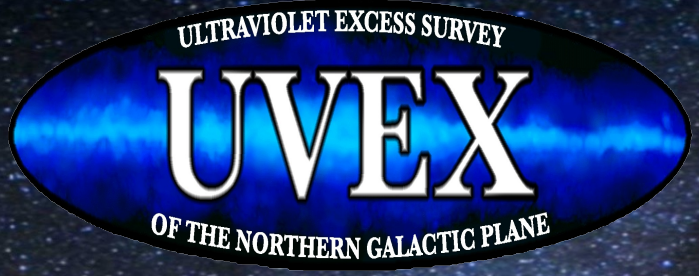

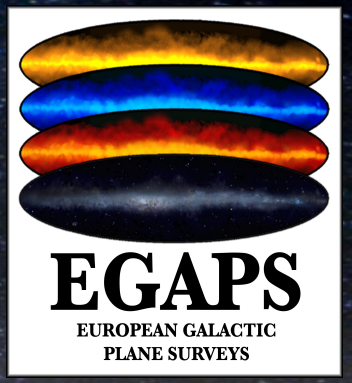

The UV-Excess survey of the Northern Galactic Plane

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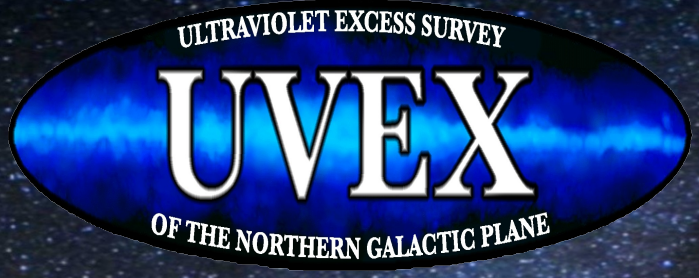
Supervisor: Prof. Paul Groot

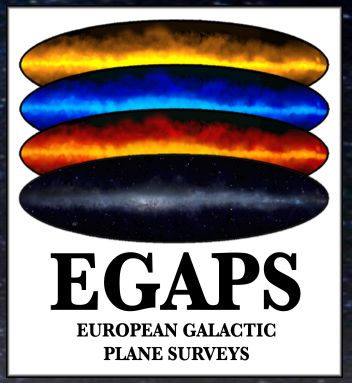
August 17, 2010 – white dwarf workshop Tübingen

Overview:

- Survey design
- Survey aims and goals
- Selection of UV-excess sources
- Spectroscopic follow-up
- Conclusions

Rosette Nebula (IPHAS)





Survey design:

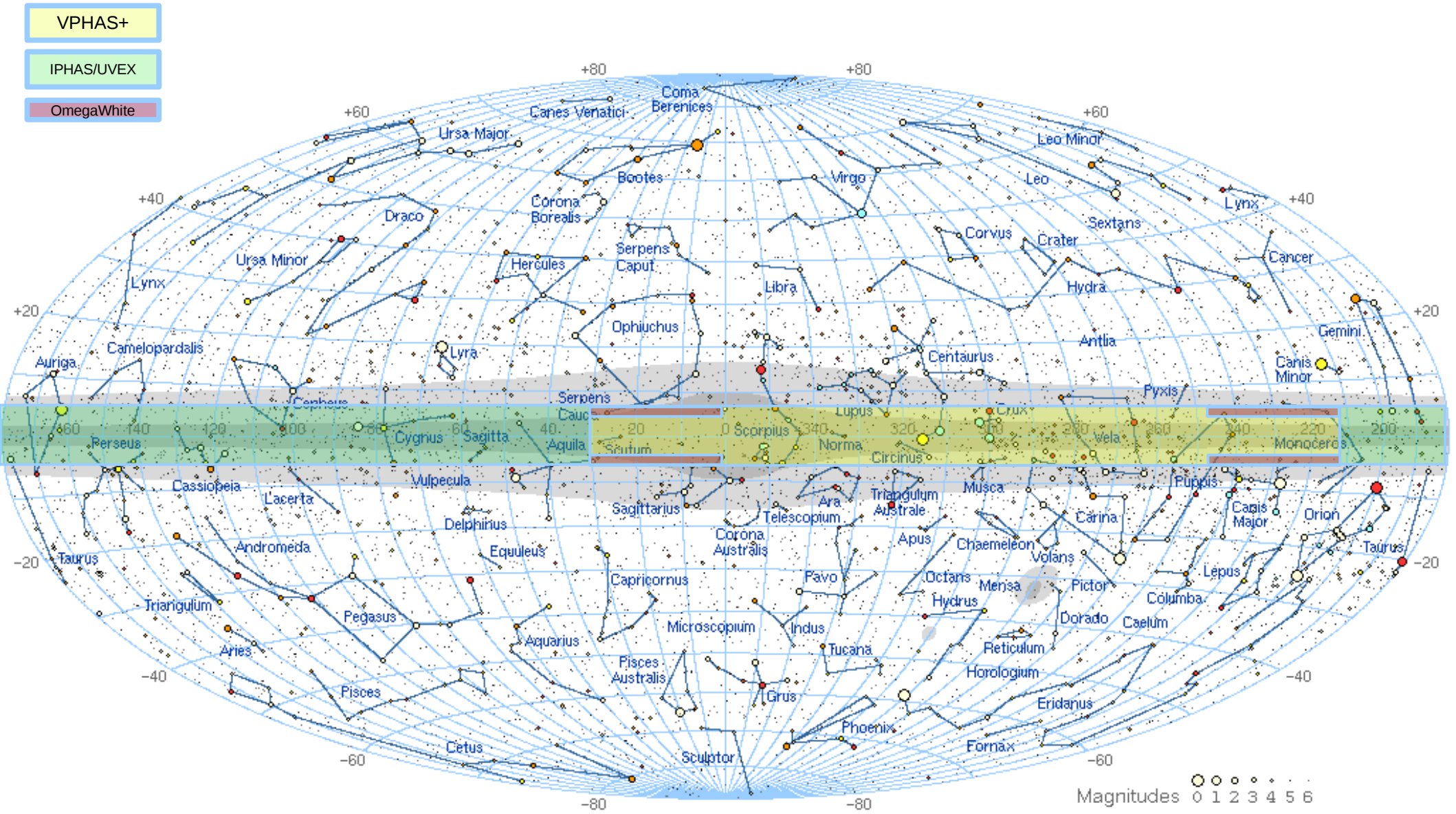
European Galactic Plane Surveys (EGAPS):

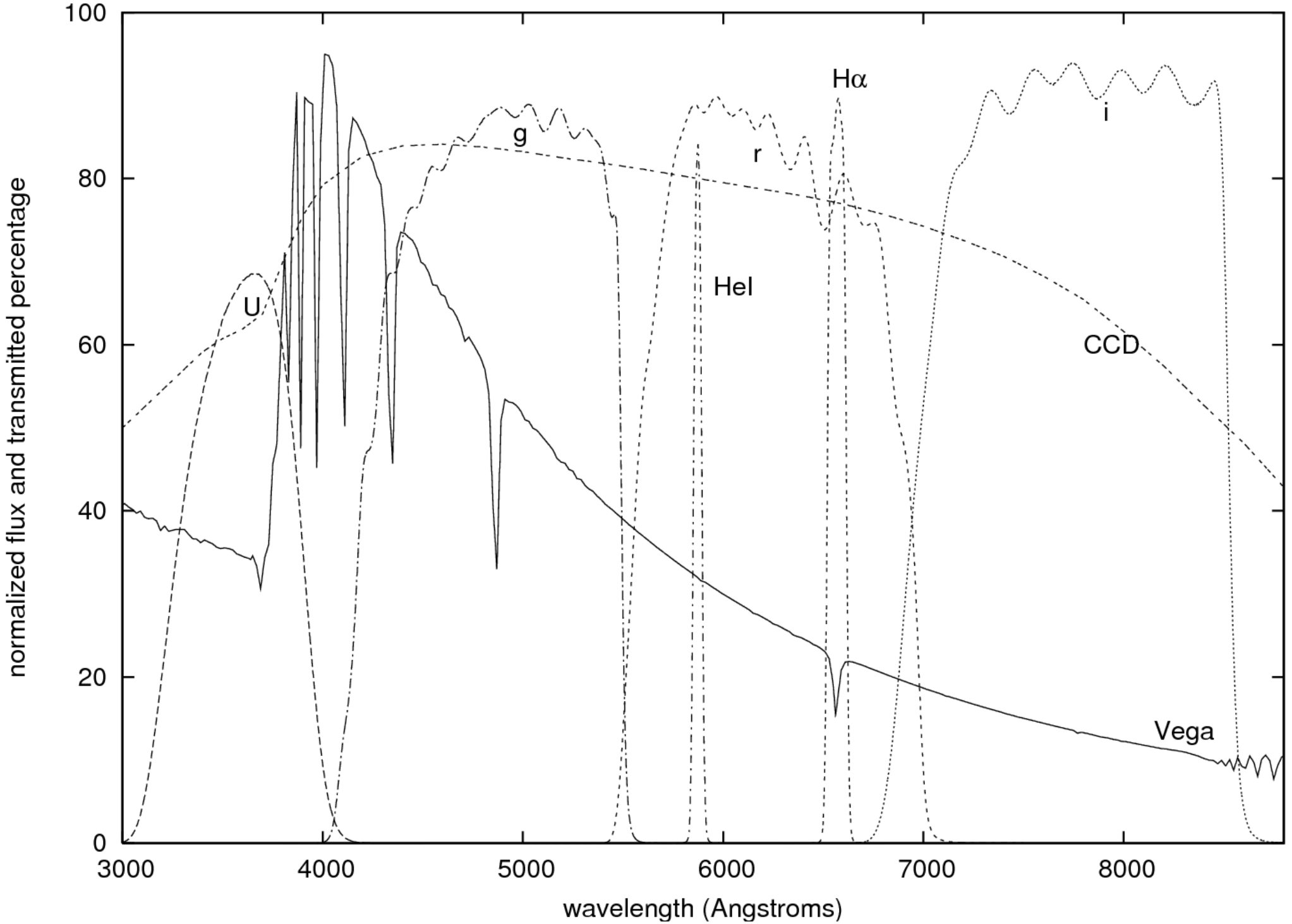
-**UVEX** (U, g, r, HeI5875) (see Groot et al., 2009)

-**IPHAS** (i, r, Hα) (see Drew et al., 2005)

image 185x10 degrees centered on the Northern Galactic Plane |b|<5 deg down to ~21-22 mag. with 0.33”/pix (2.5mtr INT+WFC, La Palma).

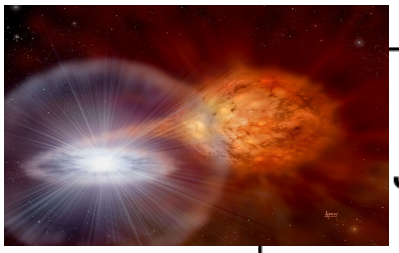
-**VPHAS+** (U, g, r, i, Hα) images the Southern Galactic Plane (2.6mtr VST, Paranal).


