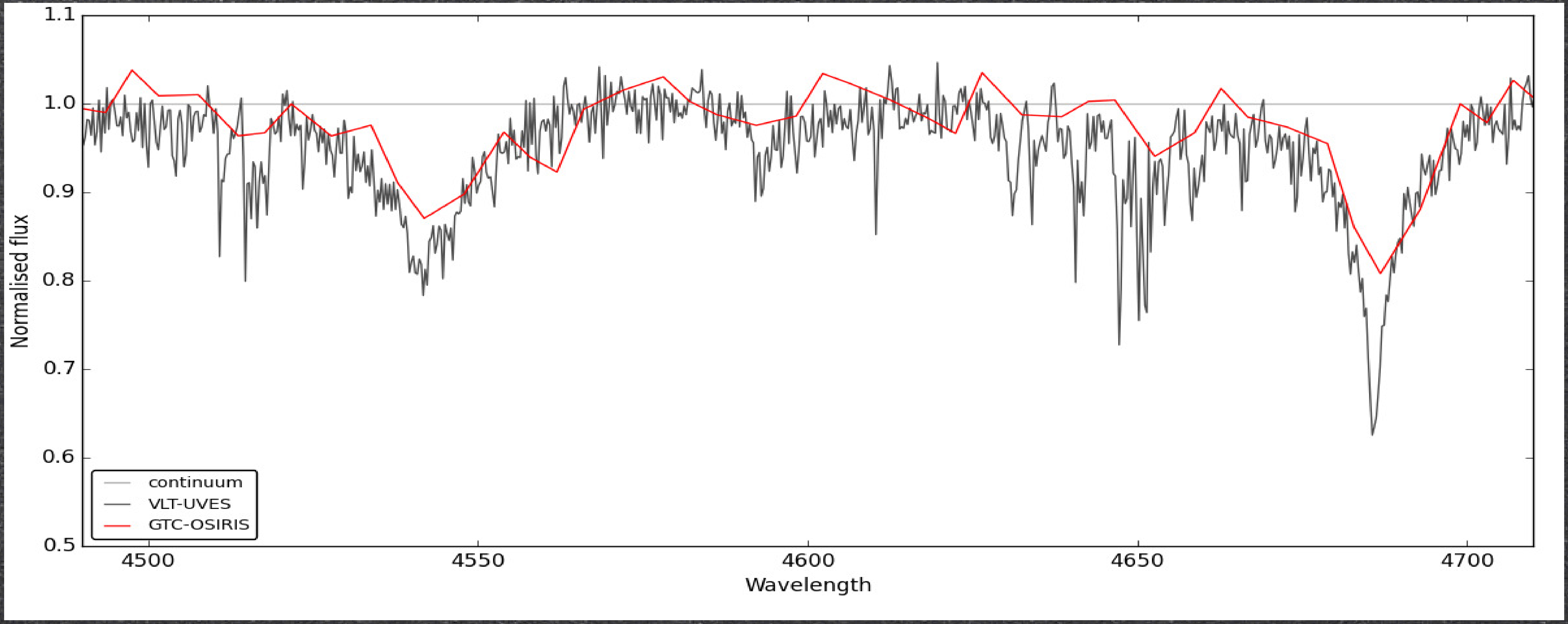
Heber 2009



a
b
c
Stable RLOF + CE channel
(mass ratio < 1.2 – 1.5)
CE-only channel
(mass ratio > 1.2 – 1.5)
Stable RLOF channel
(mass ratio < 1.2 – 1.5)
Stable RLOF
WD
MS
Wide binary
Unstable RLOF
Unstable RLOF
Stable RLOF near tip of RGB
Common envelope
Common envelope
MS
Short-period sdB binary
Short-period sdB binary
sdB with MS/SG companion
WD
MS
Wide binary
P orb = 0.1 – 10 days
M sdB = 0.40 – 0.49 M☉
P orb = 0.1 – 10 days
M sdB = 0.40 – 0.49 M☉
P orb = 10 – 500 days
M sdB = 0.30 – 0.45 M☉

Heber 2009


1.1
1.0
0.9
0.8
0.7
0.6
0.5
Normalised flux
4500
4550
4600
4650
4700
Wavelength
continuum
VLT-UVES
GTC-OSIRIS


1.1
1.0
0.9
0.8
0.7
0.6
0.5
Normalised flux
4500
4550
4600
4650
4700
Wavelength
continuum
VLT-UVES
GTC-OSIRIS

In the classification system, the depths of the Hγ (4340Å), HeI 4471Å and HeII 4541Å lines are used as guidelines to determine the Helium class, which shown as an integer between 0 (He-weak) and 40 (He-strong) and is *roughly* calculated by:

$$\begin{aligned} &20\,\frac{HeI\lambda 4471 + HeII\lambda 4541}{H\gamma - 0.83 HeII\lambda 4541} && \text{for } 0 \le \text{He-class } \le 20 \\ &40 - 20\,\frac{H\gamma - 0.83 HeII\lambda 4541}{HeI\lambda 4471 + HeII\lambda 4541} && \text{for } 21 \le \text{He-class } \le 40 \end{aligned} \quad (1.1)$$

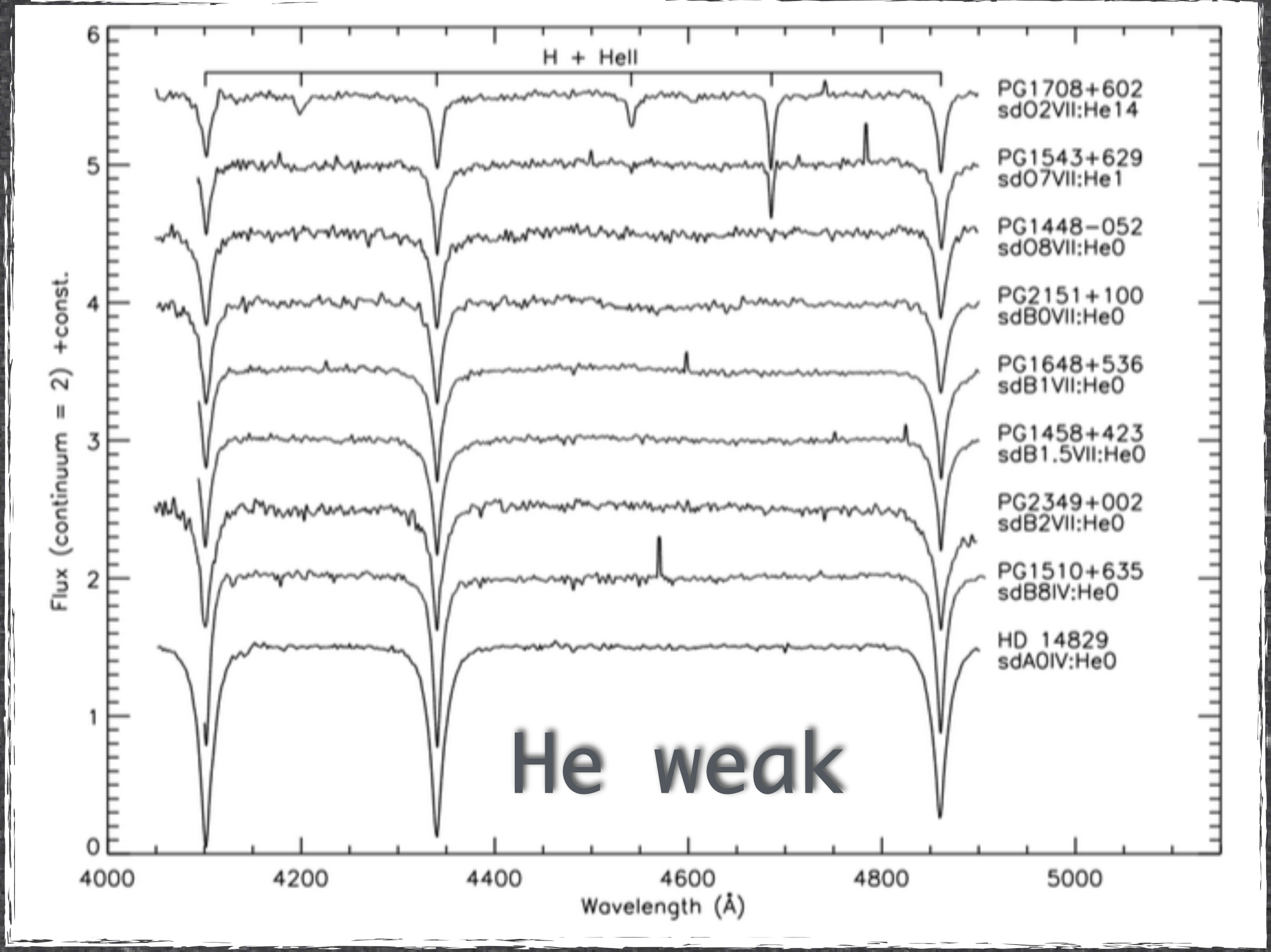
where $HeI\lambda 4471$, $HeII\lambda 4541$ and $H\gamma$ represents the depths of respective lines. The four helium class are defined as following:

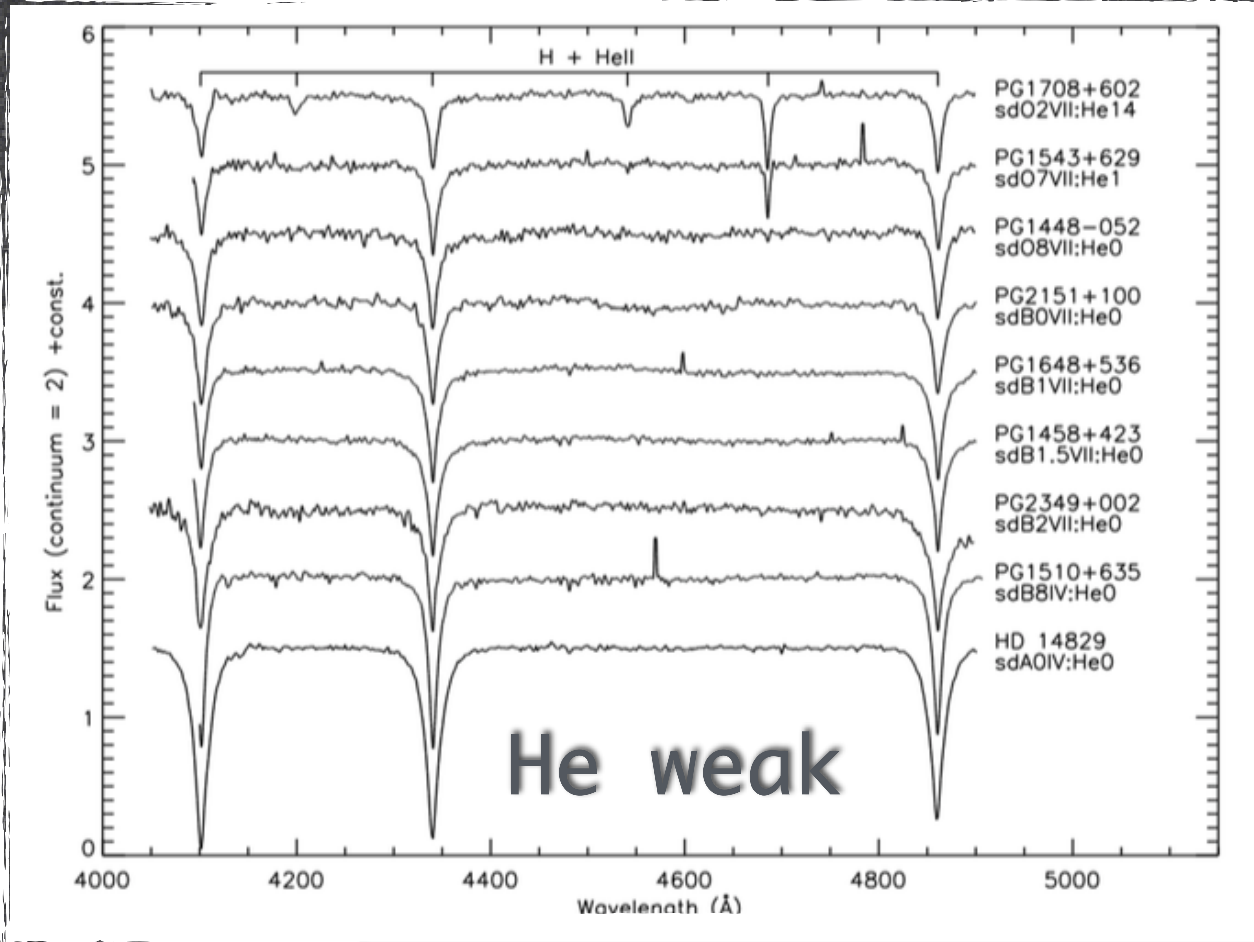
i. *He-weak*: only H lines, occasionally HeI or HeII (not both), and very weak metallic lines.

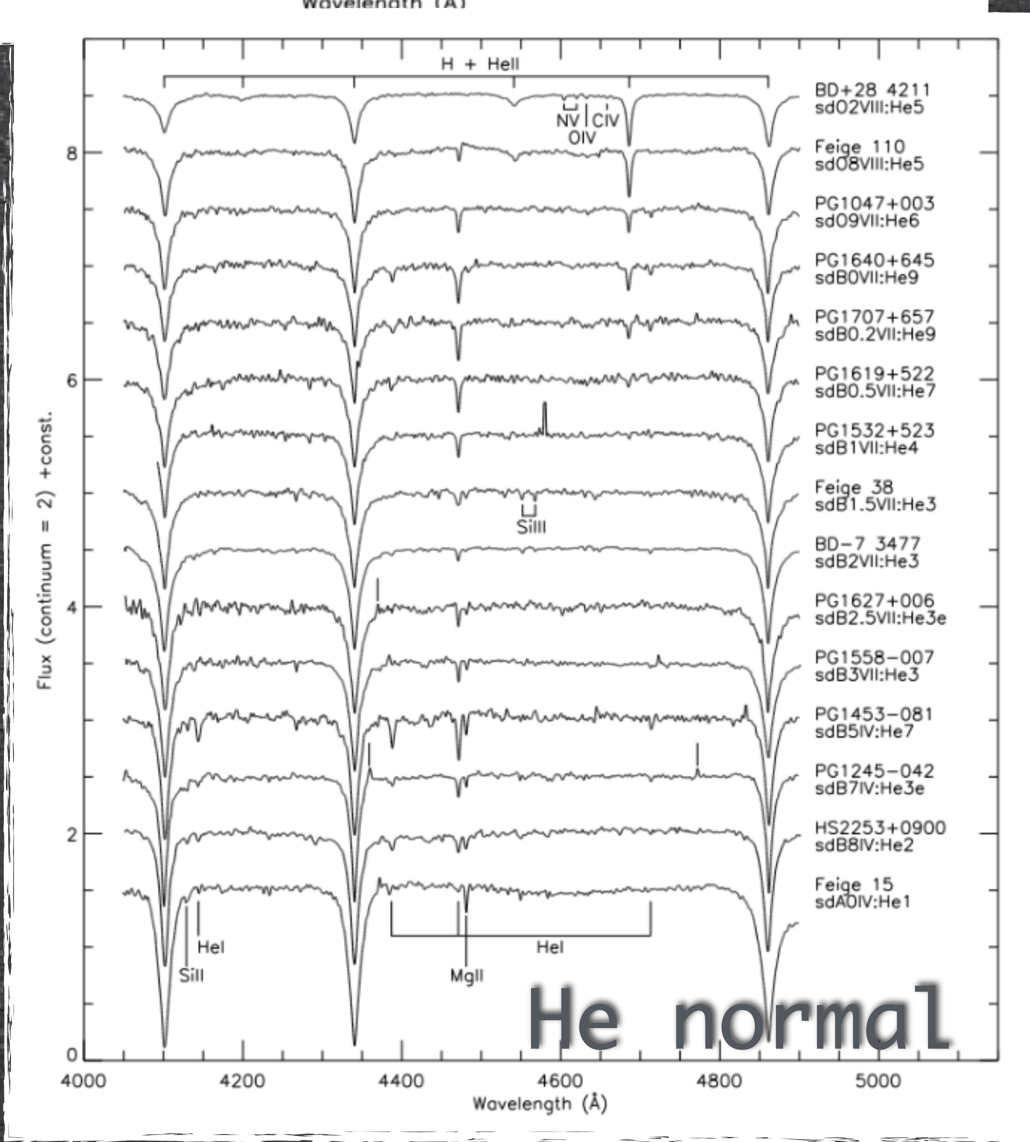
ii. *He-normal*: H lines are dominant, both HeI and HeII and/or metallic lines are present.