VPHAS+
IPHAS/UVEX
OmegaWhite
+80
+60
+40
+20
0
-20
-40
-60
-80
Coma Berenices
Canes Venatici
Ursa Major
Leo Minor
Leo
Lynx
Bootes
Virgo
Corona Borealis
Draco
Sextans
Corvus
Crater
Cancer
Ursa Minor
Serpens Caput
Hercules
Hydra
Libra
Lynx
Ophiuchus
Gemini
Camelopardalis
Auriga
Lyra
Antlia
Centaurus
Canis Minor
Serpens Cauda
Pyxis
Lupus
Crux
Scorpius
Norma
Vela
Monoceros
Cygnus
Sagitta
Aquila
Scutum
Circinus
Perseus
Cassiopeia
Vulpecula
Puppis
Lacerta
Triangulum Australe
Musca
Sagittarius
Ara
Telescopium
Carina
Canis Major
Orion
Delphinius
Corona Australis
Apus
Chaemeleon
Volans
Taurus
Andromeda
Equuleus
Octans
Mensa
Pictor
Lepus
Capricornus
Pavo
Hydrus
Columba
Triangulum
Pegasus
Microscopium
Indus
Dorado
Caelum
Aquarius
Tucana
Reticulum
Aries
Pisces Australis
Horologium
Pisces
Grus
Eridanus
Phoenix
Fornax
Cetus
Sculptor
Magnitudes 0 1 2 3 4 5 6


100
80
60
40
20
0
3000
4000
5000
6000
7000
8000
normalized flux and transmitted percentage
wavelength (Angstroms)
U
g
r
Hα
i
HeI
CCD
Vega

Survey aims and goals:

- Select a homogeneous sample of stellar remnants in our Milky Way: single and binary white dwarfs, interacting compact binaries, Cataclysmic Variables, Symbiotics, AM CVn stars. These are useful for binary and stellar evolution, gravitational wave radiation sources (LISA foreground) and accretion disk physics.
- UVEX-IPHAS: 2 epochs (~3 year baseline) r-band for proper motion and variability in the Galactic Plane.
- Arcsec scale 3D extinction map (5 colour bands) of Galactic Plane.



AM Cvn stars

V396 Hya (63m)

J1552+3201 (56m)

J1411+4812 (46m)

GP Com (46m)

J0804+1616 (44.5m)

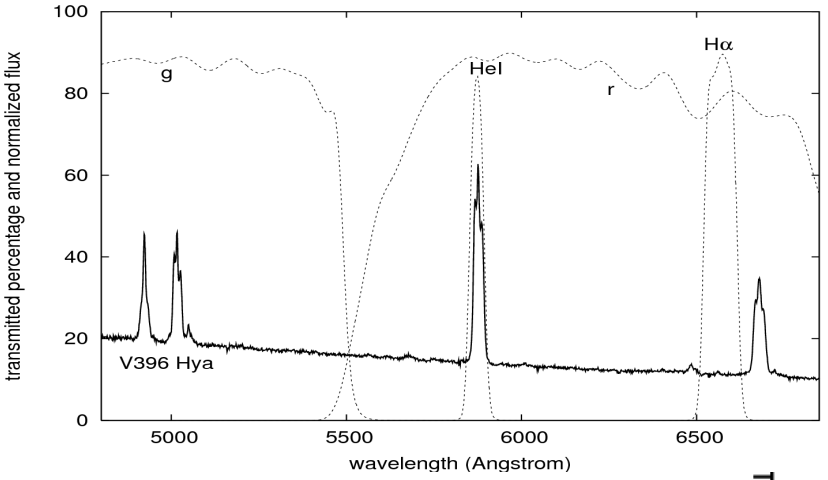
J1208+3550

J1240-0159 (37m)

J0129+3842

J0926+3624 (28m)

DB white dwarfs

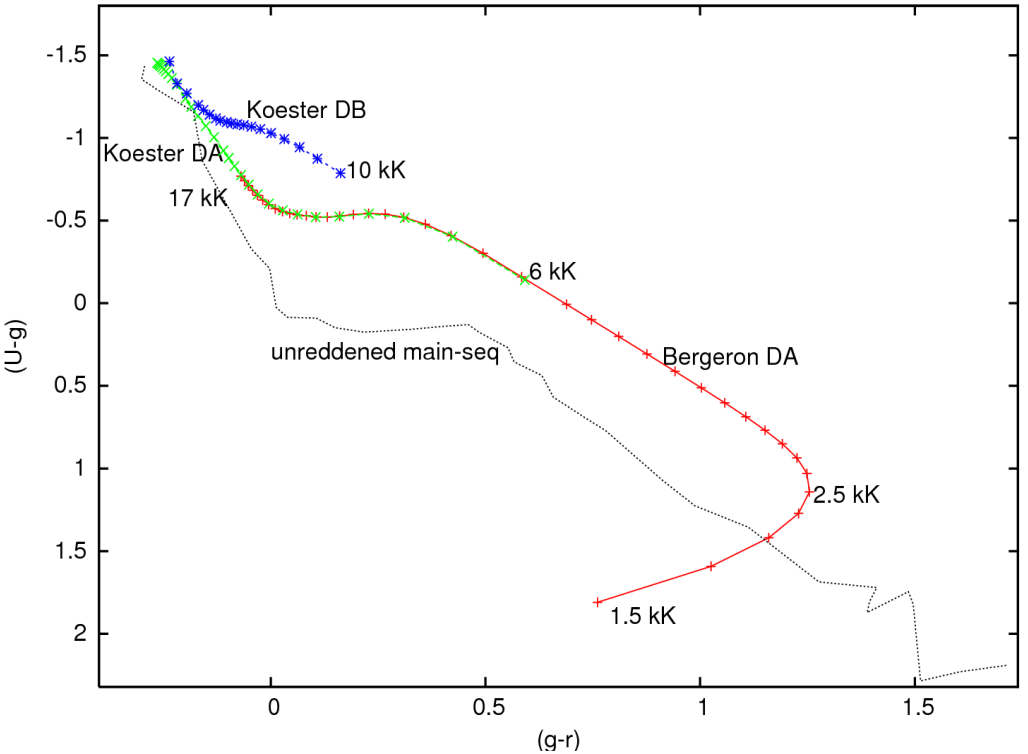


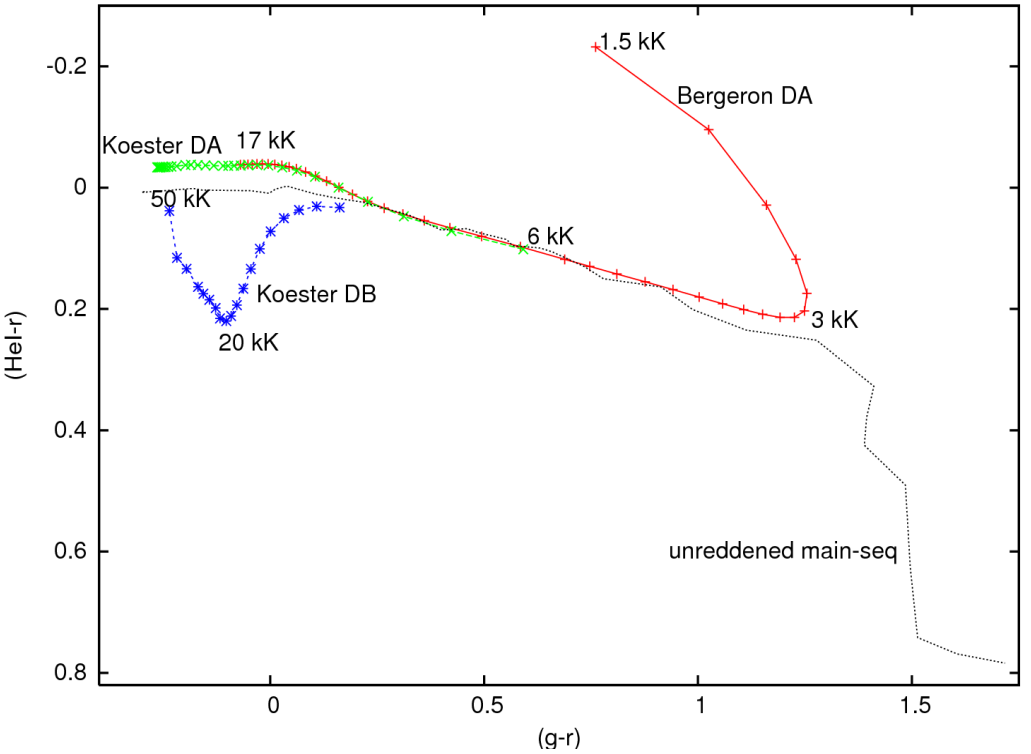
(HeI-r)

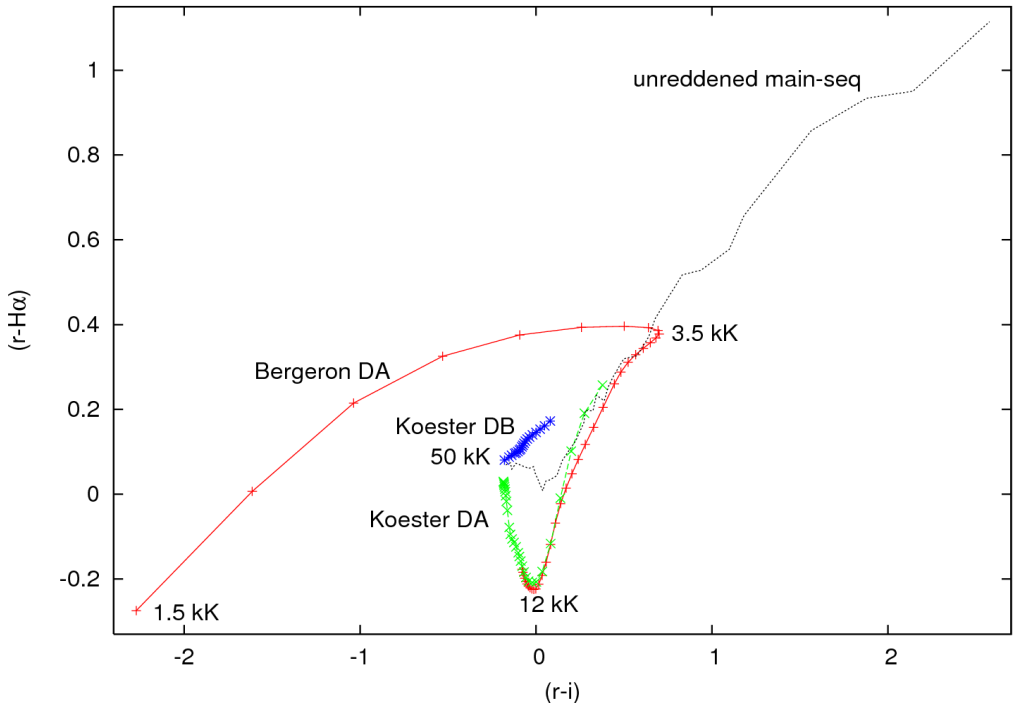
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8

0
0.5
1
1.5

(g-r)



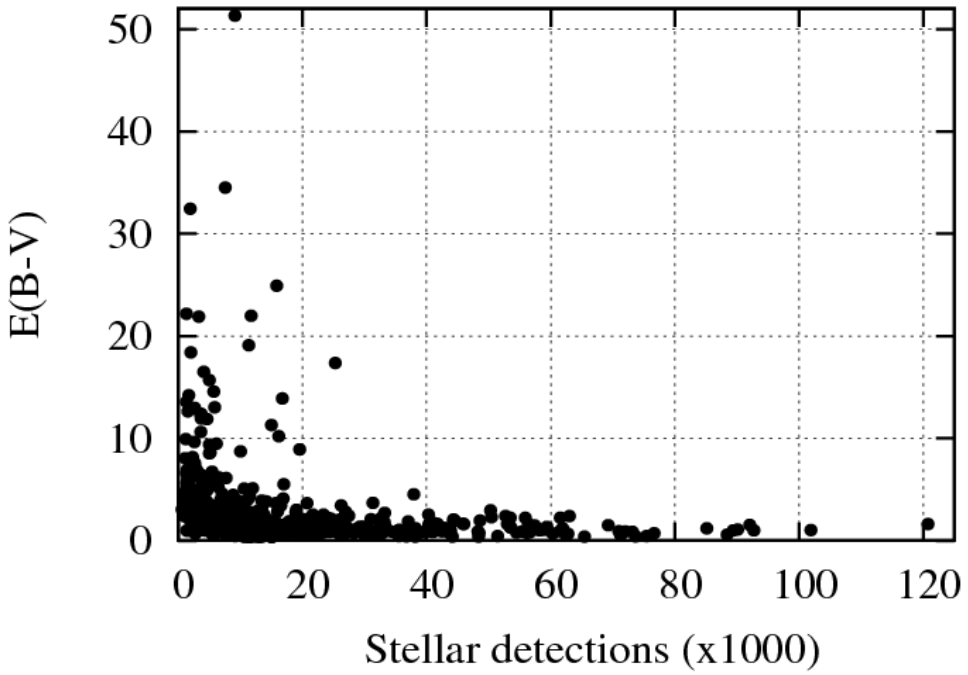


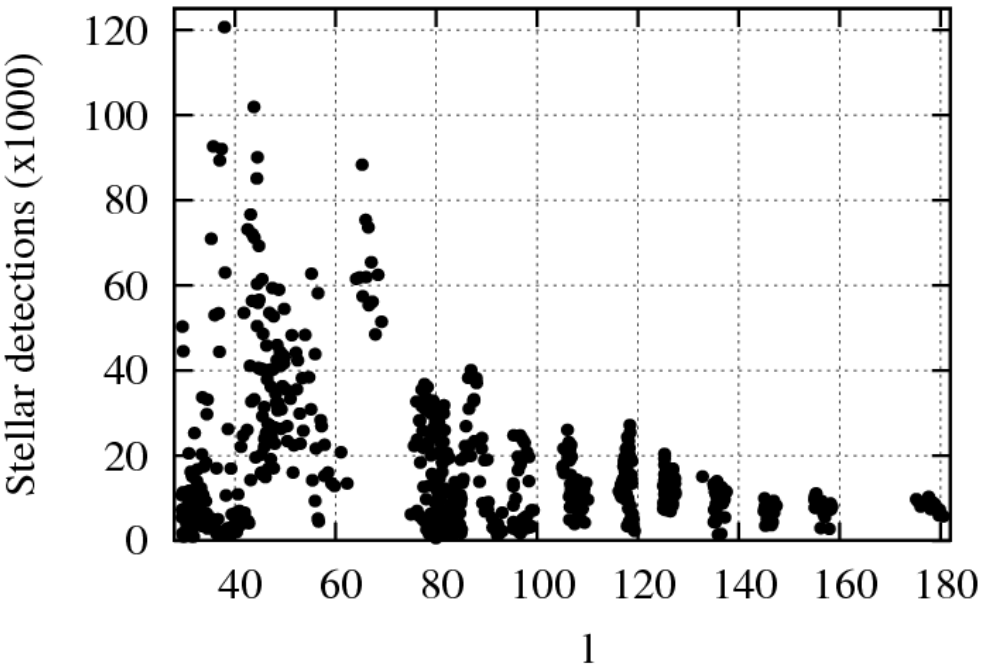


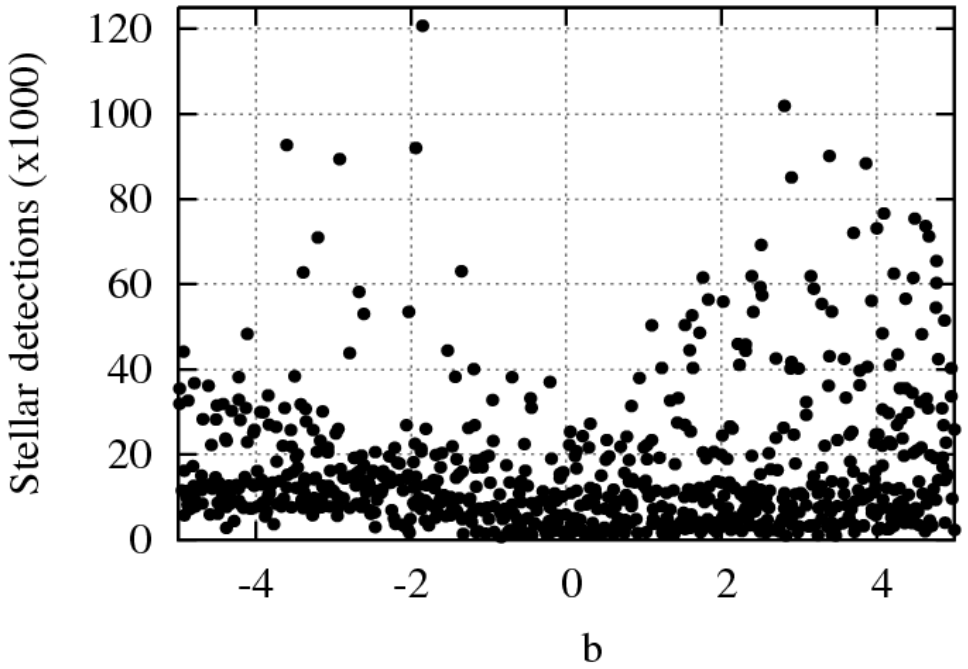
Synthetic UVEX/IPHAS colours:

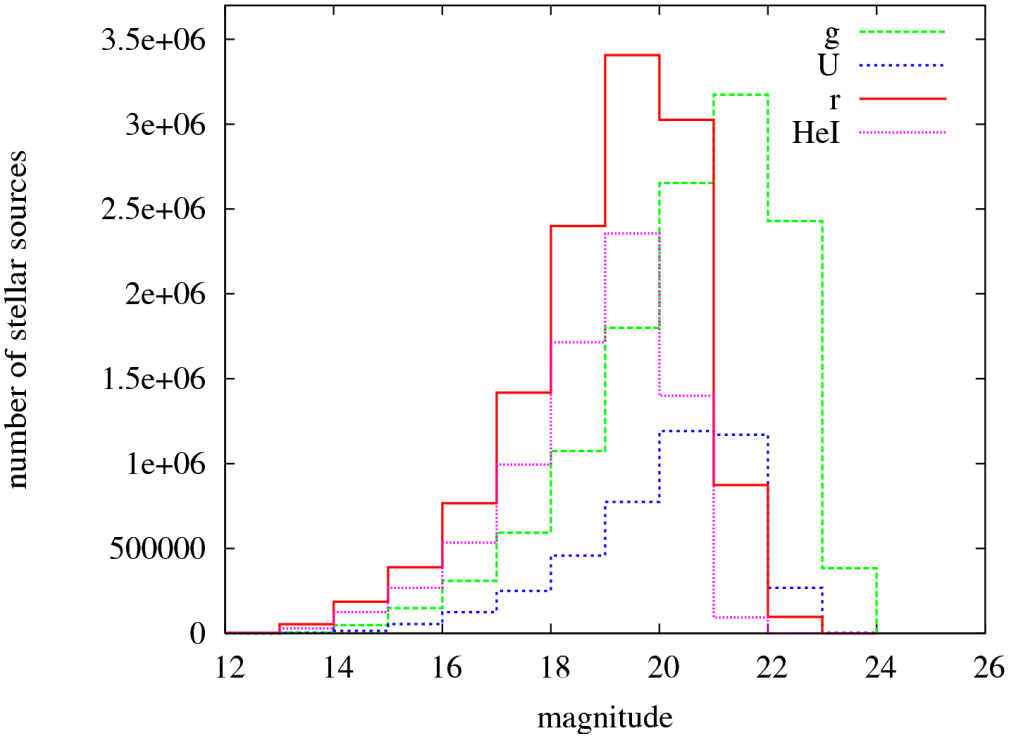
-Red: Bergeron DA white dwarfs
(T=1500-17000K, log(g)=8)
-Green: Koester DA white dwarfs
(T=6000-80000K, log(g)=8)
-Blue: Koester DB white dwarfs
(T=10000-50000K, log(g)=8)
-**Black:** Pickles main-sequence

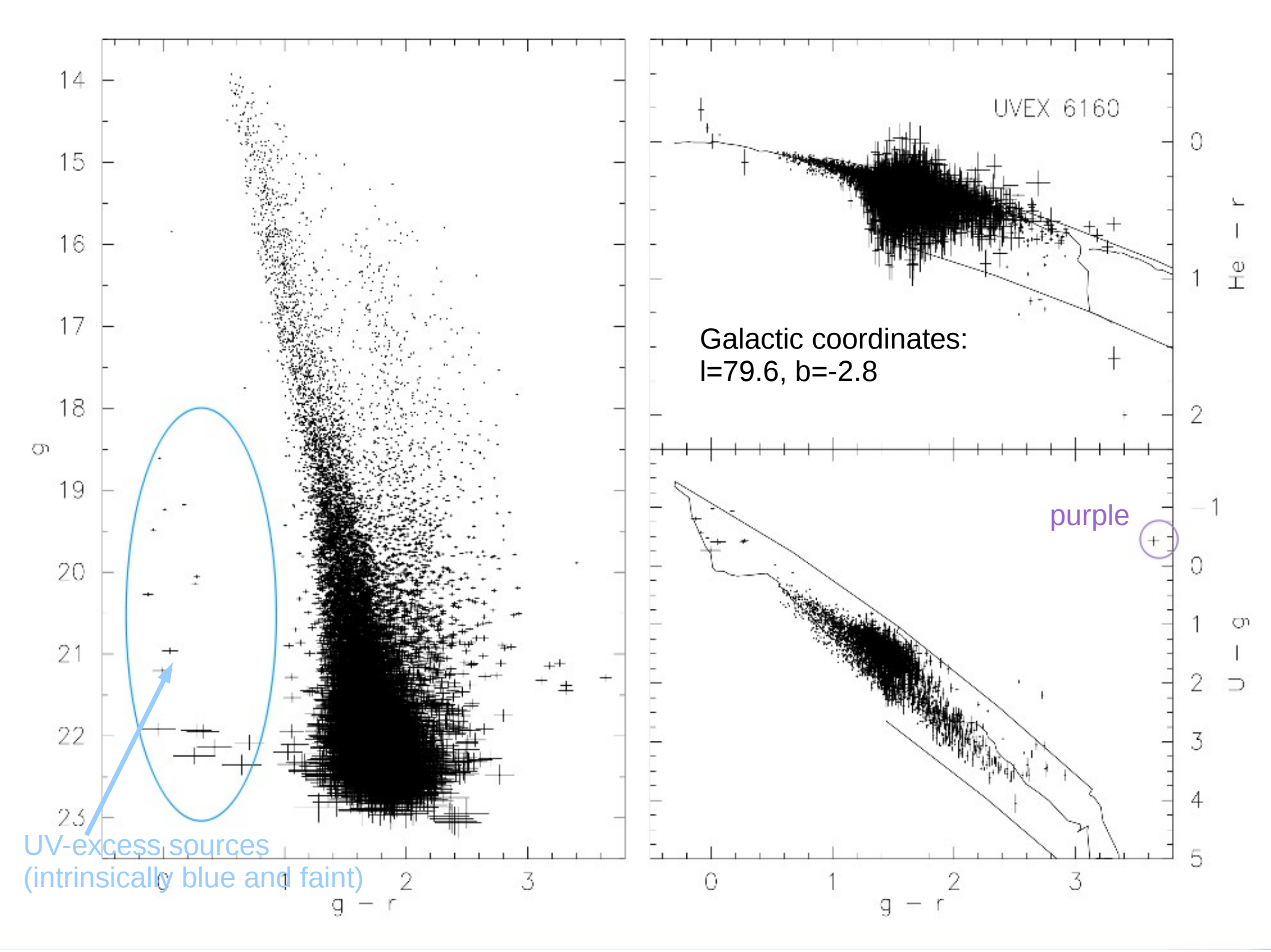
The stellar detections in the first 5 months of UVEX data:

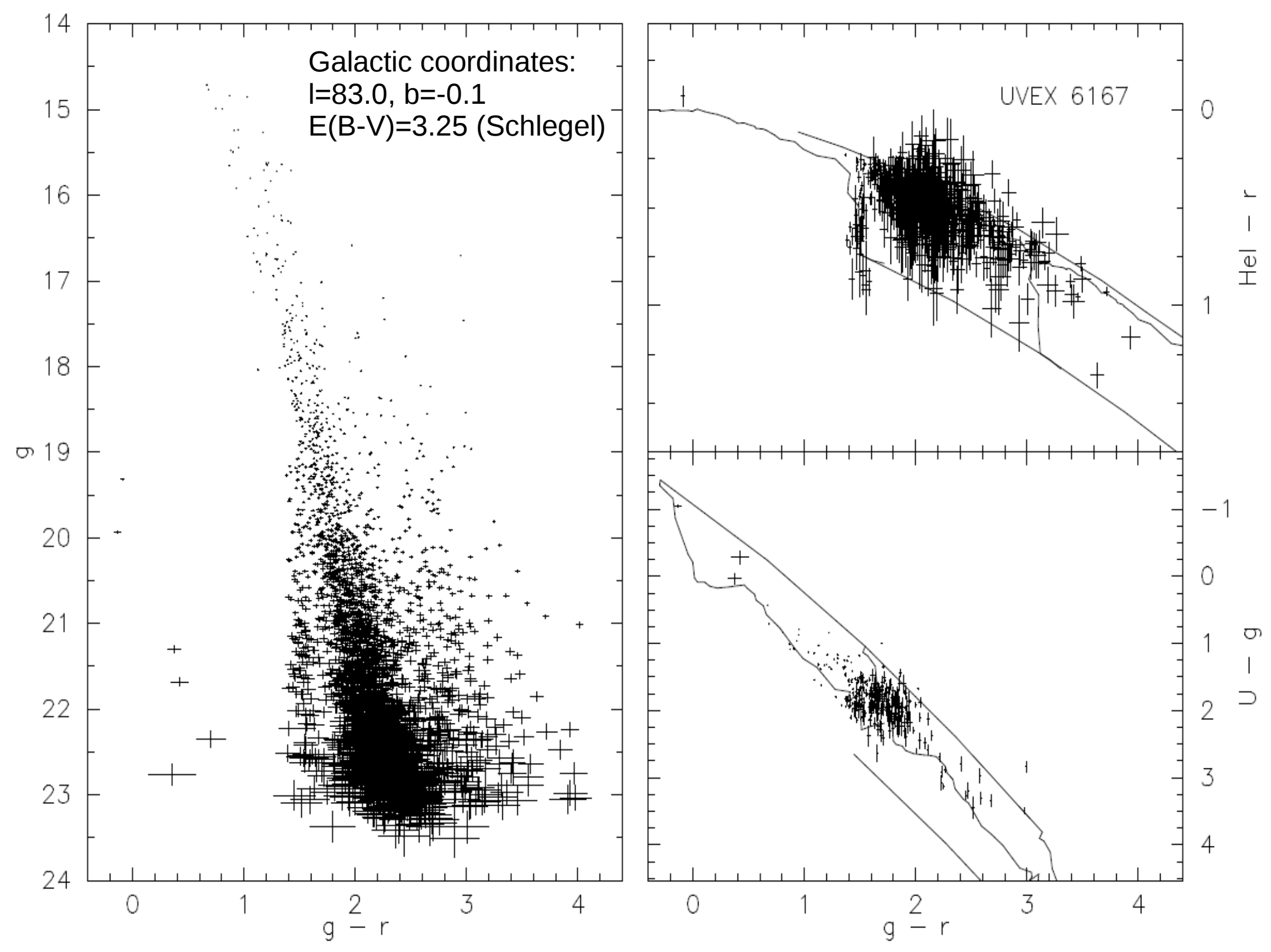









UVEX 6160
Galactic coordinates:
l=79.6, b=-2.8
purple
UV-excess sources
(intrinsically blue and faint)
g
g − r
He I − r
U − g


Galactic coordinates:
l=83.0, b=-0.1
E(B-V)=3.25 (Schlegel)
UVEX 6167
g
g − r
Hel − r
U − g

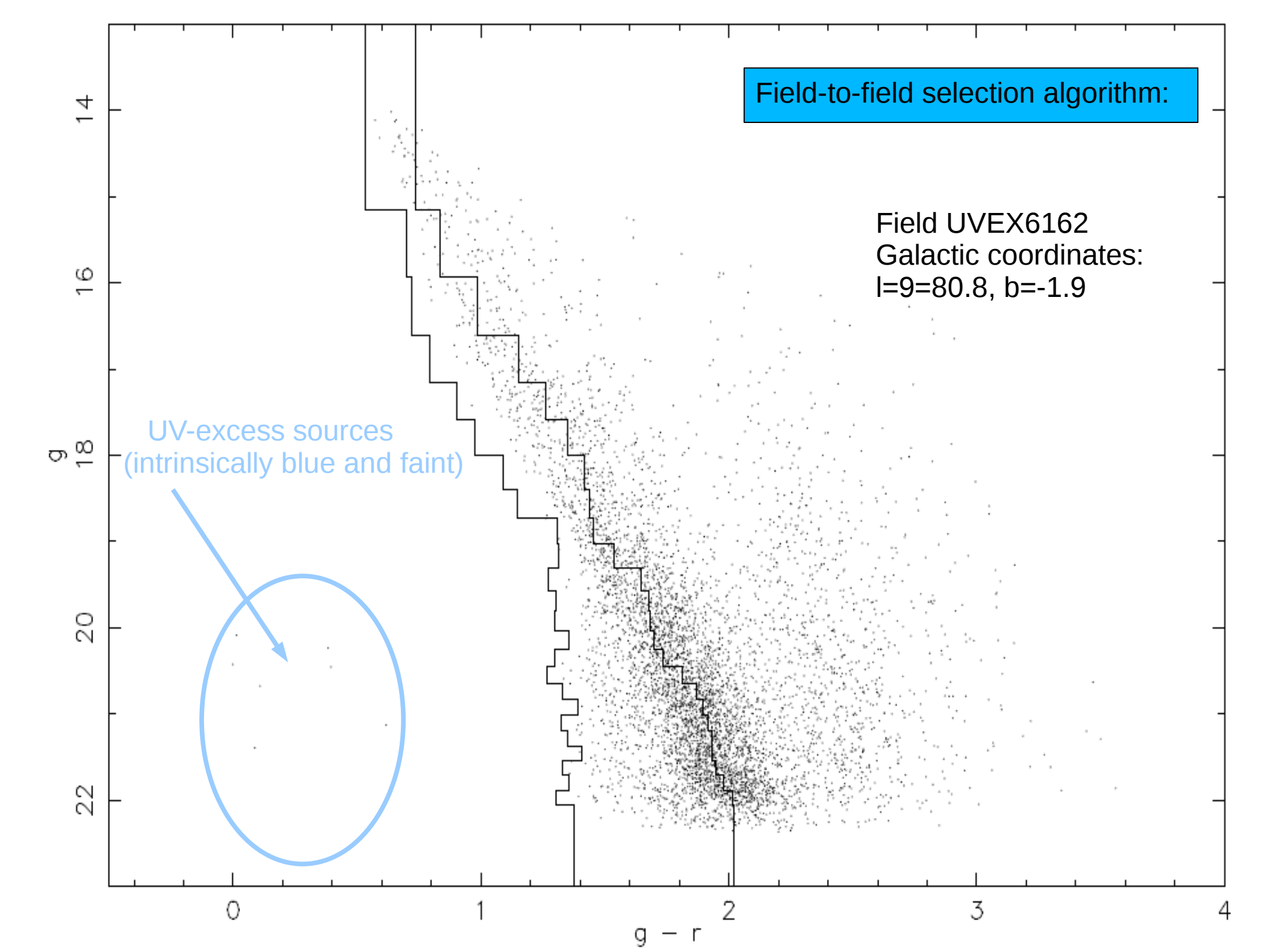
Selection of UV-excess sources:

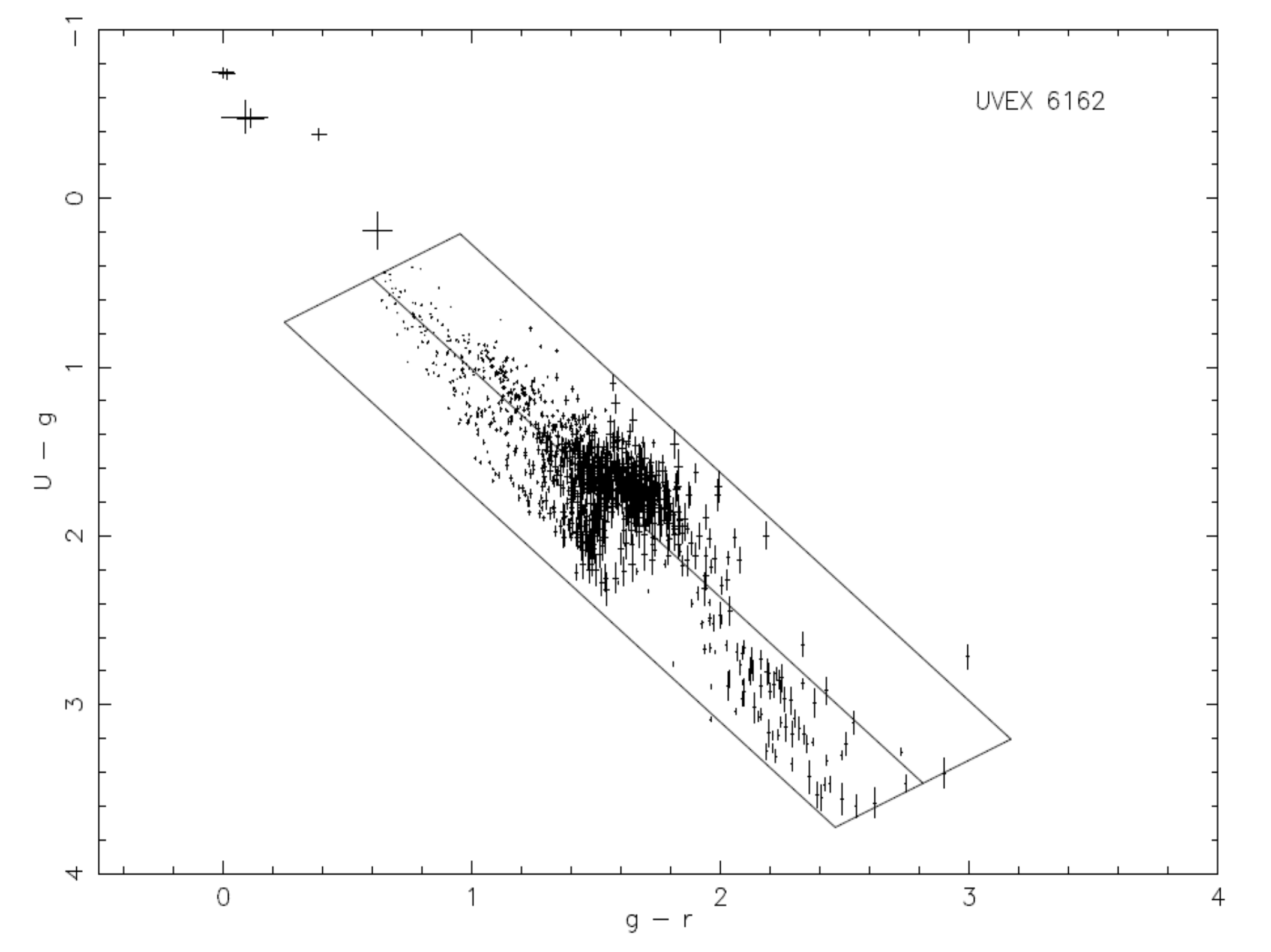
Field-to-field selection algorithm selects blue outliers in the UVEX 2- colour and colour-magnitude diagrams:
Stellar and binary remnants are intrinsically blue and faint, they separate from the main-sequence stars because of their blue colours and the reddening of the background main-sequence due to dust extinction.