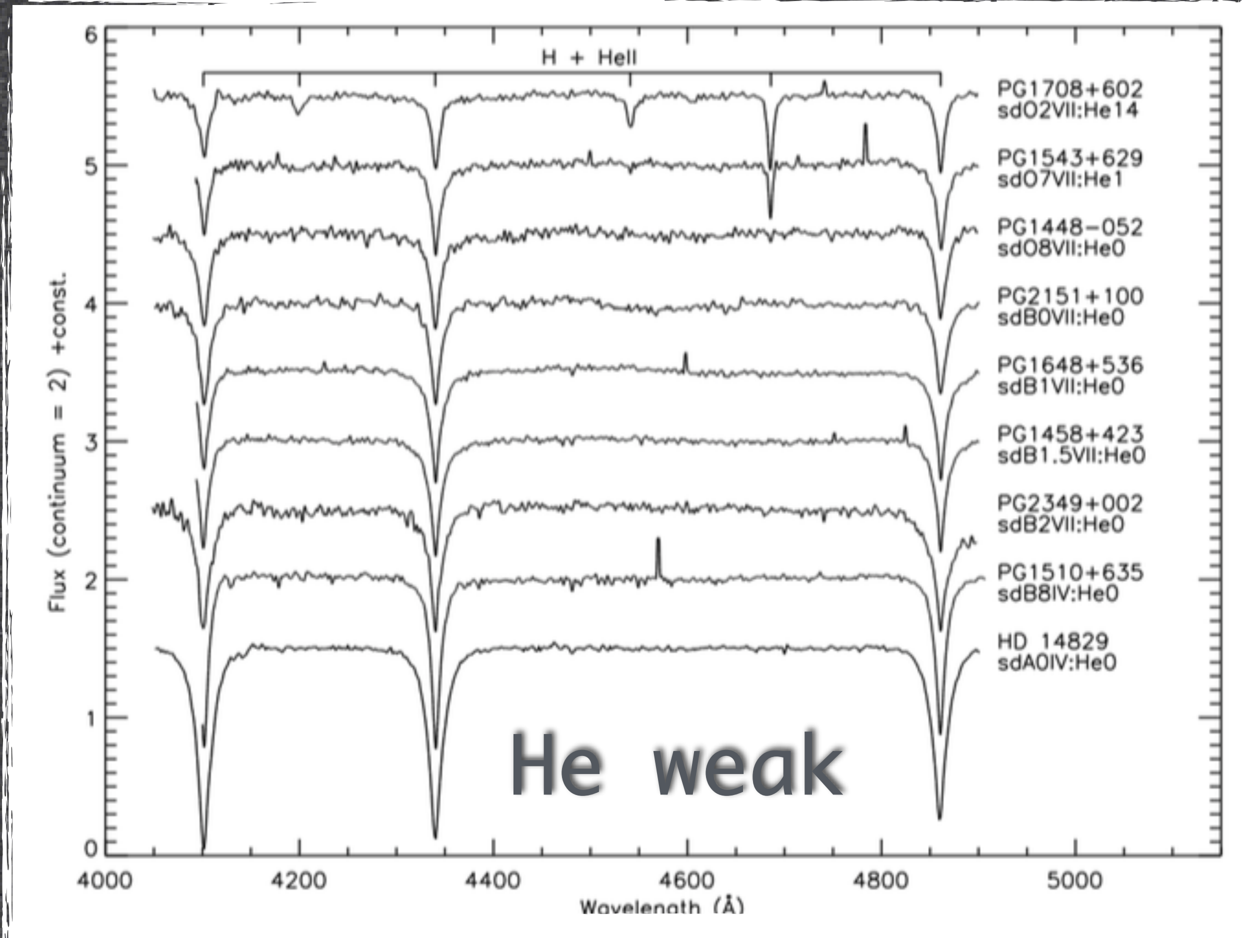
iii. *He-strong C*: He lines are dominant and C lines are present.

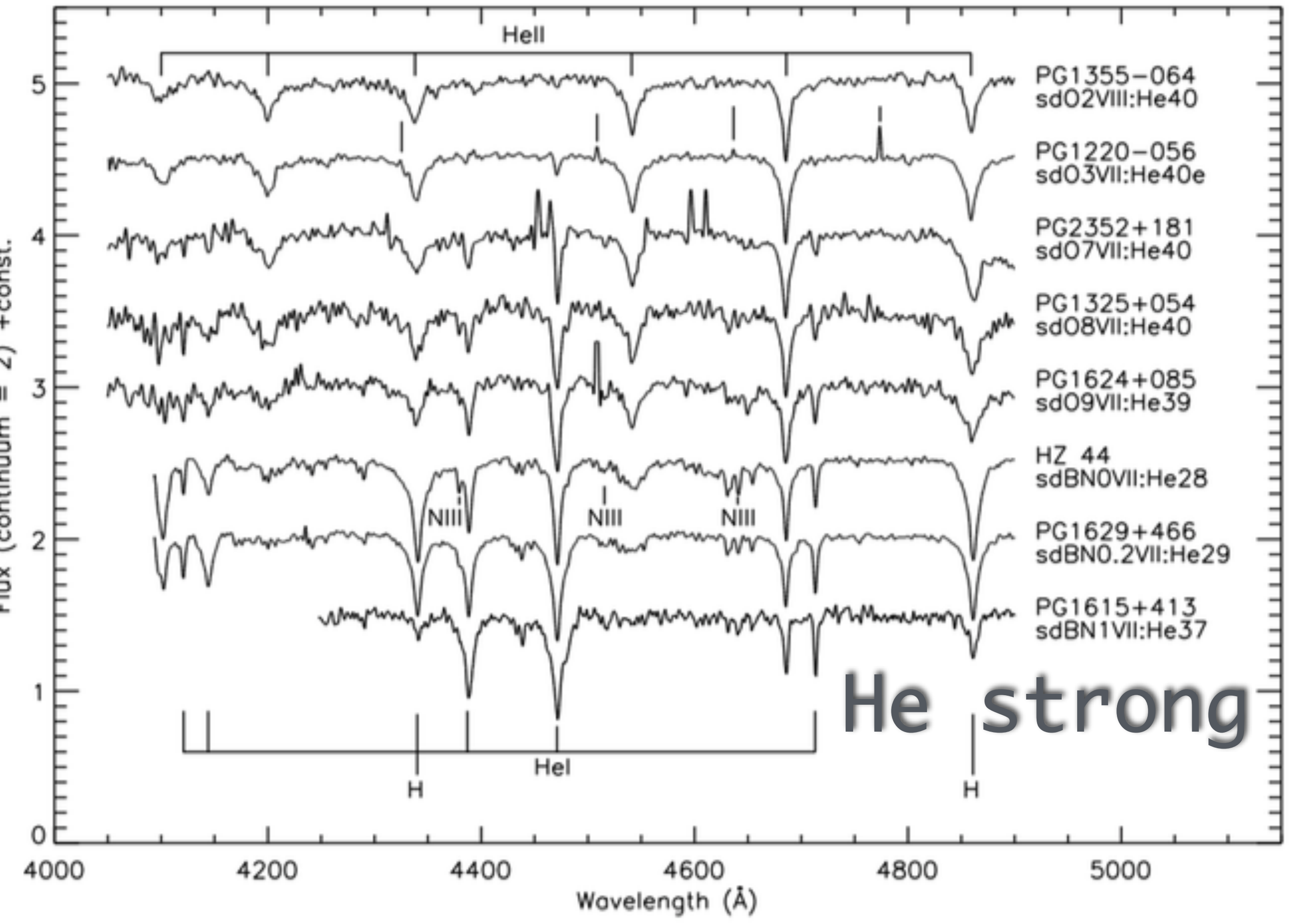
iv. *He-strong*: He lines are dominant, C lines are very weak or absent.

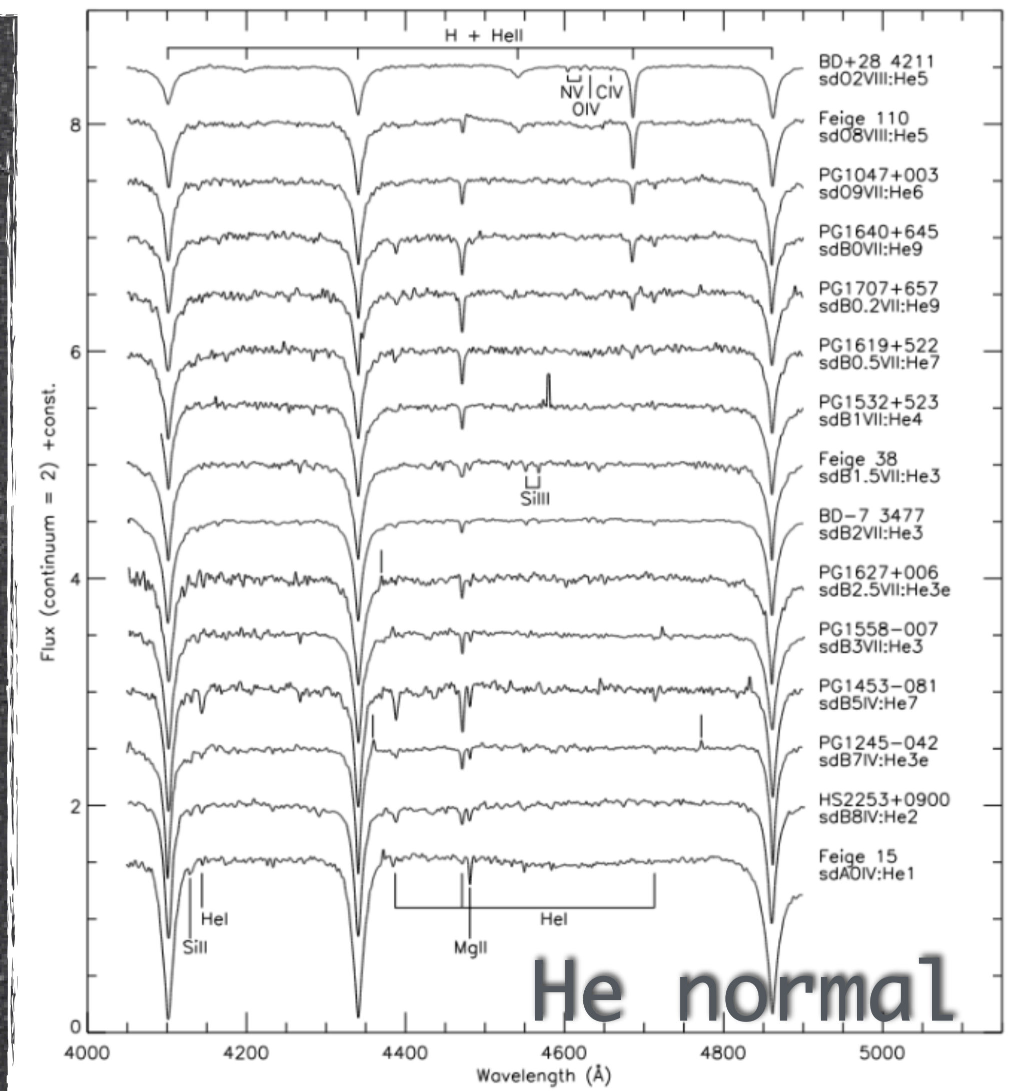

H + HeII
PG1708+602
sdO2VII:He14
PG1543+629
sdO7VII:He1
PG1448−052
sdO8VII:He0
PG2151+100
sdB0VII:He0
PG1648+536
sdB1VII:He0
PG1458+423
sdB1.5VII:He0
PG2349+002
sdB2VII:He0
PG1510+635
sdB8IV:He0
HD 14829
sdA0IV:He0
He weak
Flux (continuum = 2) +const.
Wavelength (Å)

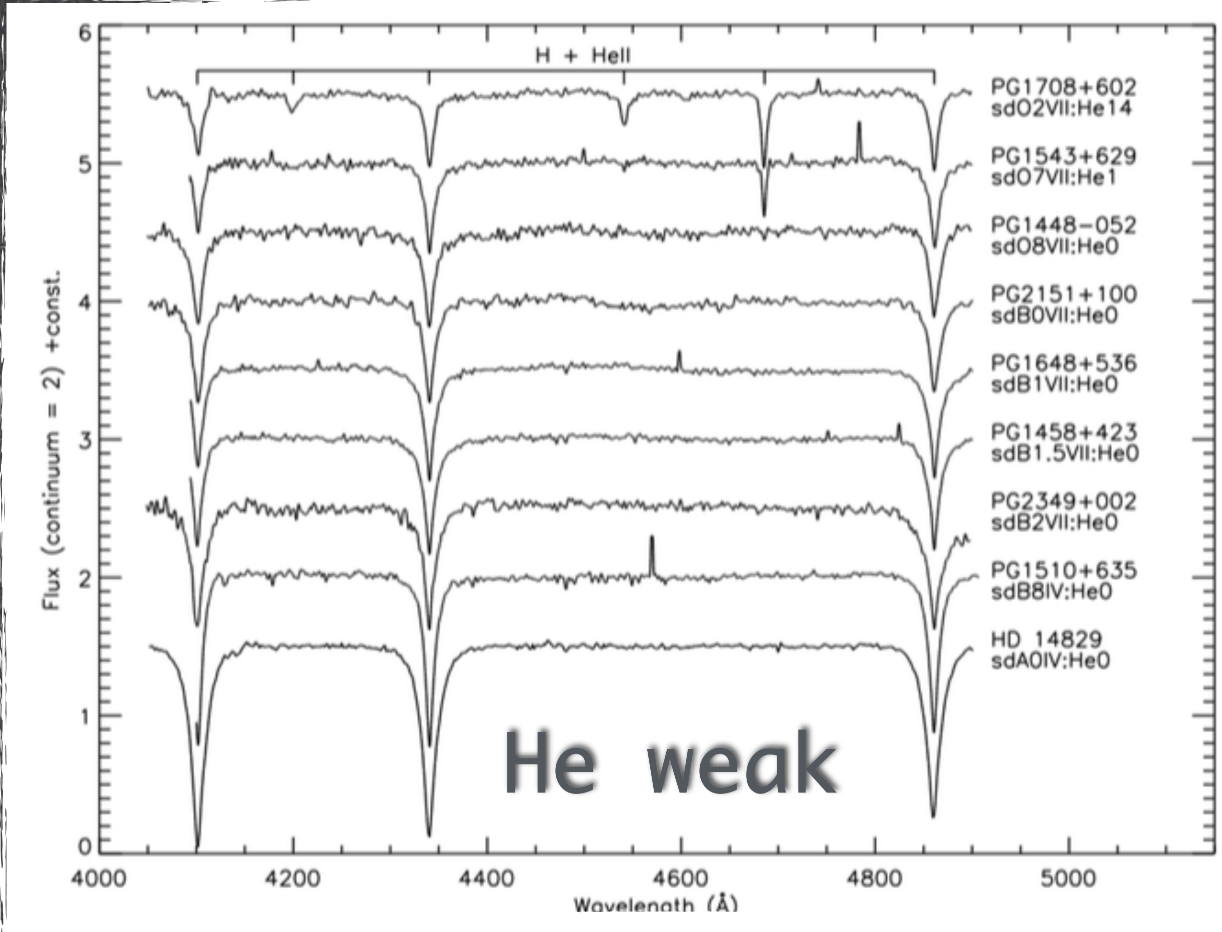

H + HeII
PG1708+602
sdO2VII:He14
PG1543+629
sdO7VII:He1
PG1448−052
sdO8VII:He0
PG2151+100
sdB0VII:He0
PG1648+536
sdB1VII:He0
PG1458+423
sdB1.5VII:He0
PG2349+002
sdB2VII:He0
PG1510+635
sdB8IV:He0
HD 14829
sdA0IV:He0
He weak
Flux (continuum = 2) +const.
Wavelength (Å)
0
1
2
3
4
5
6
4000
4200
4400
4600
4800
5000