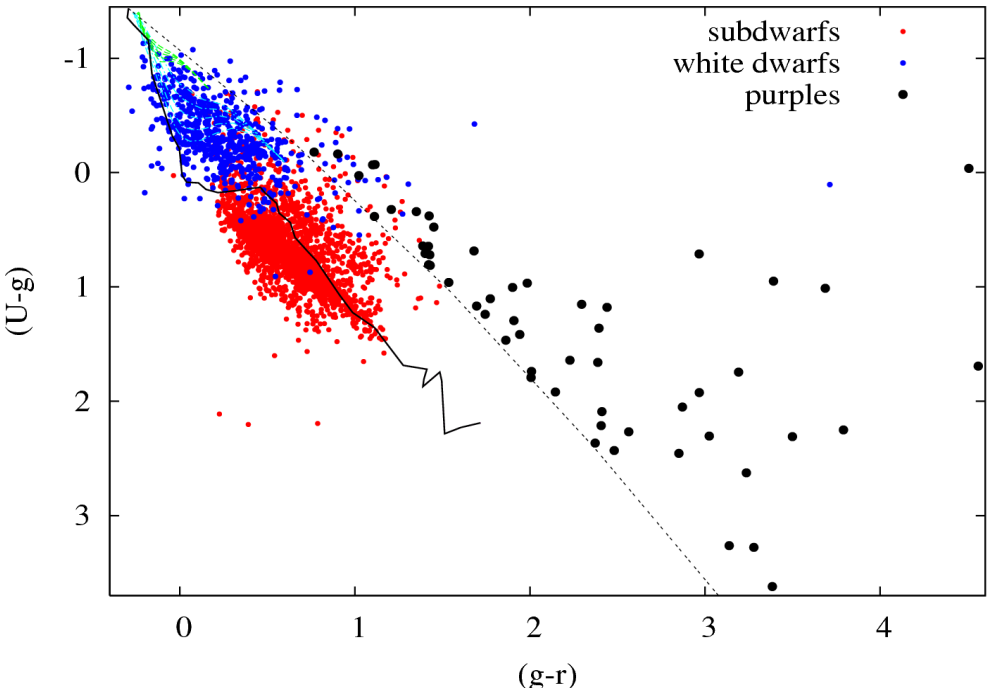
Apply to the first 5 months good UVEX data: 752 fields (203 sq.deg) with:

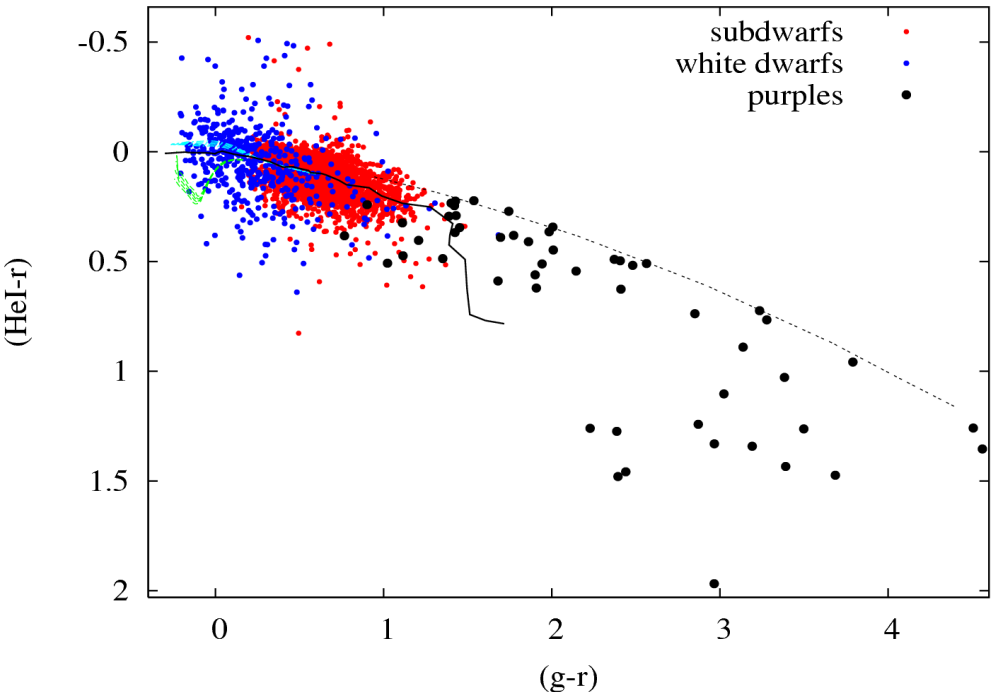
- -also a 15arcmin offset-field observation
- -g band seeing < 1.7 arcsec
- -r band background < 2000 cts/pixel
- -sources detected as stellar and prob.stellar in r and g

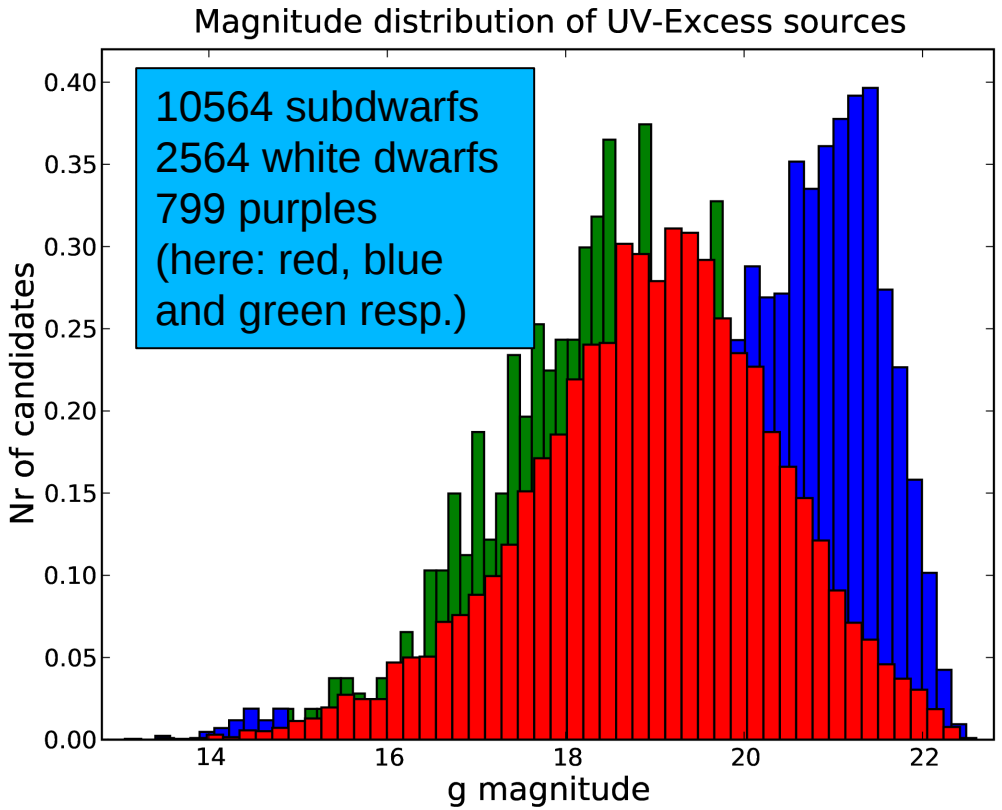
After selection: 13128 UV-excess candidates (3 populations).

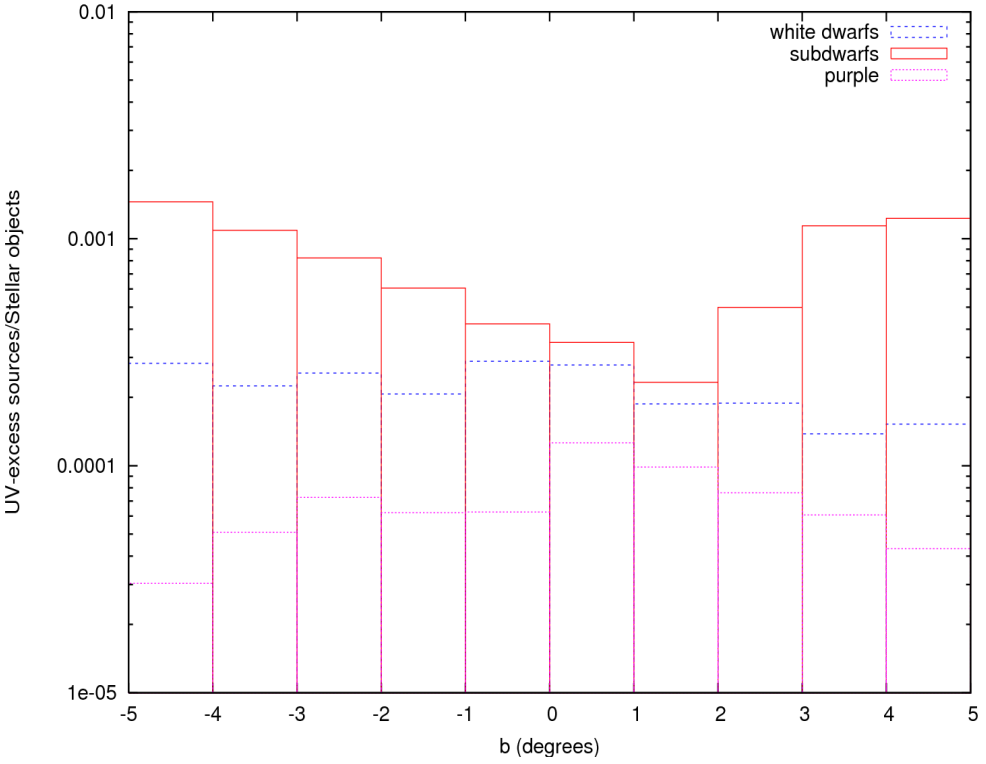

Field-to-field selection algorithm:
Field UVEX6162
Galactic coordinates:
l=9=80.8, b=-1.9
UV-excess sources
(intrinsically blue and faint)
g
14
16
18
20
22
0
1
2
3
4
g − r