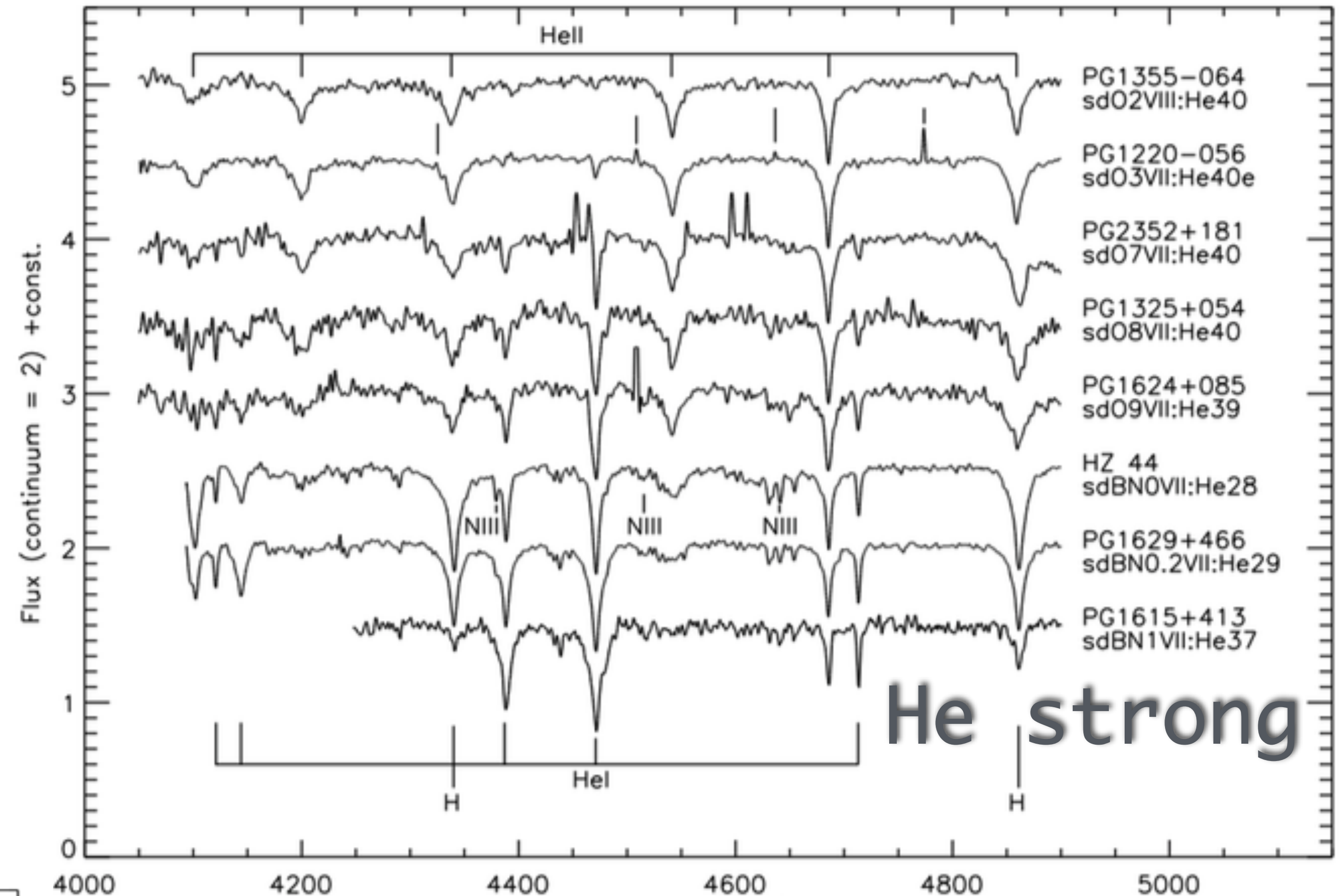

H + HeII
NV
CIV
OIV
BD+28 4211
sdO2VIII:He5
Feige 110
sdO8VIII:He5
PG1047+003
sdO9VII:He6
PG1640+645
sdB0VII:He9
PG1707+657
sdB0.2VII:He9
PG1619+522
sdB0.5VII:He7
PG1532+523
sdB1VII:He4
Feige 38
sdB1.5VII:He3
SiIII
BD−7 3477
sdB2VII:He3
PG1627+006
sdB2.5VII:He3e
PG1558−007
sdB3VII:He3
PG1453−081
sdB5IV:He7
PG1245−042
sdB7IV:He3e
HS2253+0900
sdB8IV:He2
Feige 15
sdA0IV:He1
HeI
SiII
MgII
HeI
He normal
Flux (continuum = 2) +const.
Wavelength (Å)
0
2
4
6
8
4000
4200
4400
4600
4800
5000

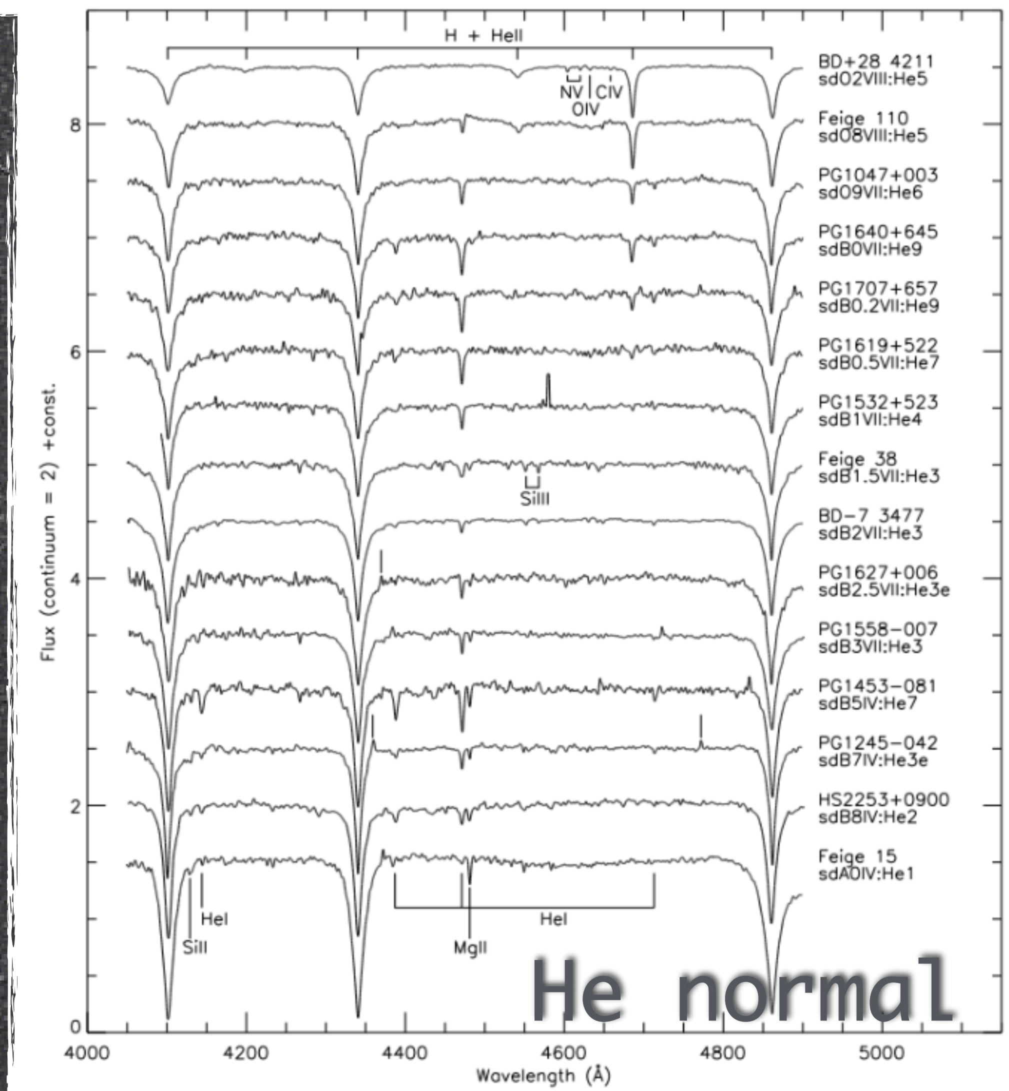

H + HeII
PG1708+602 sdO2VII:He14
PG1543+629 sdO7VII:He1
PG1448−052 sdO8VII:He0
PG2151+100 sdB0VII:He0
PG1648+536 sdB1VII:He0
PG1458+423 sdB1.5VII:He0
PG2349+002 sdB2VII:He0
PG1510+635 sdB8IV:He0
HD 14829 sdA0IV:He0
Flux (continuum = 2) +const.
Wavelength (Å)
He weak

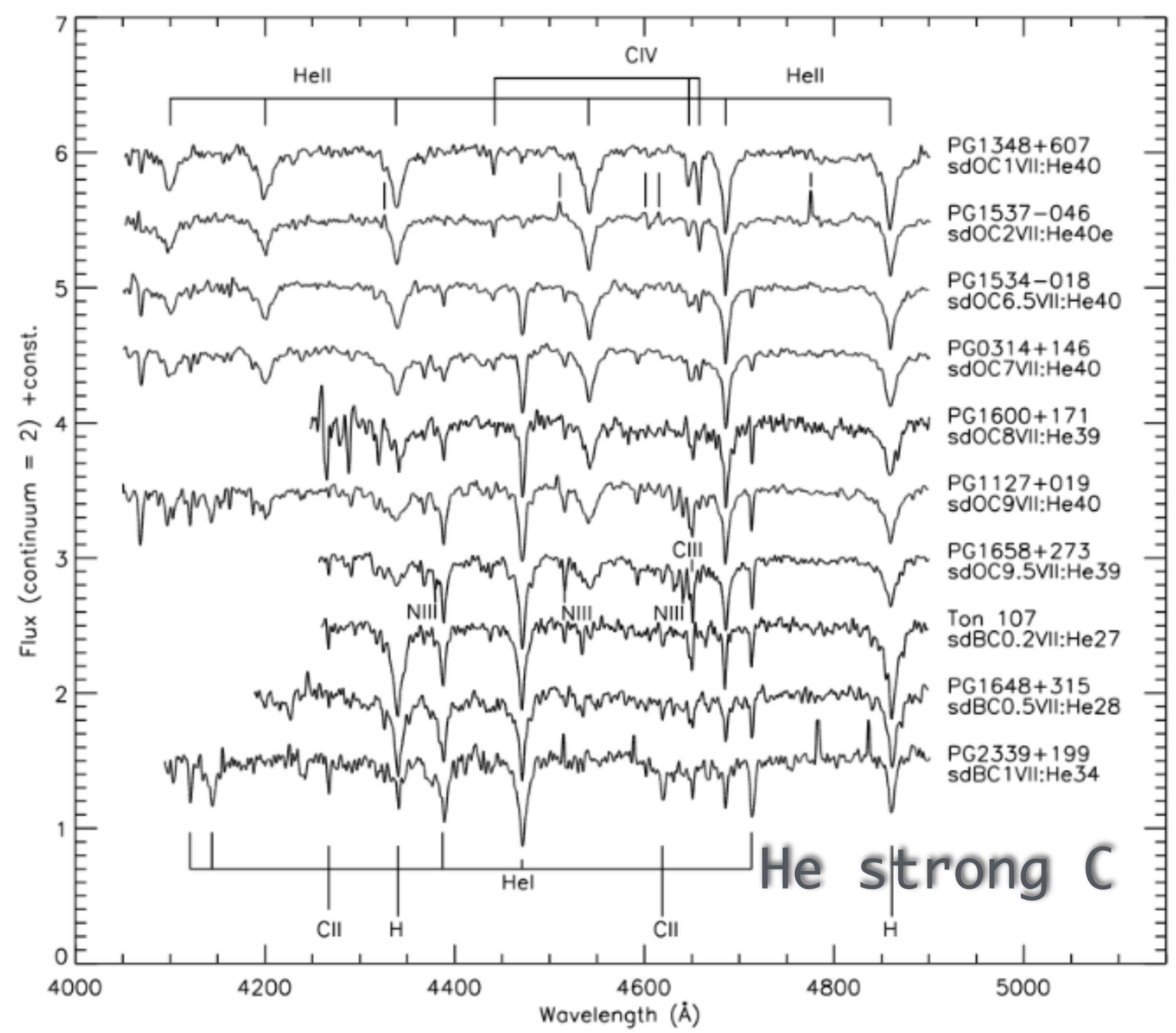

HeII
PG1355−064 sdO2VIII:He40
PG1220−056 sdO3VII:He40e
PG2352+181 sdO7VII:He40
PG1325+054 sdO8VII:He40
PG1624+085 sdO9VII:He39
HZ 44 sdBN0VII:He28
PG1629+466 sdBN0.2VII:He29
PG1615+413 sdBN1VII:He37
NIII
NIII
NIII
HeI
H
H
Flux (continuum = 2) +const.
Wavelength (Å)
He strong


H + HeII
NV
CIV
OIV
BD+28 4211 sdO2VIII:He5
Feige 110 sdO8VIII:He5
PG1047+003 sdO9VII:He6
PG1640+645 sdB0VII:He9
PG1707+657 sdB0.2VII:He9
PG1619+522 sdB0.5VII:He7
PG1532+523 sdB1VII:He4
Feige 38 sdB1.5VII:He3
SiIII
BD−7 3477 sdB2VII:He3
PG1627+006 sdB2.5VII:He3e
PG1558−007 sdB3VII:He3
PG1453−081 sdB5IV:He7
PG1245−042 sdB7IV:He3e
HS2253+0900 sdB8IV:He2
Feige 15 sdA0IV:He1
HeI
SiII
MgII
HeI
Flux (continuum = 2) +const.
Wavelength (Å)
He normal

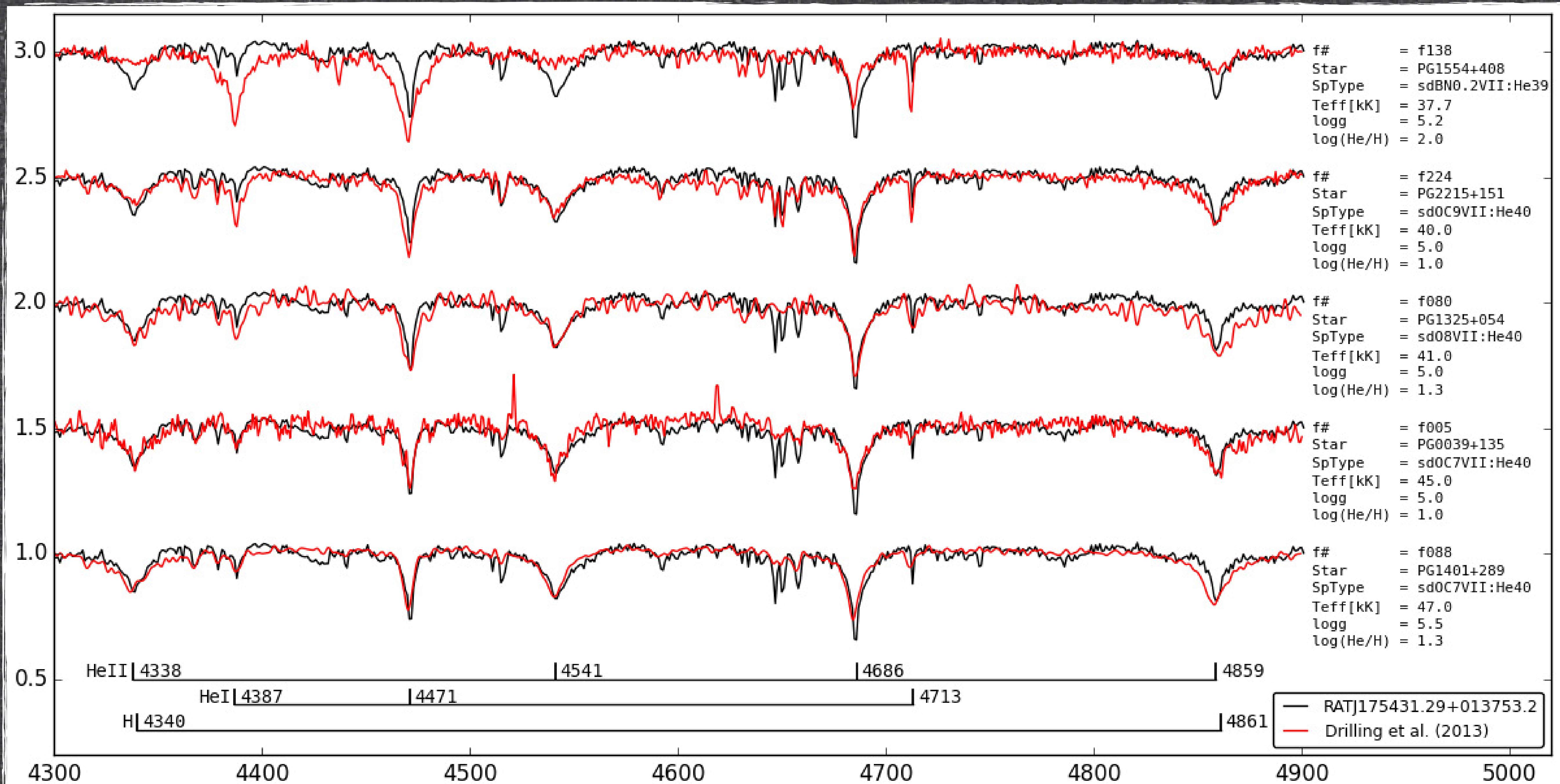

He weak
H + HeII
PG1708+602 sdO2VII:He14
PG1543+629 sdO7VII:He1
PG1448−052 sdO8VII:He0
PG2151+100 sdB0VII:He0
PG1648+536 sdB1VII:He0
PG1458+423 sdB1.5VII:He0
PG2349+002 sdB2VII:He0
PG1510+635 sdB8IV:He0
HD 14829 sdA0IV:He0
Flux (continuum = 2) +const.
Wavelength (Å)

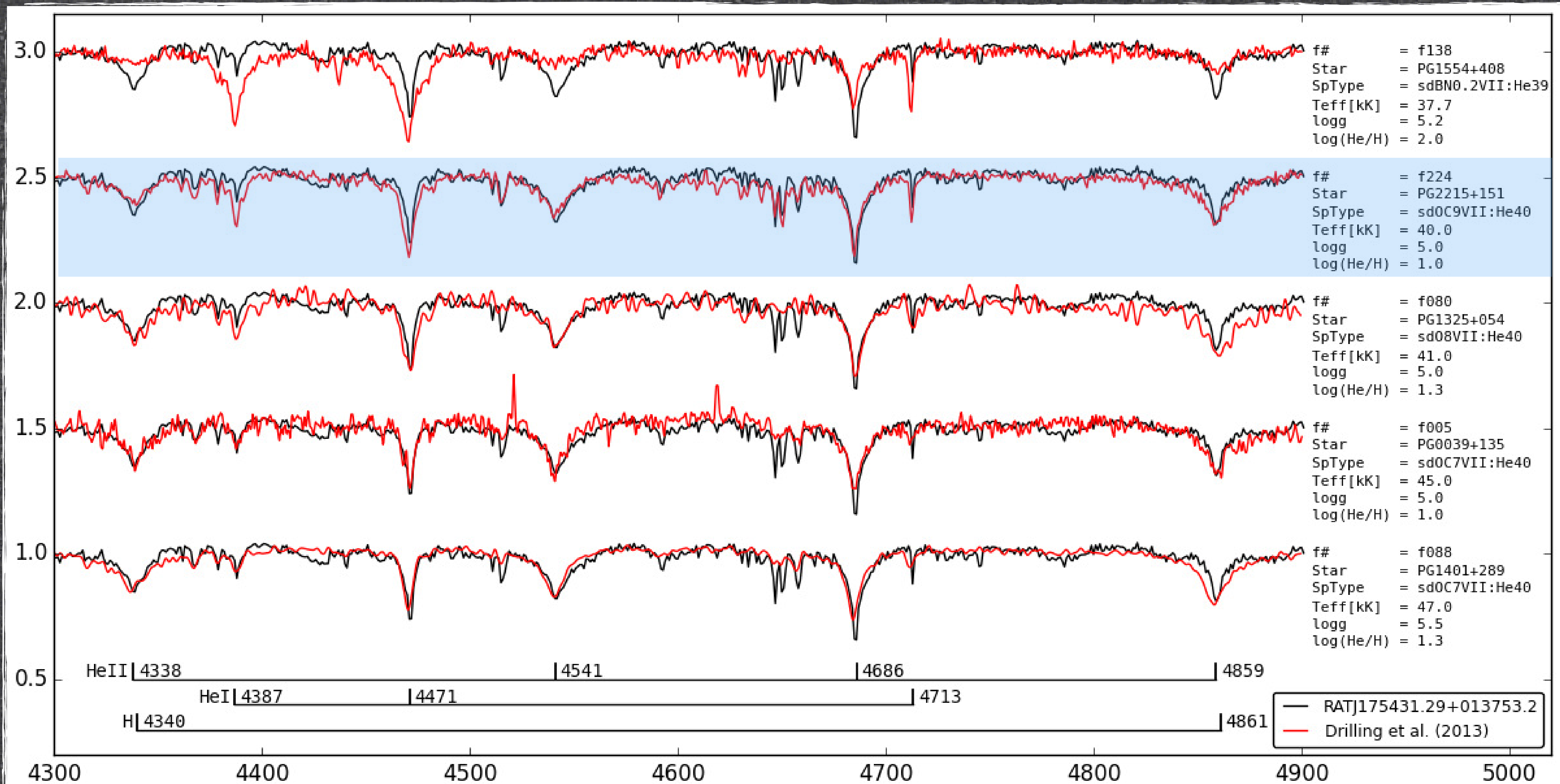

He strong
HeII
PG1355−064 sdO2VIII:He40
PG1220−056 sdO3VII:He40e
PG2352+181 sdO7VII:He40
PG1325+054 sdO8VII:He40
PG1624+085 sdO9VII:He39
HZ 44 sdBN0VII:He28
PG1629+466 sdBN0.2VII:He29
PG1615+413 sdBN1VII:He37
NIII
HeI
H
Flux (continuum = 2) +const.


He normal
H + HeII
NV
OIV
CIV
BD+28 4211 sdO2VIII:He5
Feige 110 sdO8VIII:He5
PG1047+003 sdO9VII:He6
PG1640+645 sdB0VII:He9
PG1707+657 sdB0.2VII:He9
PG1619+522 sdB0.5VII:He7
PG1532+523 sdB1VII:He4
Feige 38 sdB1.5VII:He3
SiIII
BD−7 3477 sdB2VII:He3
PG1627+006 sdB2.5VII:He3e
PG1558−007 sdB3VII:He3
PG1453−081 sdB5IV:He7
PG1245−042 sdB7IV:He3e
HS2253+0900 sdB8IV:He2
Feige 15 sdA0IV:He1
HeI
SiII
MgII
Flux (continuum = 2) +const.
Wavelength (Å)

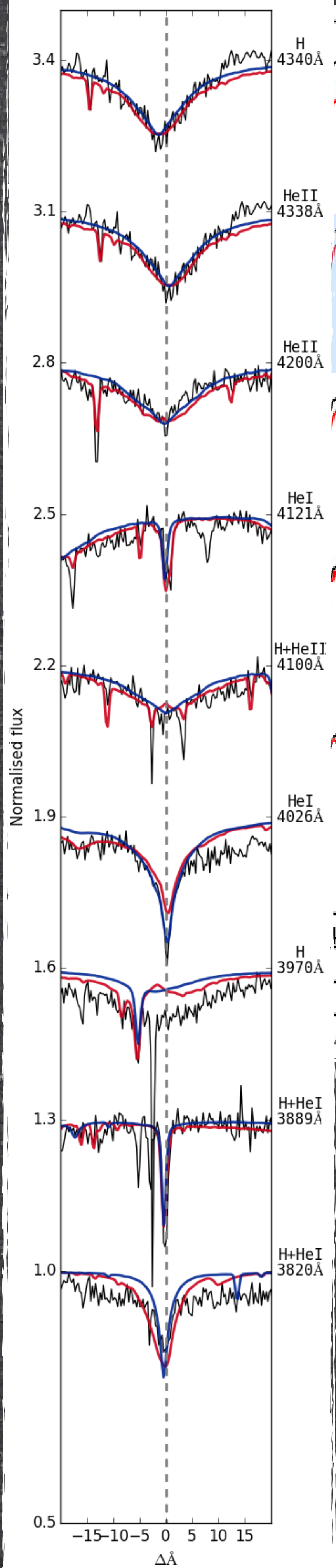

He strong C
HeII
CIV
PG1348+607 sdOC1VII:He40
PG1537−046 sdOC2VII:He40e
PG1534−018 sdOC6.5VII:He40
PG0314+146 sdOC7VII:He40
PG1600+171 sdOC8VII:He39
PG1127+019 sdOC9VII:He40
CIII
PG1658+273 sdOC9.5VII:He39
NIII
Ton 107 sdBC0.2VII:He27
PG1648+315 sdBC0.5VII:He28
PG2339+199 sdBC1VII:He34
HeI
CII
H
Flux (continuum = 2) +const.
Wavelength (Å)

08.09.2016 / UAK2016

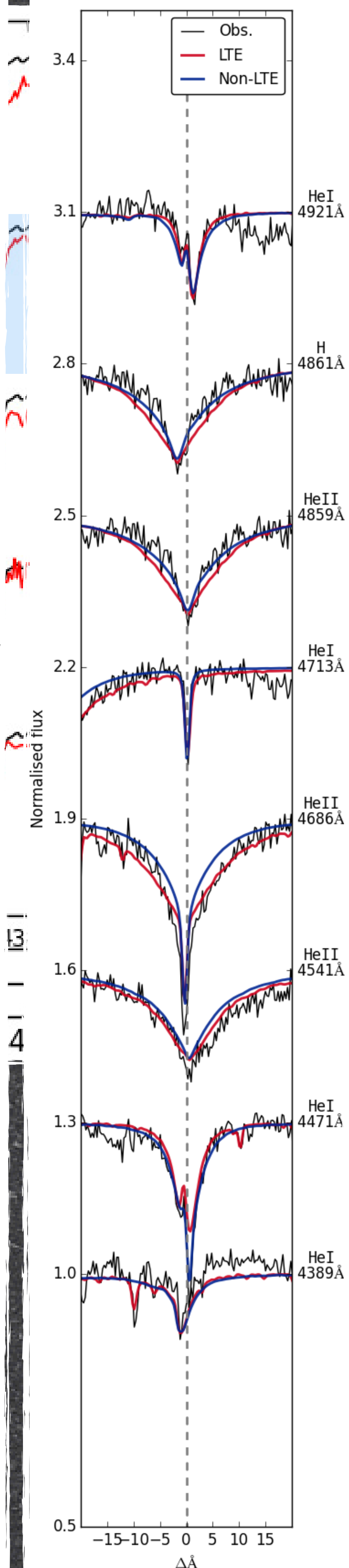

3.0
2.5
2.0
1.5
1.0
0.5
4300
4400
4500
4600
4700
4800
4900
5000
f# = f138
Star = PG1554+408
SpType = sdBN0.2VII:He39
Teff[kK] = 37.7
logg = 5.2
log(He/H) = 2.0
f# = f224
Star = PG2215+151
SpType = sdOC9VII:He40
Teff[kK] = 40.0
logg = 5.0
log(He/H) = 1.0
f# = f080
Star = PG1325+054
SpType = sdO8VII:He40
Teff[kK] = 41.0
logg = 5.0
log(He/H) = 1.3
f# = f005
Star = PG0039+135
SpType = sdOC7VII:He40
Teff[kK] = 45.0
logg = 5.0
log(He/H) = 1.0
f# = f088
Star = PG1401+289
SpType = sdOC7VII:He40
Teff[kK] = 47.0
logg = 5.5
log(He/H) = 1.3
HeII 4338 4541 4686 4859
HeI 4387 4471 4713
H 4340 4861
RATJ175431.29+013753.2
Drilling et al. (2013)



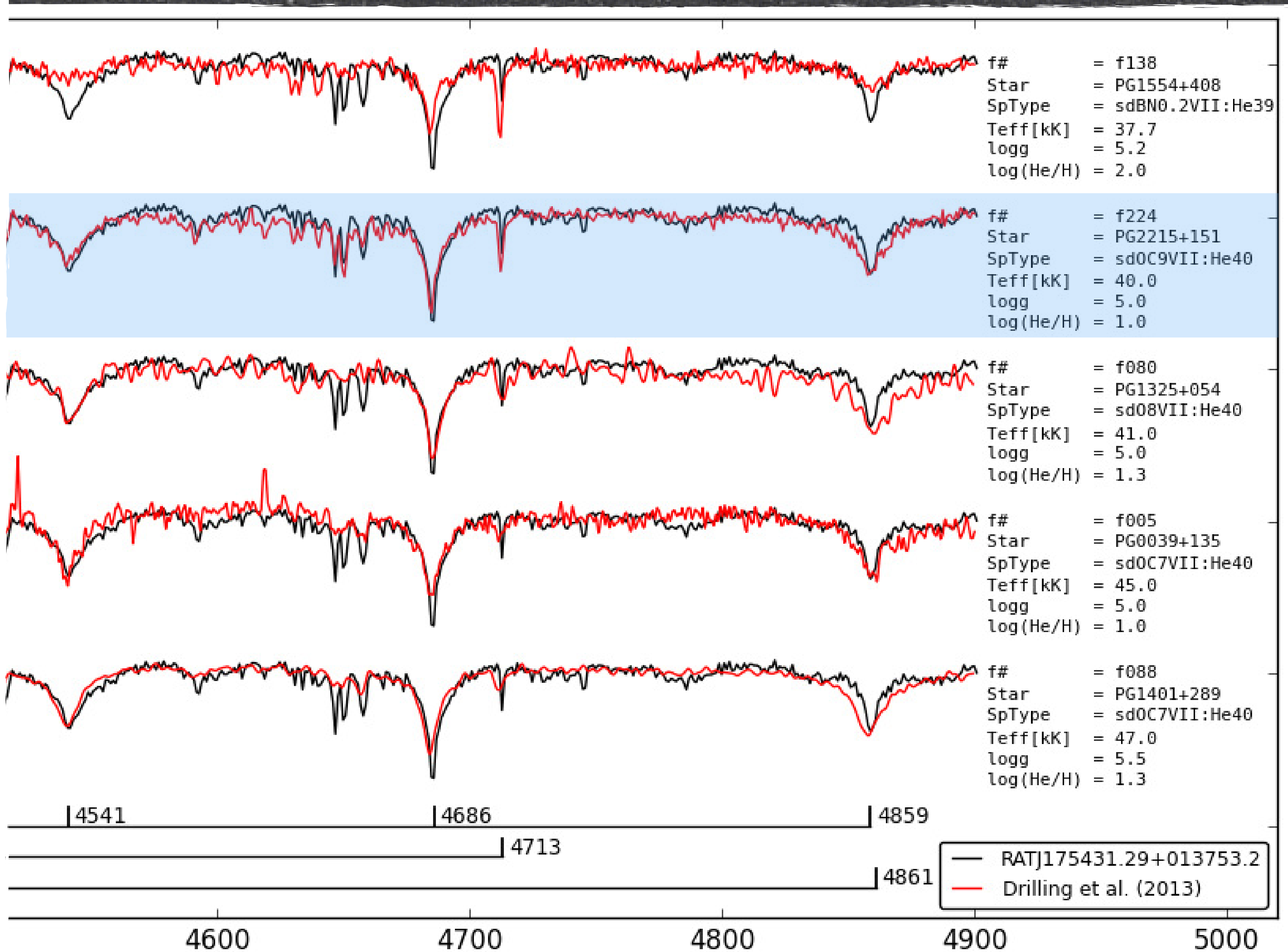
3.0
2.5
2.0
1.5
1.0
0.5
4300
4400
4500
4600
4700
4800
4900
5000
f# = f138
Star = PG1554+408
SpType = sdBN0.2VII:He39
Teff[kK] = 37.7
logg = 5.2
log(He/H) = 2.0
f# = f224
Star = PG2215+151
SpType = sdOC9VII:He40
Teff[kK] = 40.0
logg = 5.0
log(He/H) = 1.0
f# = f080
Star = PG1325+054
SpType = sdO8VII:He40
Teff[kK] = 41.0
logg = 5.0
log(He/H) = 1.3
f# = f005
Star = PG0039+135
SpType = sdOC7VII:He40
Teff[kK] = 45.0
logg = 5.0
log(He/H) = 1.0
f# = f088
Star = PG1401+289
SpType = sdOC7VII:He40
Teff[kK] = 47.0
logg = 5.5
log(He/H) = 1.3
HeII 4338 4541 4686 4859
HeI 4387 4471 4713
H 4340 4861
RATJ175431.29+013753.2
Drilling et al. (2013)