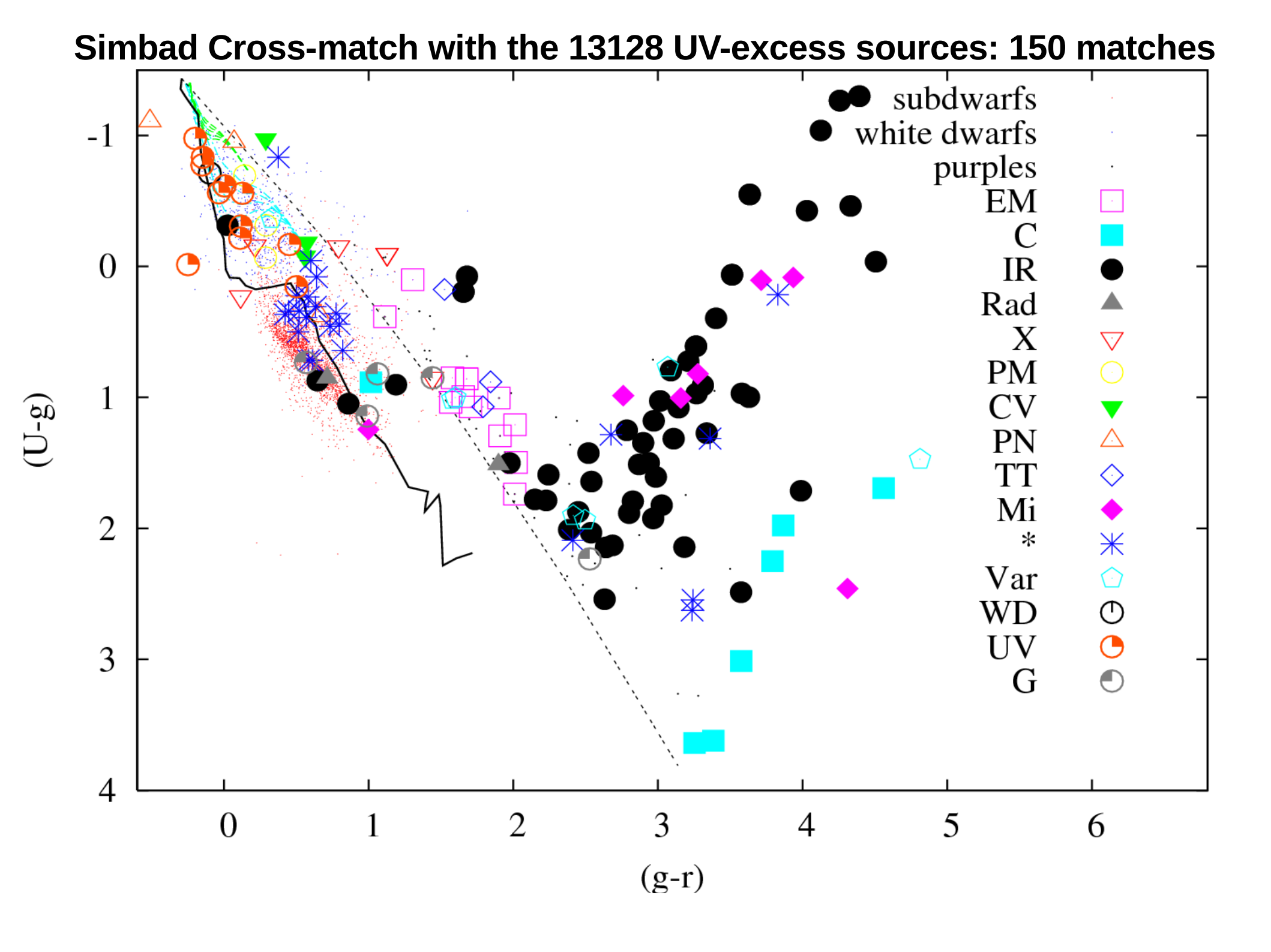

UVEX 6162
U − g
g − r
−1
0
1
2
3
4
0
1
2
3
4

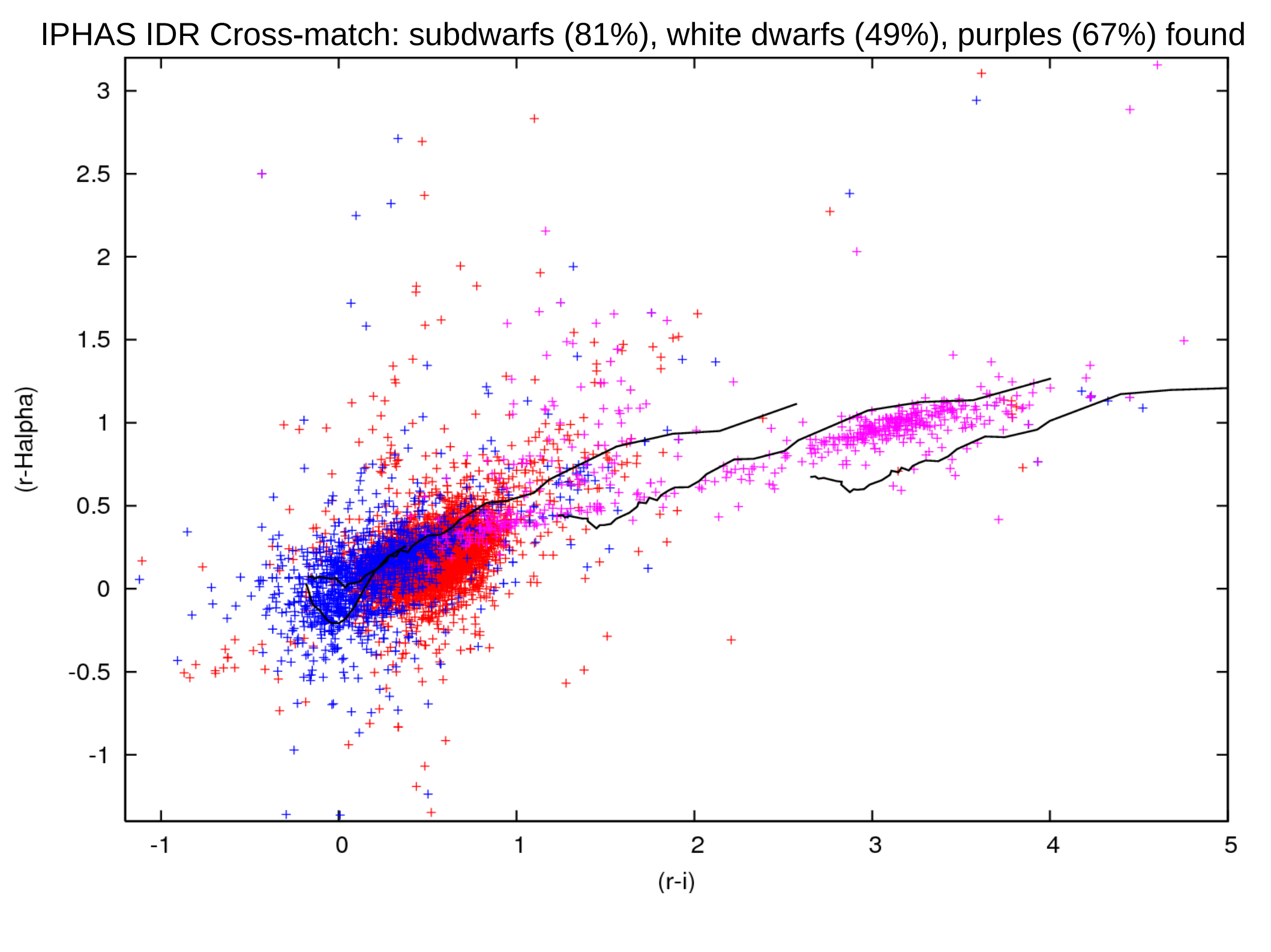

subdwarfs
white dwarfs
purples
(U-g)
(g-r)


subdwarfs
white dwarfs
purples
(HeI-r)
(g-r)

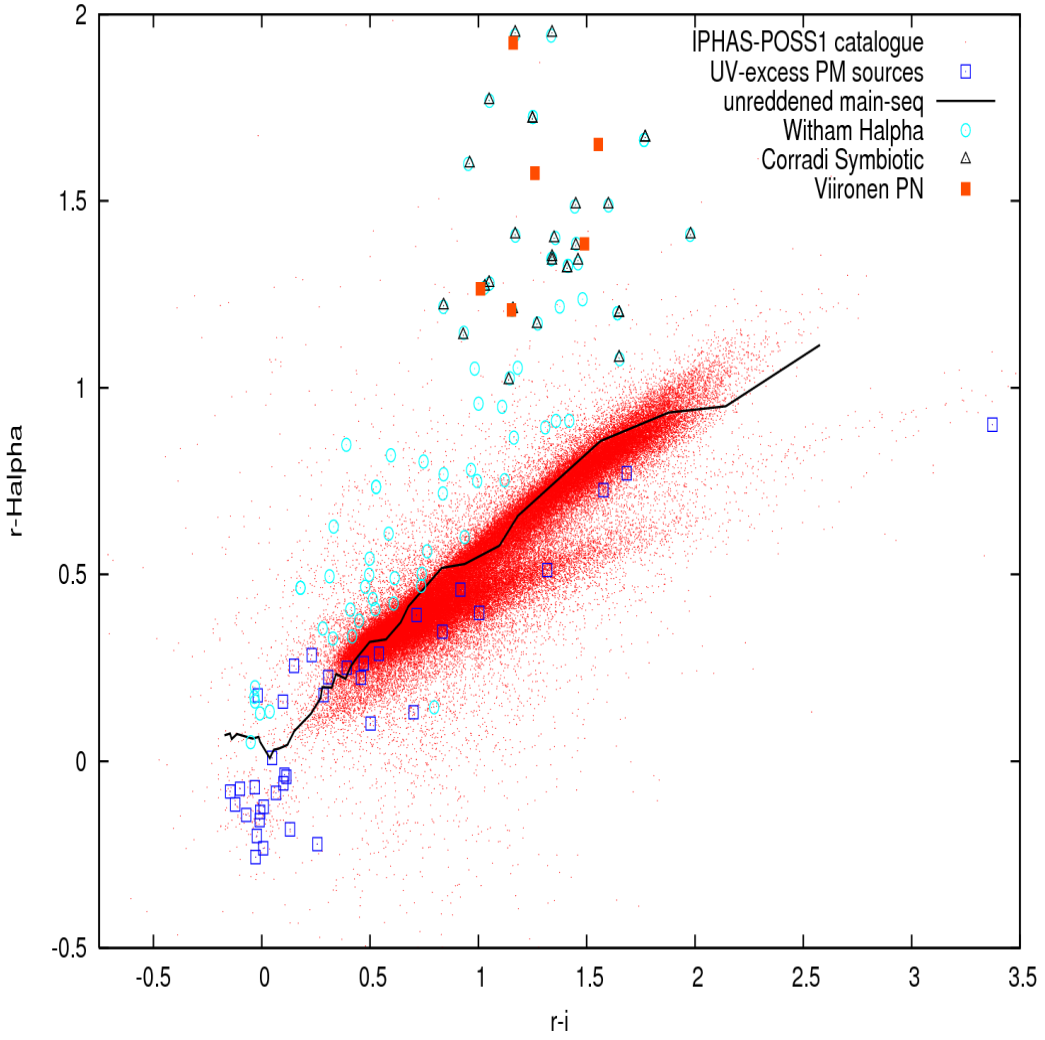

Magnitude distribution of UV-Excess sources
10564 subdwarfs
2564 white dwarfs
799 purples
(here: red, blue
and green resp.)
Nr of candidates
g magnitude