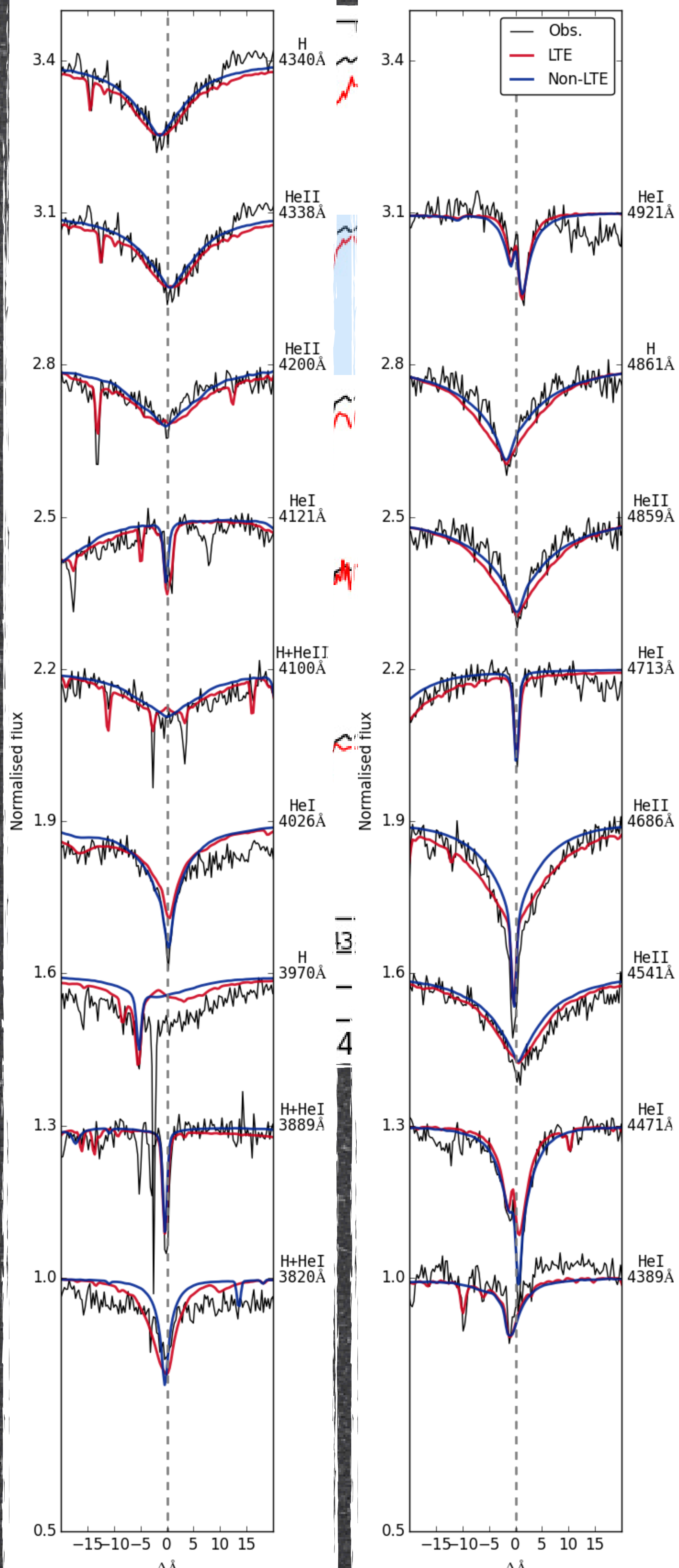
Normalised flux
ΔÅ
H 4340Å
HeII 4338Å
HeII 4200Å
HeI 4121Å
H+HeII 4100Å
HeI 4026Å
H 3970Å
H+HeI 3889Å
H+HeI 3820Å

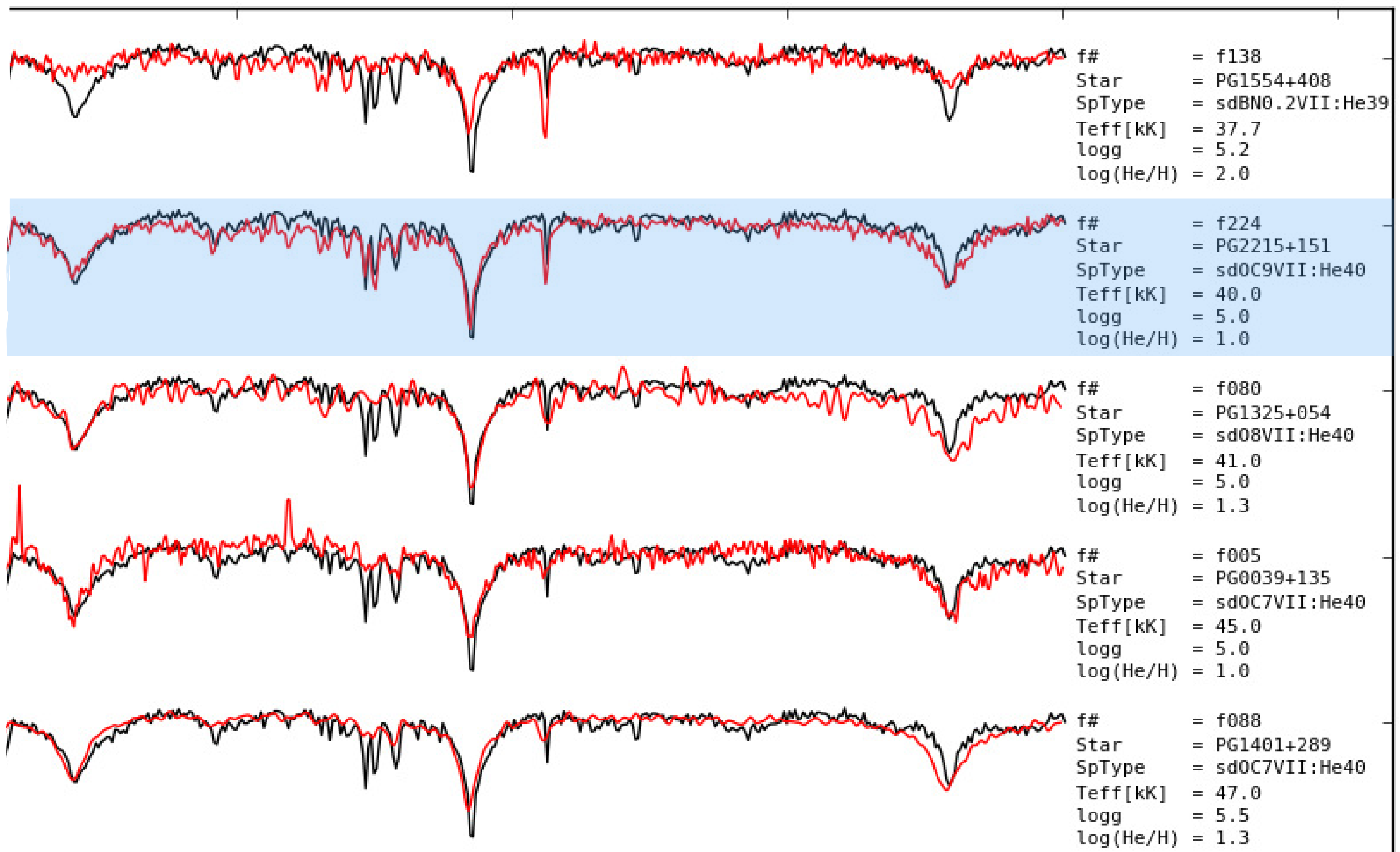


Obs.
LTE
Non-LTE
Normalised flux
ΔÅ
HeI 4921Å
H 4861Å
HeII 4859Å
HeI 4713Å
HeII 4686Å
HeII 4541Å
HeI 4471Å
HeI 4389Å

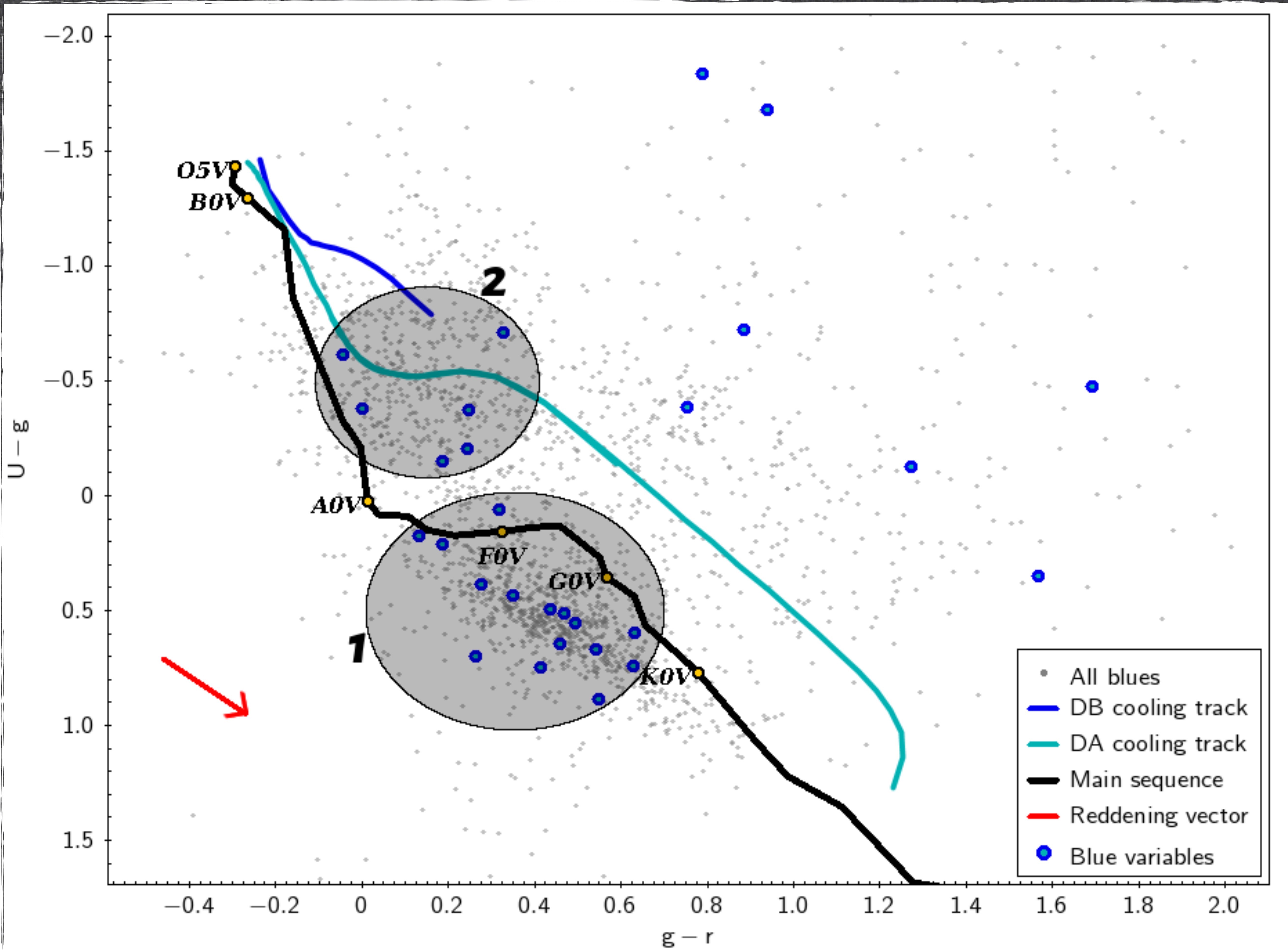


f# = f138
Star = PG1554+408
SpType = sdBN0.2VII:He39
Teff[kK] = 37.7
logg = 5.2
log(He/H) = 2.0
f# = f224
Star = PG2215+151
SpType = sdOC9VII:He40
Teff[kK] = 40.0
logg = 5.0
log(He/H) = 1.0
f# = f080
Star = PG1325+054
SpType = sdO8VII:He40
Teff[kK] = 41.0
logg = 5.0
log(He/H) = 1.3
f# = f005
Star = PG0039+135
SpType = sdOC7VII:He40
Teff[kK] = 45.0
logg = 5.0
log(He/H) = 1.0
f# = f088
Star = PG1401+289
SpType = sdOC7VII:He40
Teff[kK] = 47.0
logg = 5.5
log(He/H) = 1.3
4541
4686
4859
4713
4861
RATJ175431.29+013753.2
Drilling et al. (2013)
4600
4700
4800
4900
5000

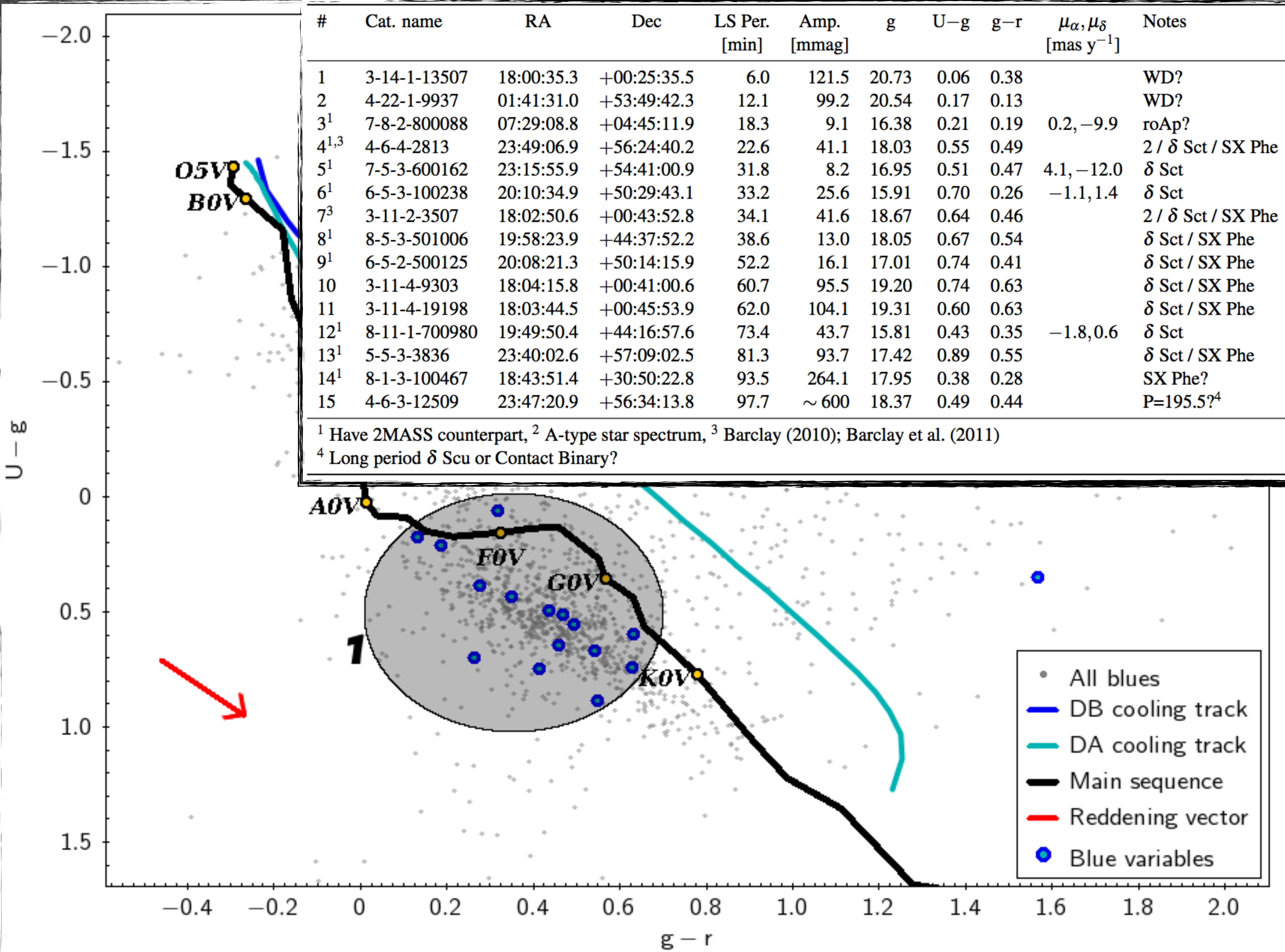




		RATJ1754+0137	RATJ1759+0119
Drilling Classification	**Class**	sdOC7.5VII:He40	sdOC9VII:He40
	T_{eff} **[K]**	44000 ± 1600	40000 ± 1600
	$\log g$ **[cgs]**	5.0	5.0
	log(nHe/nH)	1.3	1.0
Spectral Fitting	**Spectral Type Index**	6.9 ± 1.4	8.5 ± 1.4
	T_{eff} **[K]**	46000 ± 2000	42000 ± 2000
	$\log g$ **[cgs]**	6.2 ± 0.4	5.4 ± 0.4
	log(nHe/nH)	4.0	4.0