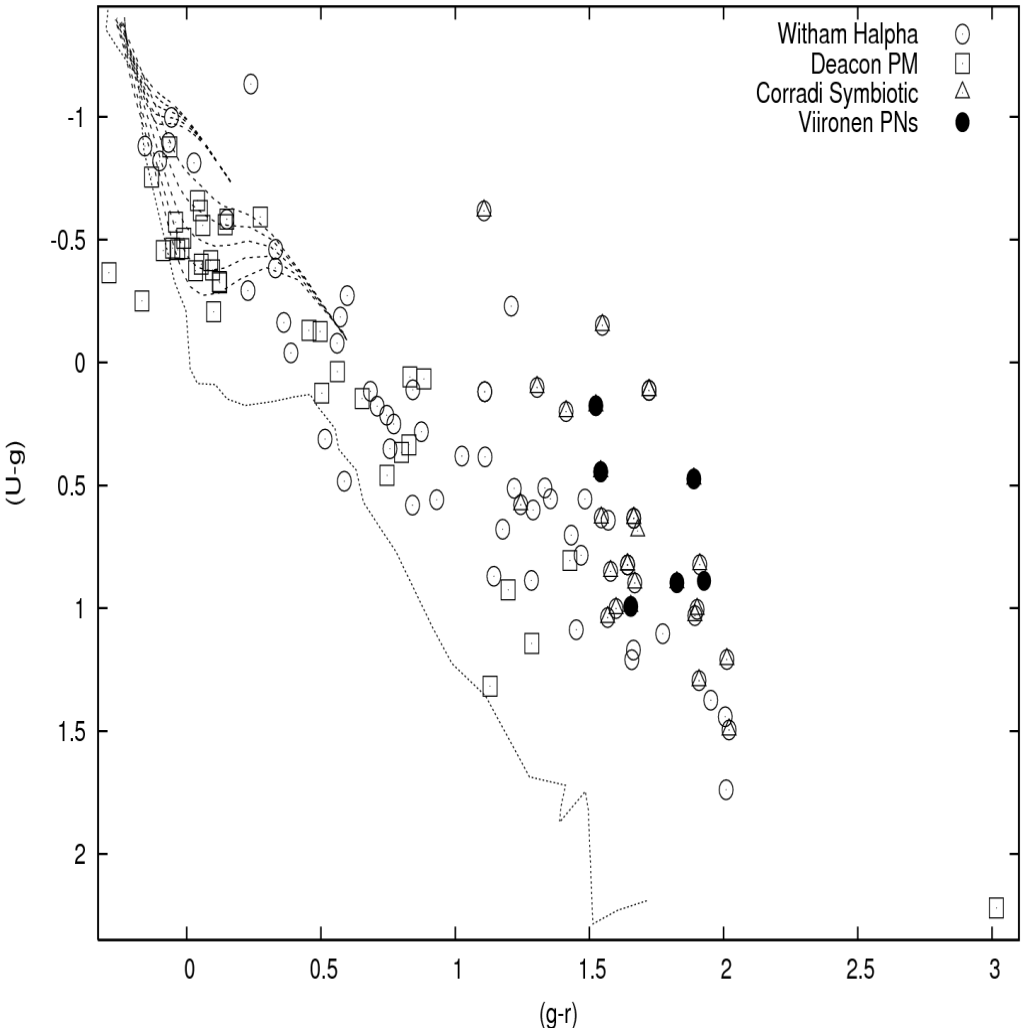

white dwarfs
subdwarfs
purple
UV-excess sources/Stellar objects
b (degrees)

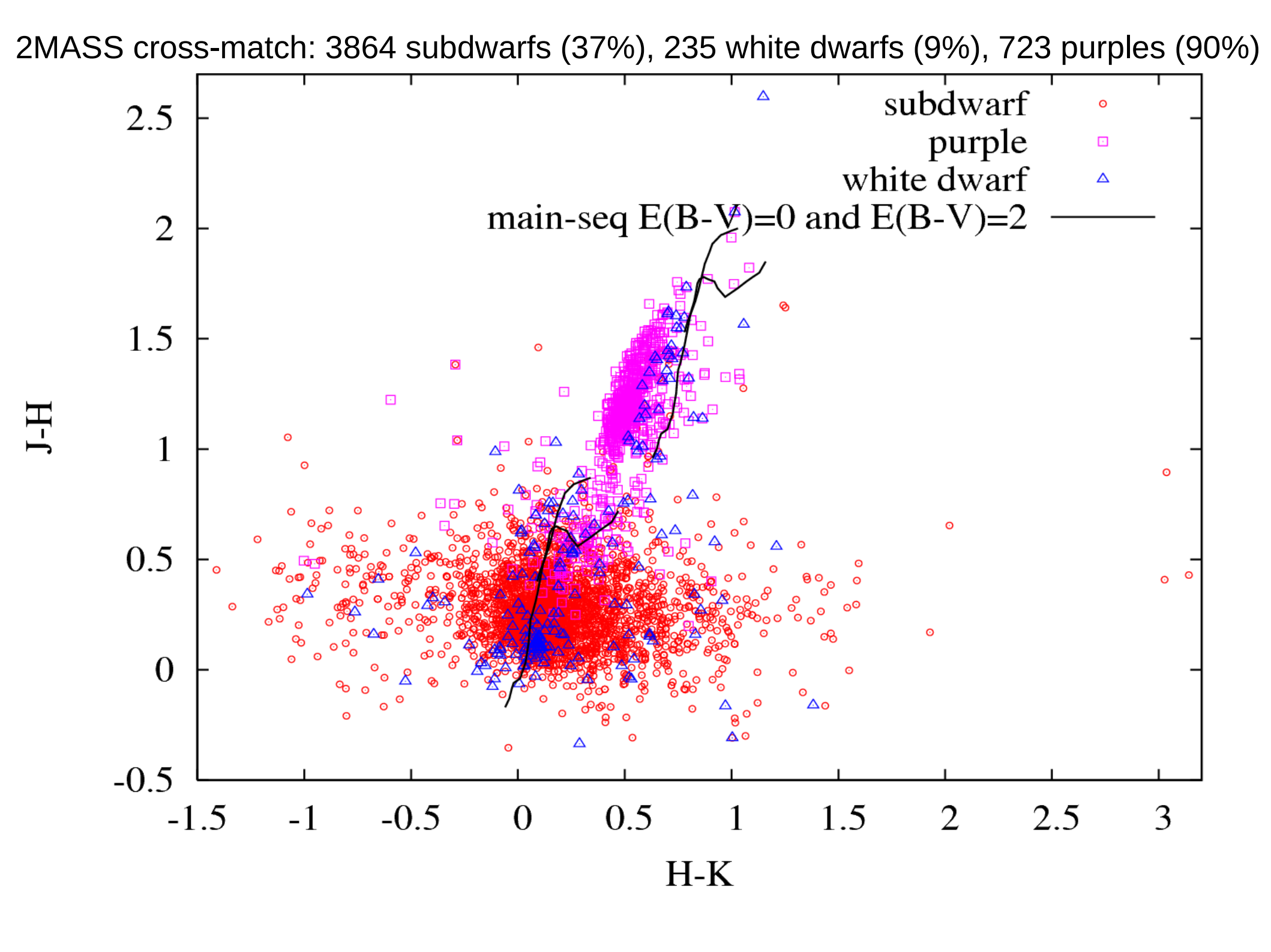

Simbad Cross-match with the 13128 UV-excess sources: 150 matches
subdwarfs
white dwarfs
purples
EM
C
IR
Rad
X
PM
CV
PN
TT
Mi
*
Var
WD
UV
G
(U-g)
(g-r)
-1
0
1
2
3
4
0
1
2
3
4
5
6


IPHAS IDR Cross-match: subdwarfs (81%), white dwarfs (49%), purples (67%) found
(r-Halpha)
(r-i)
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1
0
1
2
3
4
5

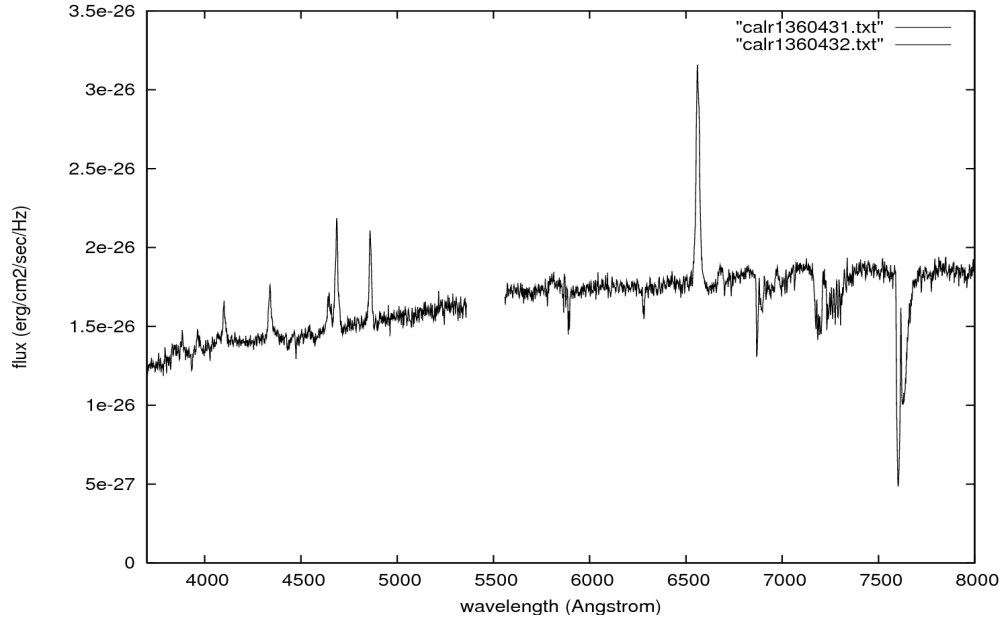
Deacon POSSI-IPHAS PM catalog cross-match: 10 subdwarfs, 31 white dwarfs, 2 purples
Witham Hα emission line object catalog cross-match: 29 subdwarfs, 22 white dwarfs, 31 purples
Corradi Symbiotic stars catalog cross-match: 6 subdwarfs, 6 white dwarfs, 18 purples
Viironen Planetary Nebulae catalog cross-match: 2 subdwarfs, 1 white dwarf, 4 purples