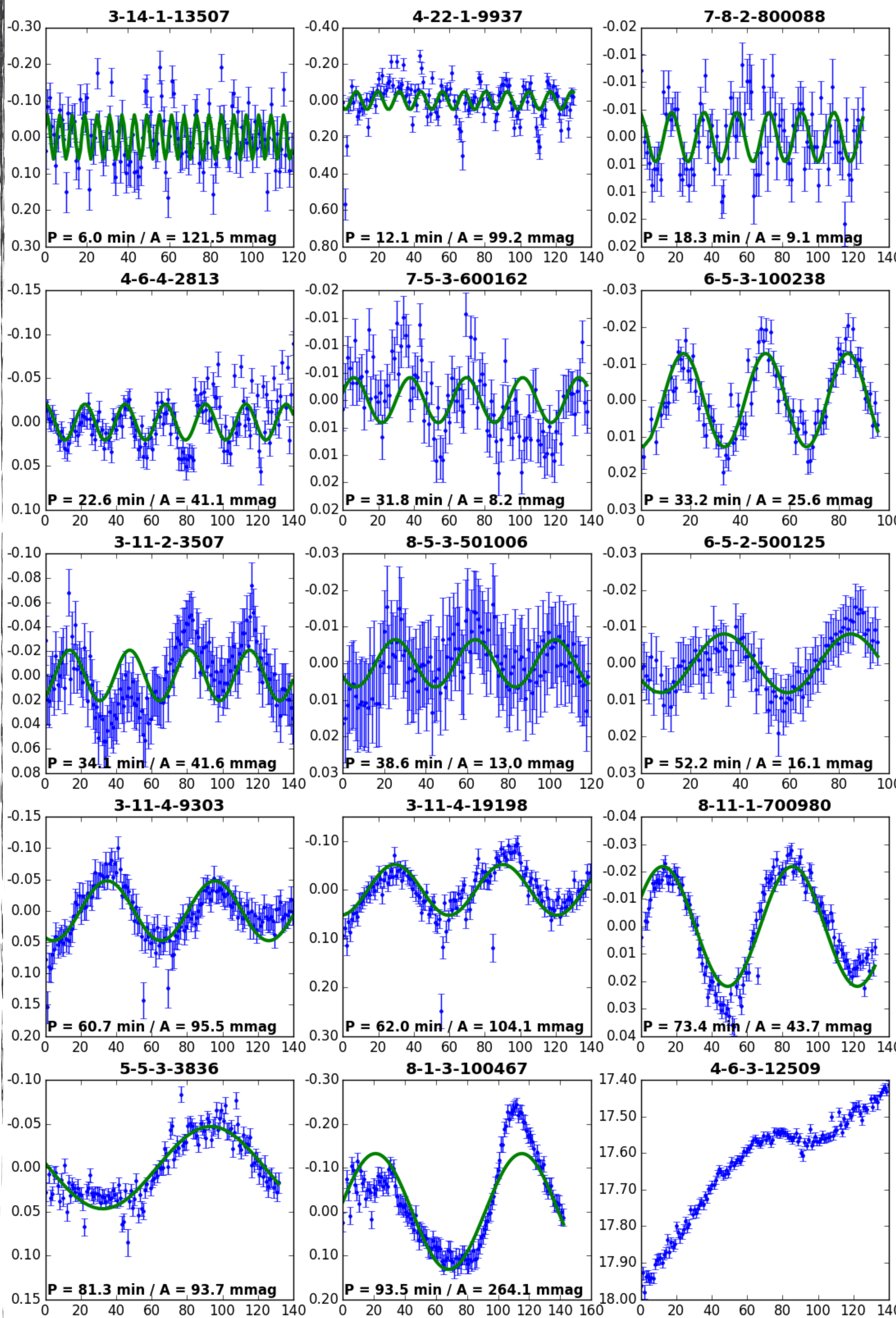


−2.0
−1.5
−1.0
−0.5
0
0.5
1.0
1.5
U − g
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
g − r
O5V
B0V
A0V
F0V
G0V
K0V
1
2
All blues
DB cooling track
DA cooling track
Main sequence
Reddening vector
Blue variables



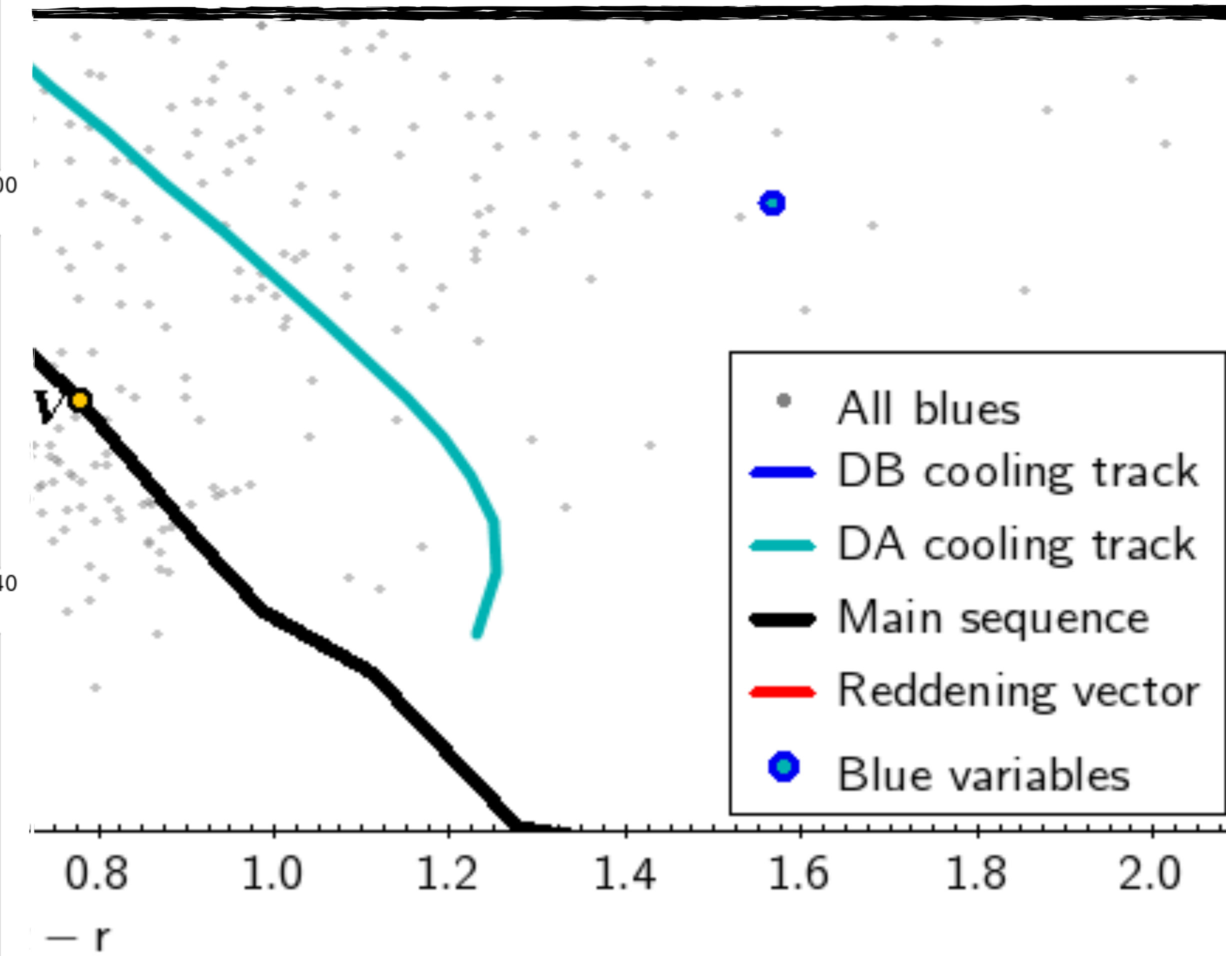
#	Cat. name	RA	Dec	LS Per. [min]	Amp. [mmag]	g	U−g	g−r	μ_α, μ_δ [mas y^{-1}]	Notes
1	3-14-1-13507	18:00:35.3	+00:25:35.5	6.0	121.5	20.73	0.06	0.38		WD?
2	4-22-1-9937	01:41:31.0	+53:49:42.3	12.1	99.2	20.54	0.17	0.13		WD?
3[1]	7-8-2-800088	07:29:08.8	+04:45:11.9	18.3	9.1	16.38	0.21	0.19	0.2, −9.9	roAp?
4[1,3]	4-6-4-2813	23:49:06.9	+56:24:40.2	22.6	41.1	18.03	0.55	0.49		2 / δ Sct / SX Phe
5[1]	7-5-3-600162	23:15:55.9	+54:41:00.9	31.8	8.2	16.95	0.51	0.47	4.1, −12.0	δ Sct
6[1]	6-5-3-100238	20:10:34.9	+50:29:43.1	33.2	25.6	15.91	0.70	0.26	−1.1, 1.4	δ Sct
7[3]	3-11-2-3507	18:02:50.6	+00:43:52.8	34.1	41.6	18.67	0.64	0.46		2 / δ Sct / SX Phe
8[1]	8-5-3-501006	19:58:23.9	+44:37:52.2	38.6	13.0	18.05	0.67	0.54		δ Sct / SX Phe
9[1]	6-5-2-500125	20:08:21.3	+50:14:15.9	52.2	16.1	17.01	0.74	0.41		δ Sct / SX Phe
10	3-11-4-9303	18:04:15.8	+00:41:00.6	60.7	95.5	19.20	0.74	0.63		δ Sct / SX Phe
11	3-11-4-19198	18:03:44.5	+00:45:53.9	62.0	104.1	19.31	0.60	0.63		δ Sct / SX Phe
12[1]	8-11-1-700980	19:49:50.4	+44:16:57.6	73.4	43.7	15.81	0.43	0.35	−1.8, 0.6	δ Sct
13[1]	5-5-3-3836	23:40:02.6	+57:09:02.5	81.3	93.7	17.42	0.89	0.55		δ Sct / SX Phe
14[1]	8-1-3-100467	18:43:51.4	+30:50:22.8	93.5	264.1	17.95	0.38	0.28		SX Phe?
15	4-6-3-12509	23:47:20.9	+56:34:13.8	97.7	∼ 600	18.37	0.49	0.44		P=195.5?[4]

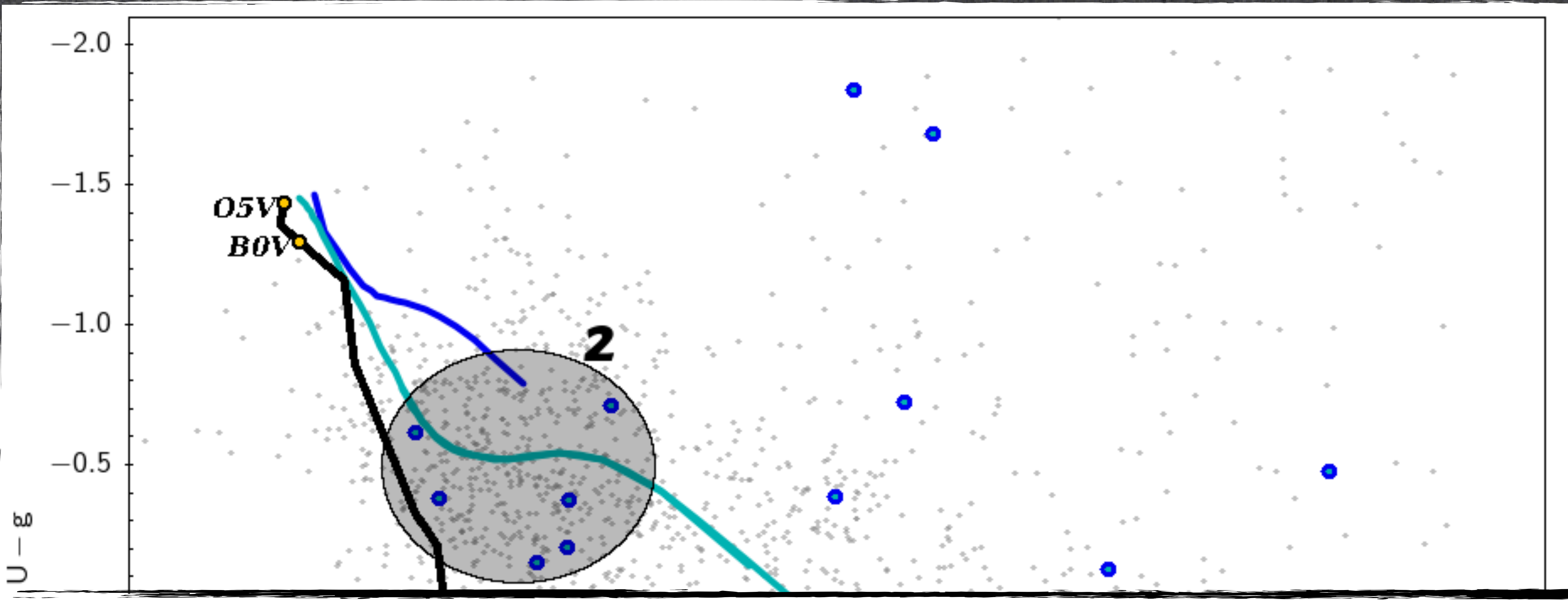
[1] Have 2MASS counterpart, [2] A-type star spectrum, [3] Barclay (2010); Barclay et al. (2011)
[4] Long period δ Scu or Contact Binary?



	LS Per. [min]	Amp. [mmag]	g	U−g	g−r	μ_α, μ_δ [mas y^{-1}]	Notes
5.5	6.0	121.5	20.73	0.06	0.38		WD?
2.3	12.1	99.2	20.54	0.17	0.13		WD?
1.9	18.3	9.1	16.38	0.21	0.19	0.2, −9.9	roAp?
0.2	22.6	41.1	18.03	0.55	0.49		2 / δ Sct / SX Phe
0.9	31.8	8.2	16.95	0.51	0.47	4.1, −12.0	δ Sct
3.1	33.2	25.6	15.91	0.70	0.26	−1.1, 1.4	δ Sct
2.8	34.1	41.6	18.67	0.64	0.46		2 / δ Sct / SX Phe
2.2	38.6	13.0	18.05	0.67	0.54		δ Sct / SX Phe
5.9	52.2	16.1	17.01	0.74	0.41		δ Sct / SX Phe
0.6	60.7	95.5	19.20	0.74	0.63		δ Sct / SX Phe
3.9	62.0	104.1	19.31	0.60	0.63		δ Sct / SX Phe
7.6	73.4	43.7	15.81	0.43	0.35	−1.8, 0.6	δ Sct
2.5	81.3	93.7	17.42	0.89	0.55		δ Sct / SX Phe
2.8	93.5	264.1	17.95	0.38	0.28		SX Phe?
3.8	97.7	∼ 600	18.37	0.49	0.44		P=195.5?[4]

rum, [3] Barclay (2010); Barclay et al. (2011)



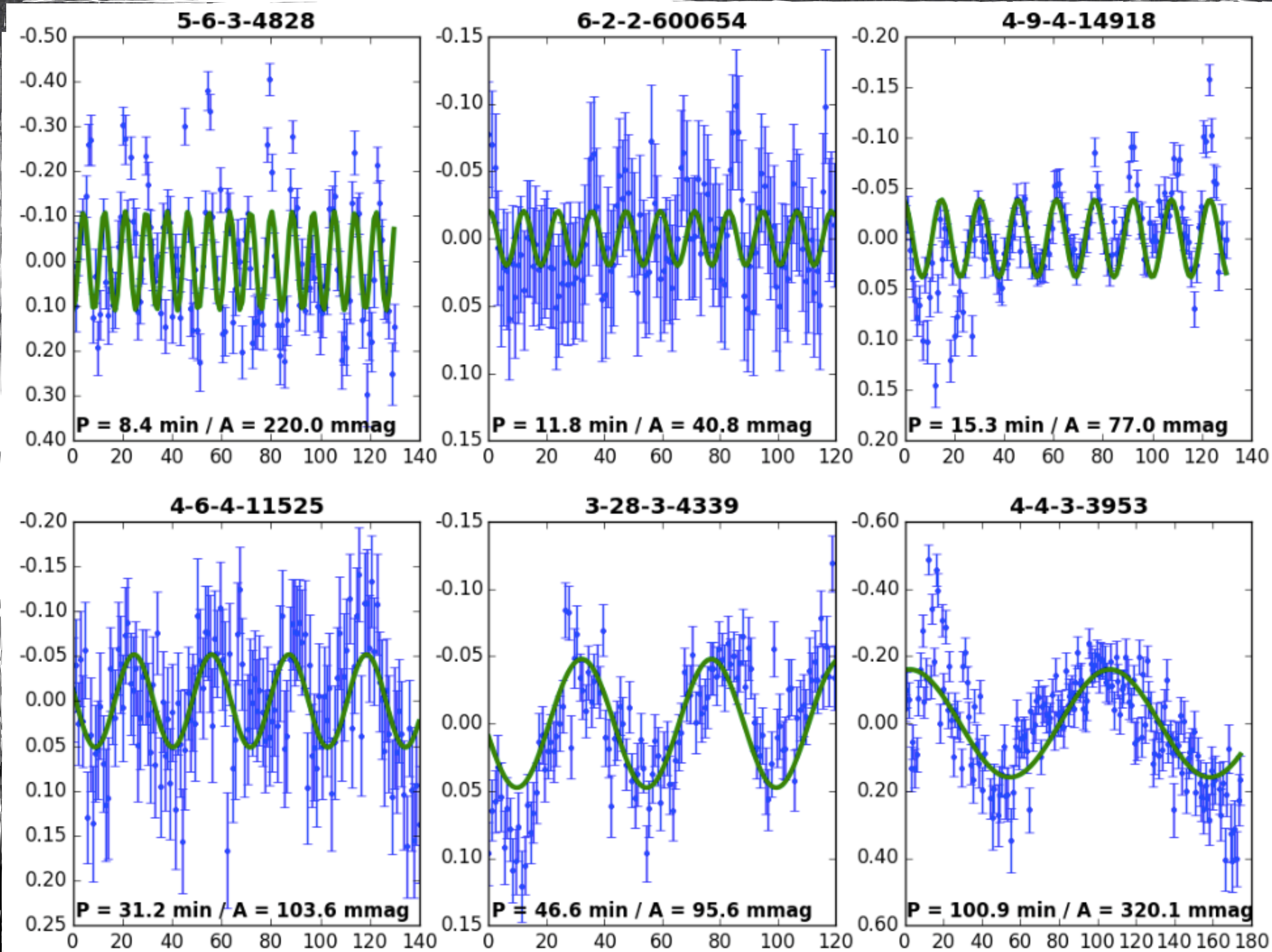


#	Cat. name	RA	Dec	LS Per. [min]	Amp. [mmag]	g	U−g	g−r	Notes
1	5-6-3-4828	04:32:10.4	+40:33:34.0	8.4	220.0	20.50	−0.20	0.24	Pul.WD[1,2]
2	6-2-2-600654	00:01:34.9	+51:06:04.5	11.8	40.8	19.16	−0.38	0.00	ZZ Ceti
3	4-9-4-14918	20:59:03.0	+45:37:36.1	15.3	77.0	18.43	−0.15	0.19	ZZ Ceti[2]
4	4-6-4-11525	23:47:46.8	+56:28:52.2	31.2	103.6	21.18	−0.38	0.25	Pul.WD[2]
5	3-28-3-4339	20:31:33.6	+27:34:32.6	46.6	95.6	20.09	−0.71	0.38	Pul.WD
6	4-4-3-3953	02:52:37.1	+50:51:25.5	100.9	320.1	20.40	−0.62	−0.04	β Cep?

[1] Low signal-to-noise spectrum, no obvious emission lines

[2] Barclay (2010) and Barclay et al. (2011)

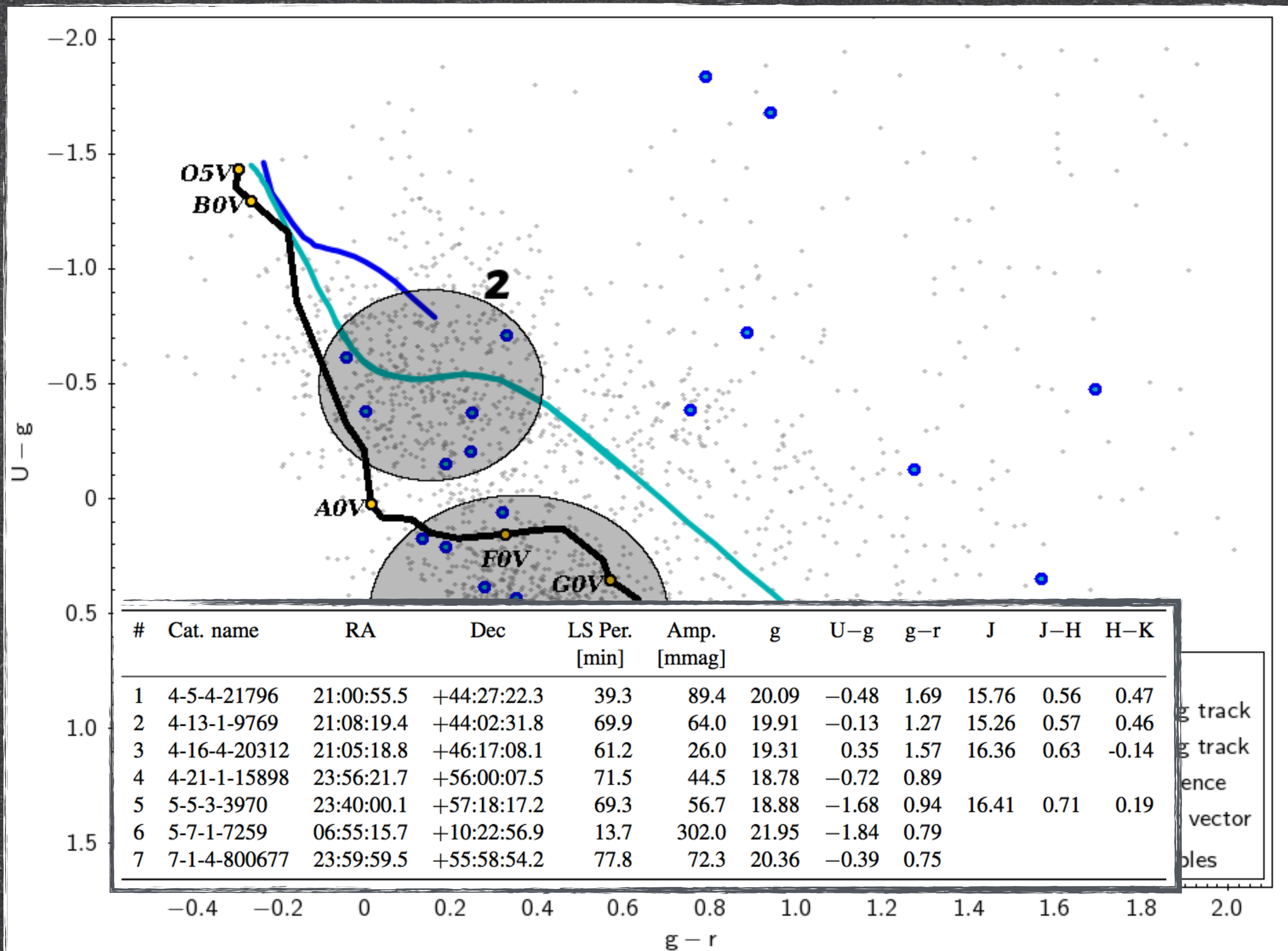
g − r



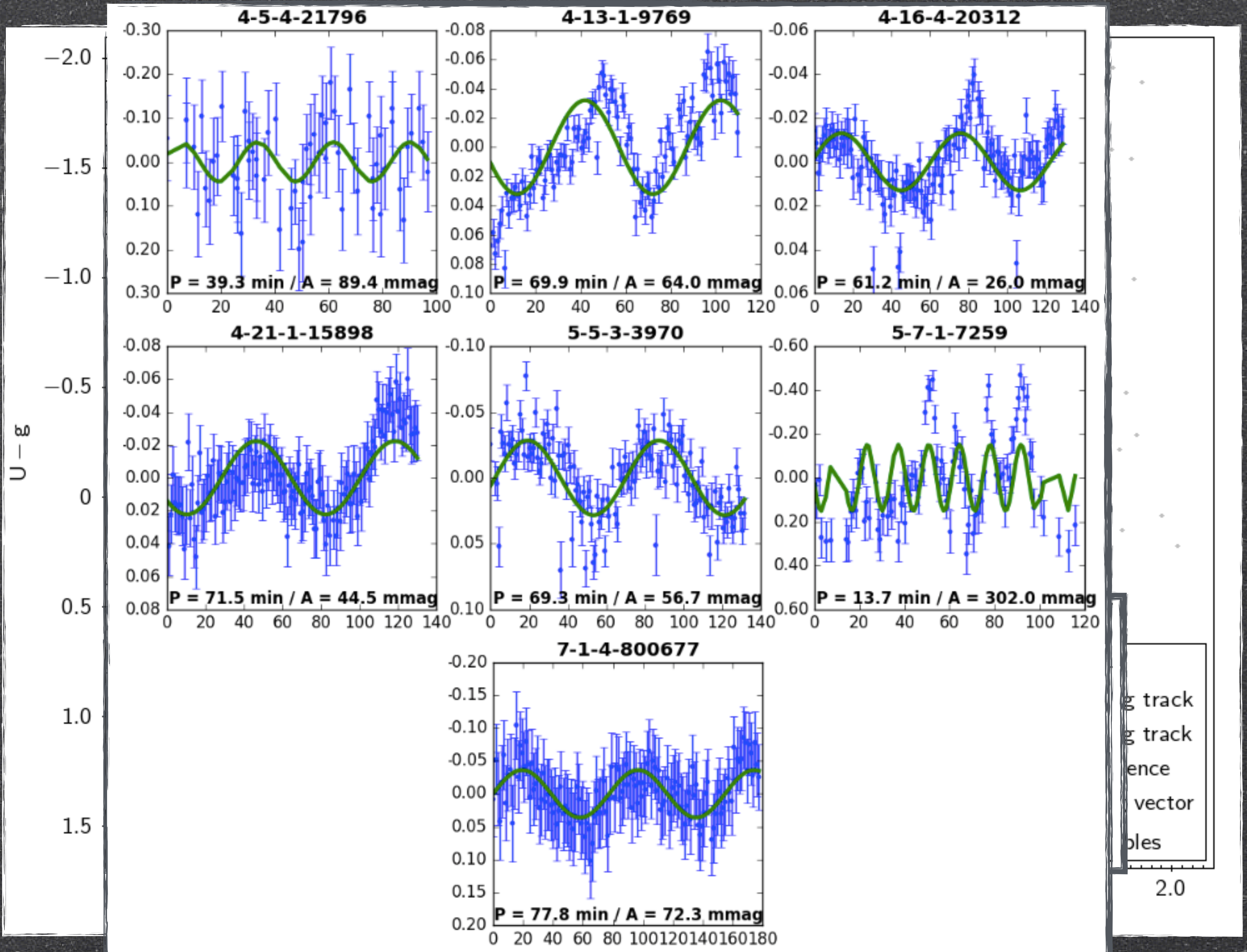
Notes
Pul.WD[1,2]
ZZ Ceti
ZZ Ceti[2]
Pul.WD[2]
Pul.WD
β Cep?

[1] Low signal-to-noise spectrum, no obvious emission lines
[2] Barclay (2010) and Barclay et al. (2011)

g − r



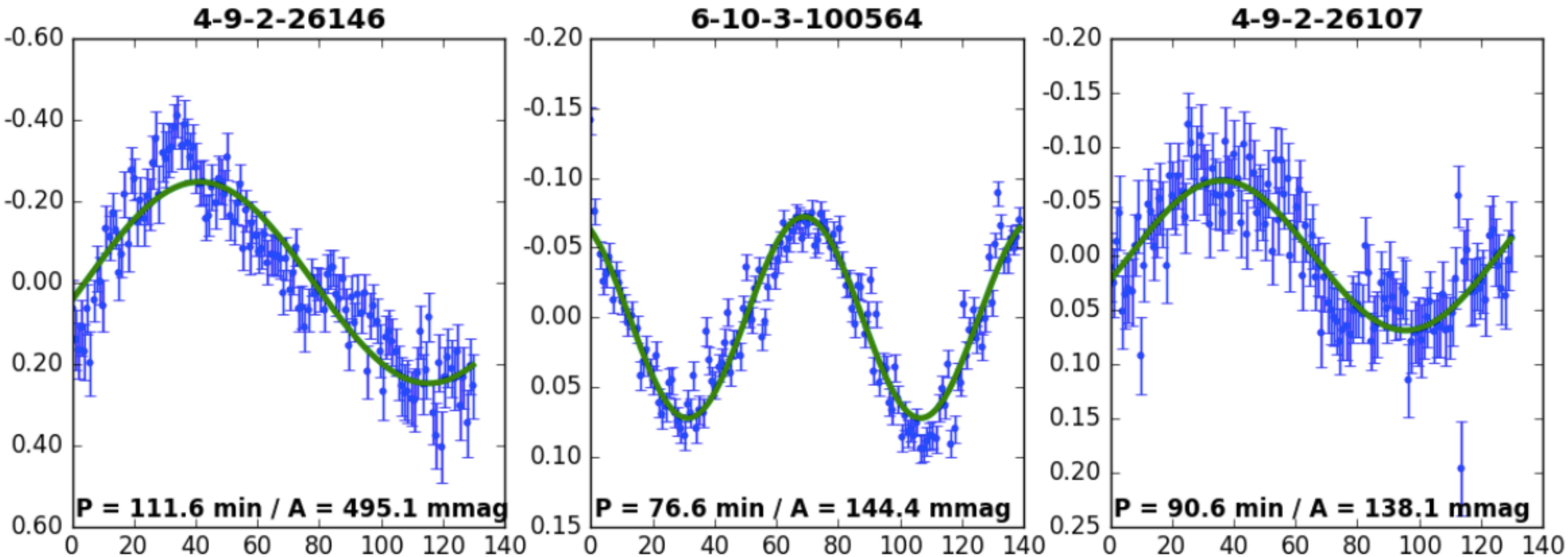
#	Cat. name	RA	Dec	LS Per. [min]	Amp. [mmag]	g	U−g	g−r	J	J−H	H−K
1	4-5-4-21796	21:00:55.5	+44:27:22.3	39.3	89.4	20.09	−0.48	1.69	15.76	0.56	0.47
2	4-13-1-9769	21:08:19.4	+44:02:31.8	69.9	64.0	19.91	−0.13	1.27	15.26	0.57	0.46
3	4-16-4-20312	21:05:18.8	+46:17:08.1	61.2	26.0	19.31	0.35	1.57	16.36	0.63	-0.14
4	4-21-1-15898	23:56:21.7	+56:00:07.5	71.5	44.5	18.78	−0.72	0.89			
5	5-5-3-3970	23:40:00.1	+57:18:17.2	69.3	56.7	18.88	−1.68	0.94	16.41	0.71	0.19
6	5-7-1-7259	06:55:15.7	+10:22:56.9	13.7	302.0	21.95	−1.84	0.79			
7	7-1-4-800677	23:59:59.5	+55:58:54.2	77.8	72.3	20.36	−0.39	0.75			



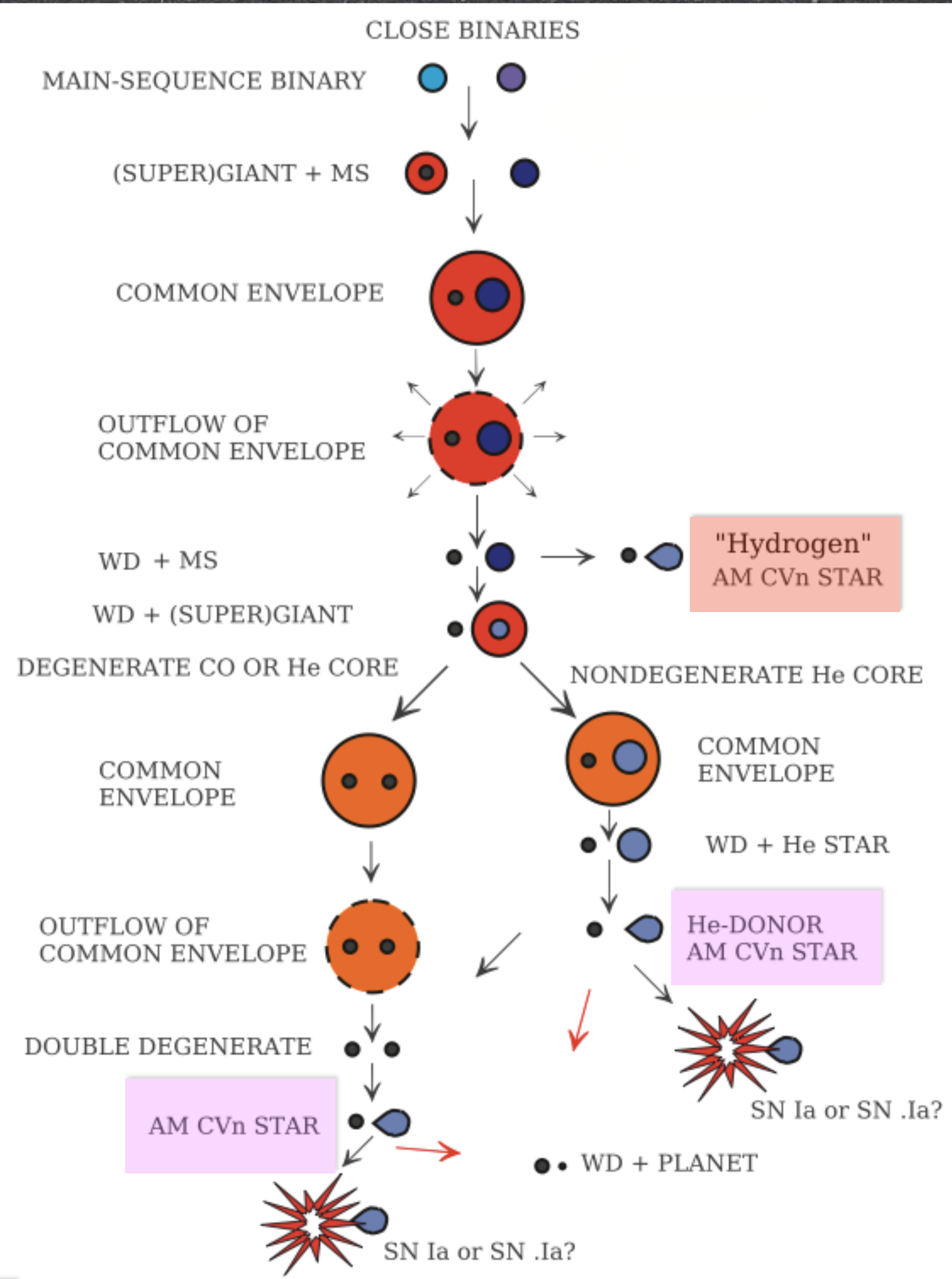
4-5-4-21796
P = 39.3 min / A = 89.4 mmag
4-13-1-9769
P = 69.9 min / A = 64.0 mmag
4-16-4-20312
P = 61.2 min / A = 26.0 mmag
4-21-1-15898
P = 71.5 min / A = 44.5 mmag
5-5-3-3970
P = 69.3 min / A = 56.7 mmag
5-7-1-7259
P = 13.7 min / A = 302.0 mmag
7-1-4-800677
P = 77.8 min / A = 72.3 mmag
U − g

#	Cat. name	RA	Dec	LS Per. [min]	Amp. [mmag]	g	g−r	Notes
1	4-9-2-26146	20:57:26.5	+45:19:23.0	55.8[1]	495.1	20.89	0.05	δ Scu? / CB?
2	6-10-3-100564	20:07:59.4	+49:50:03.7	76.6	144.4	17.68	0.33	δ Scu? / GW Vir?
3	4-9-2-26107	20:57:32.0	+45:19:24.5	90.6	138.1	20.64	0.78	δ Scu?

[1] Is LS period half of the real period?



Teşekkürler!


CLOSE BINARIES
MAIN-SEQUENCE BINARY
(SUPER)GIANT + MS
COMMON ENVELOPE
OUTFLOW OF
COMMON ENVELOPE
WD + MS
"Hydrogen"
AM CVn STAR
WD + (SUPER)GIANT
DEGENERATE CO OR He CORE
NONDEGENERATE He CORE
COMMON
ENVELOPE
COMMON
ENVELOPE
WD + He STAR
OUTFLOW OF
COMMON ENVELOPE
He-DONOR
AM CVn STAR
DOUBLE DEGENERATE
SN Ia or SN .Ia?
AM CVn STAR
WD + PLANET
SN Ia or SN .Ia?

Survey	Cadence	Limiting magnitude
RATS	3 minutes	g' = 23
SuperWASP	1 minute - 40 minutes	W = 15
Faint Sky Variability Survey	12 minutes	V = 24
Palomar Transient Factory	1 minute - 5 days	R = 21
Large Synoptic Survey Telescope	3 days	R = 24.5

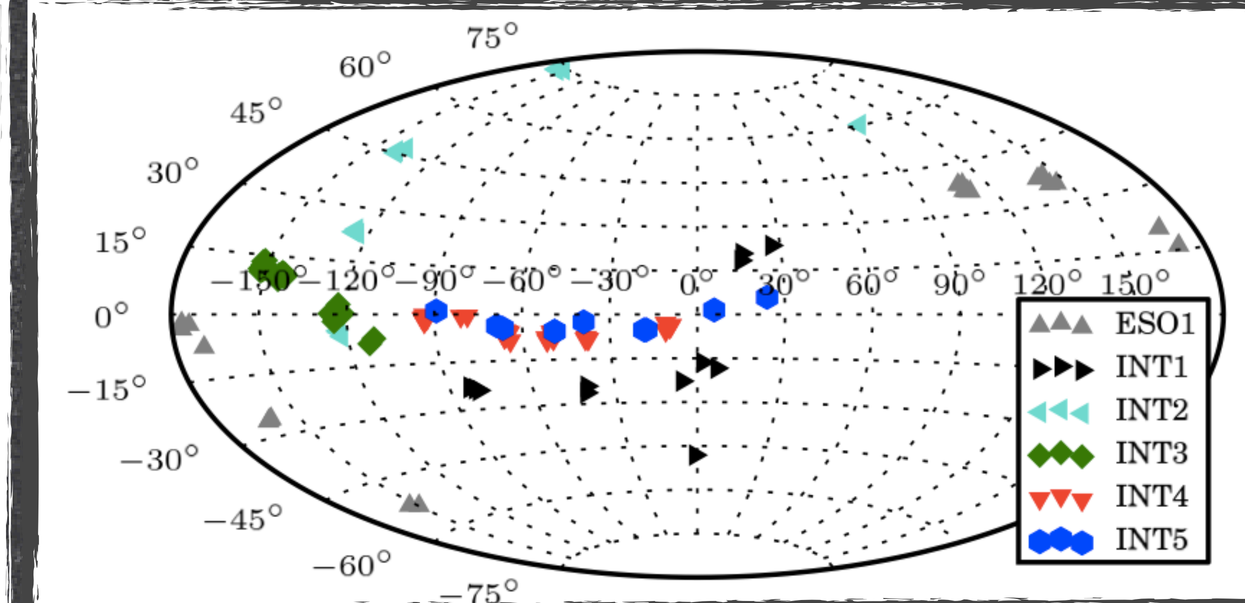
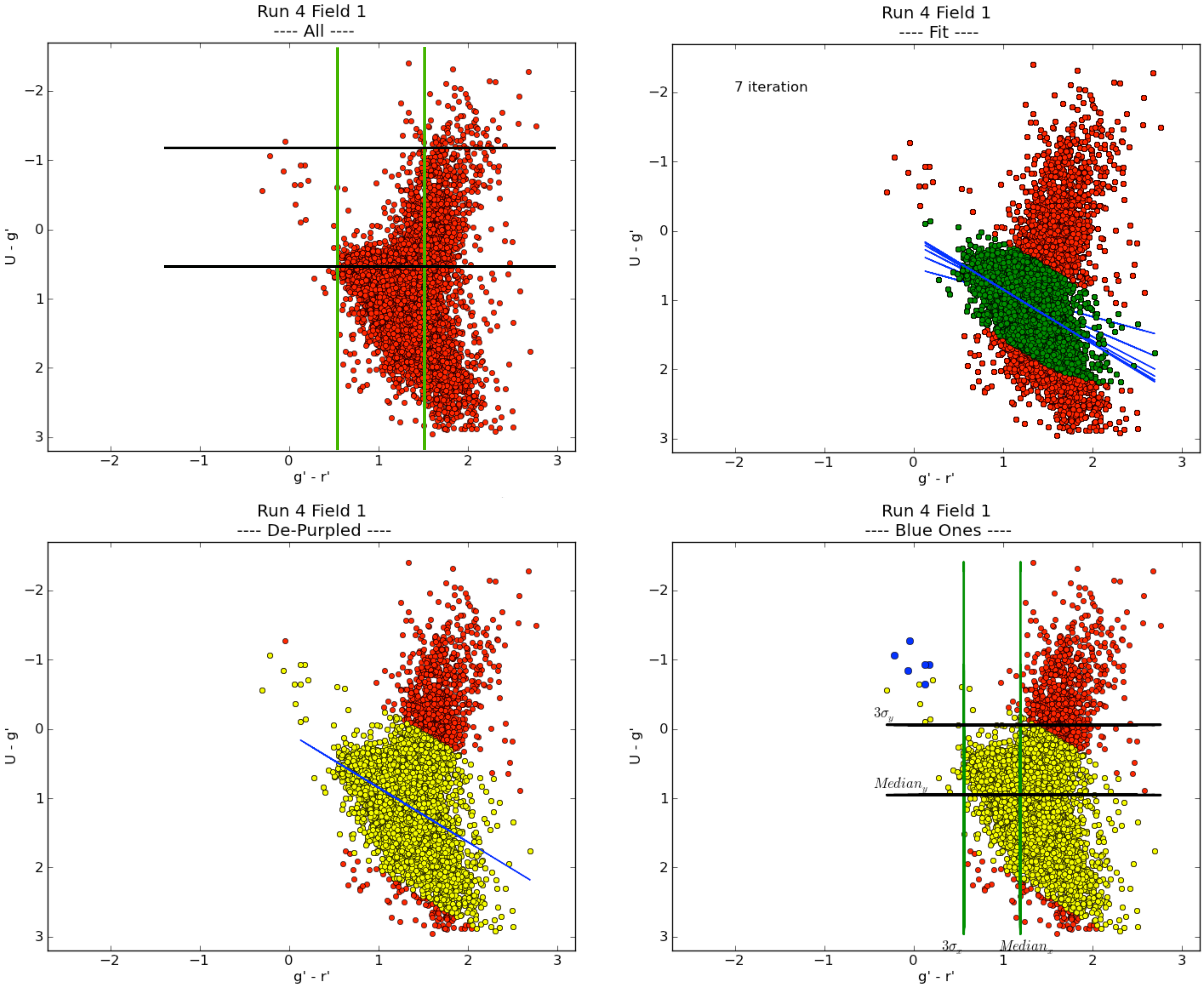
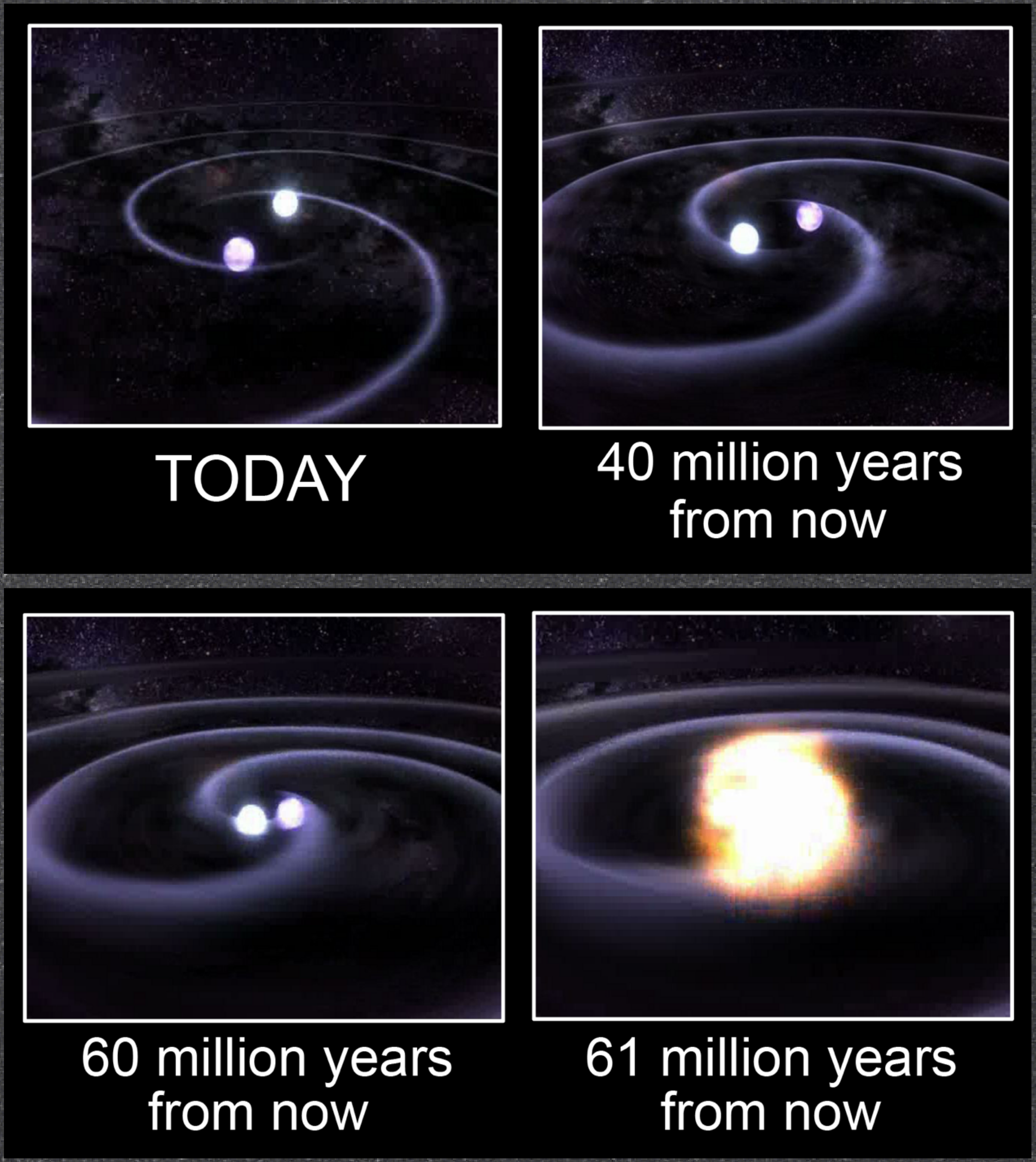


Figure 1. The position of the field centres of all the fields observed during the first five years of the RATS project. The fields are plotted in Galactic coordinates using an Aitoff projection. Many of the fields are spatially close and so appear as only a single point in this figure.

Run	Date	Sq Degrees	Filters	Stars
INT1	2003 Nov 28-30	4	WBVi'	46k
INT2	2005 May 28-31	3.5	WBVi'	234k
ESO1	2005 Jun 03-07	3	WBVi'	750k
INT3	2007 Jun 12-20	6.5	WUg'r'	1224k
INT4	2007 Oct 13-20	7.2	WUg'r'	679k
INT5	2008 Nov 03-09	2.1	WUg'r'	113k
INT6	2009 Oct 09–13	2.5	WUg'r'	384k
INT7	2009 Dec 08–12	2.5	WUg'r'	154k
ESO2	2010 Mar 18–24	4.5	WUBV	531k
INT8	2010 Jun 16–20	4.4	WUg'r'	369k


Run 4 Field 1
---- All ----
U - g'
g' - r'
Run 4 Field 1
---- Fit ----
7 iteration
U - g'
g' - r'
Run 4 Field 1
---- De-Purpled ----
U - g'
g' - r'
Run 4 Field 1
---- Blue Ones ----
$3\sigma_y$
$Median_y$
$3\sigma_x$
$Median_x$
U - g'
g' - r'


TODAY
40 million years from now
60 million years from now
61 million years from now