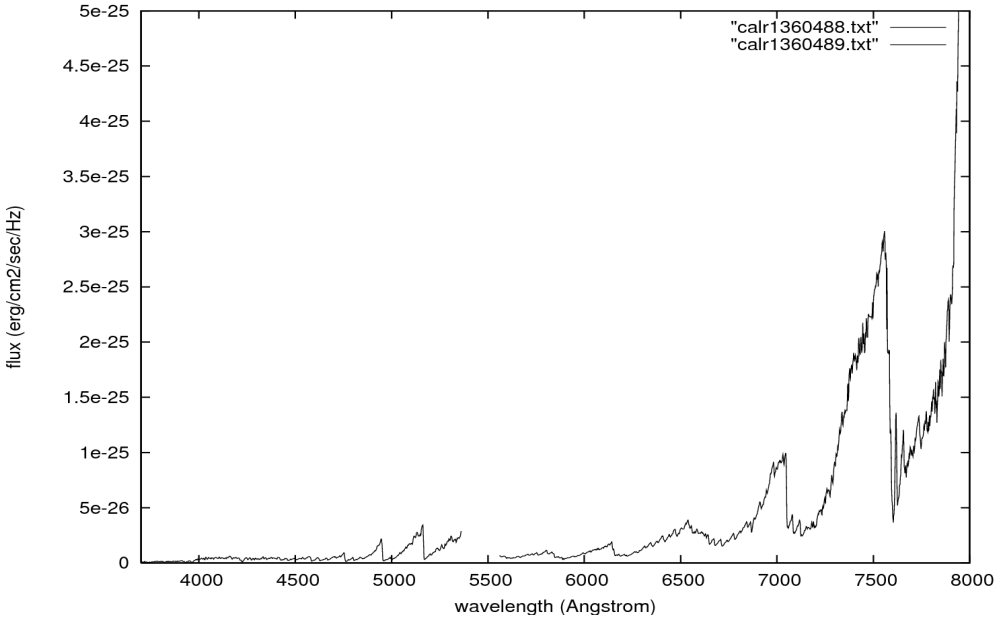


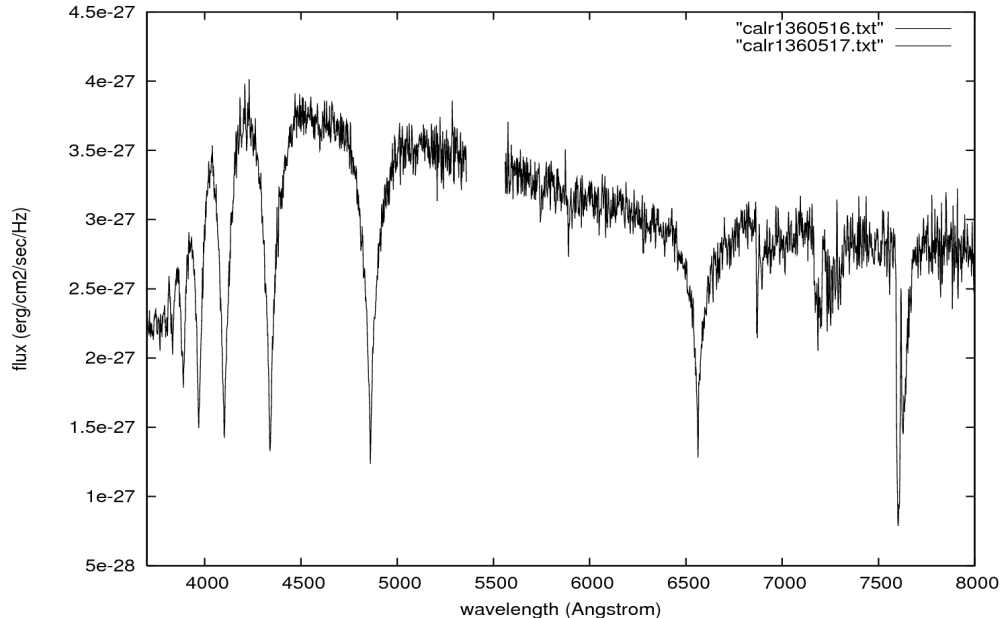


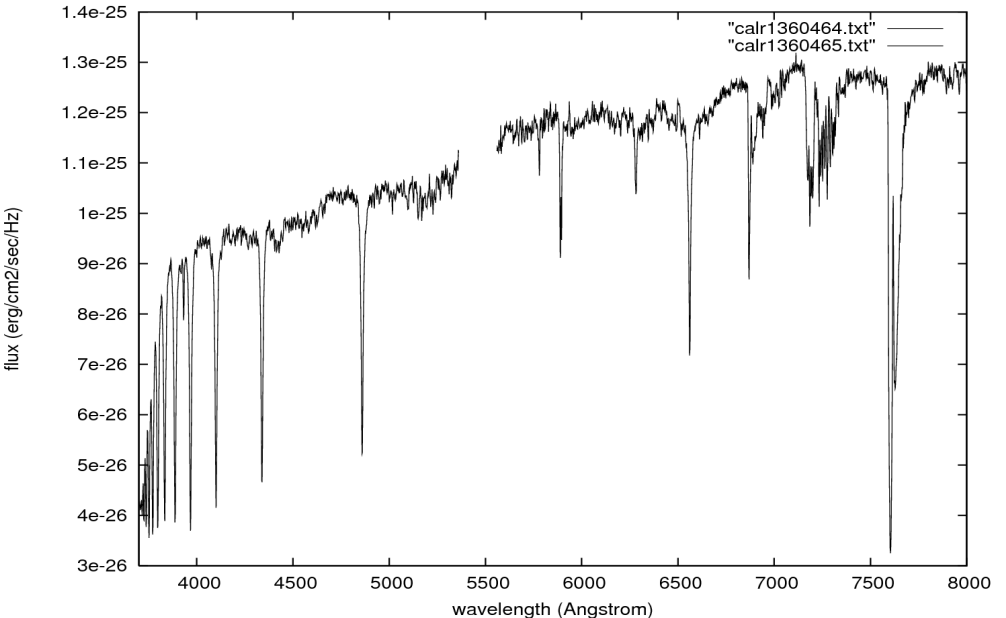

2MASS cross-match: 3864 subdwarfs (37%), 235 white dwarfs (9%), 723 purples (90%)
subdwarf
purple
white dwarf
main-seq E(B-V)=0 and E(B-V)=2
J-H
H-K
2.5
2
1.5
1
0.5
0
-0.5
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
3

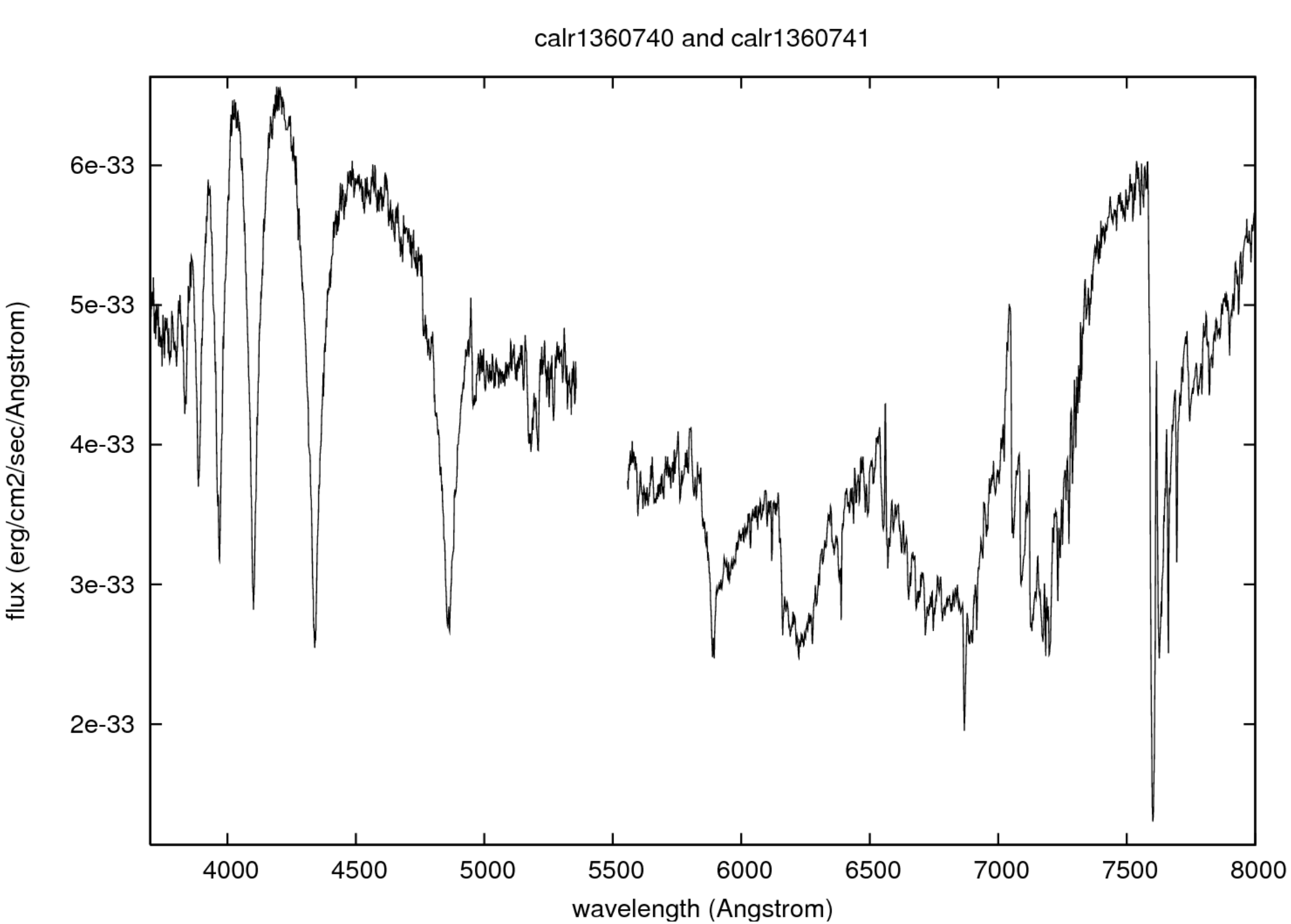
Spectroscopic follow-up for 110 UV-excess candidates

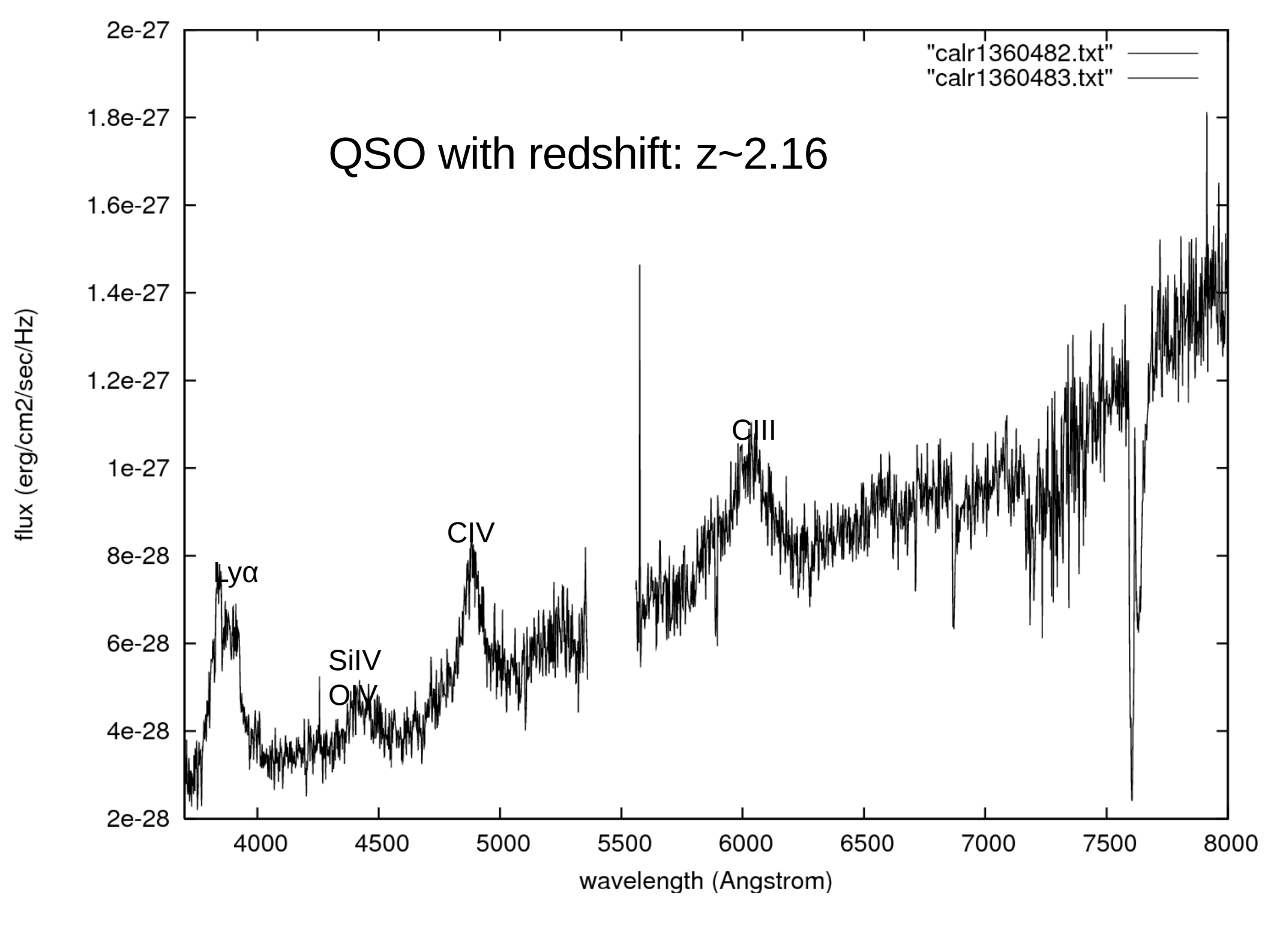


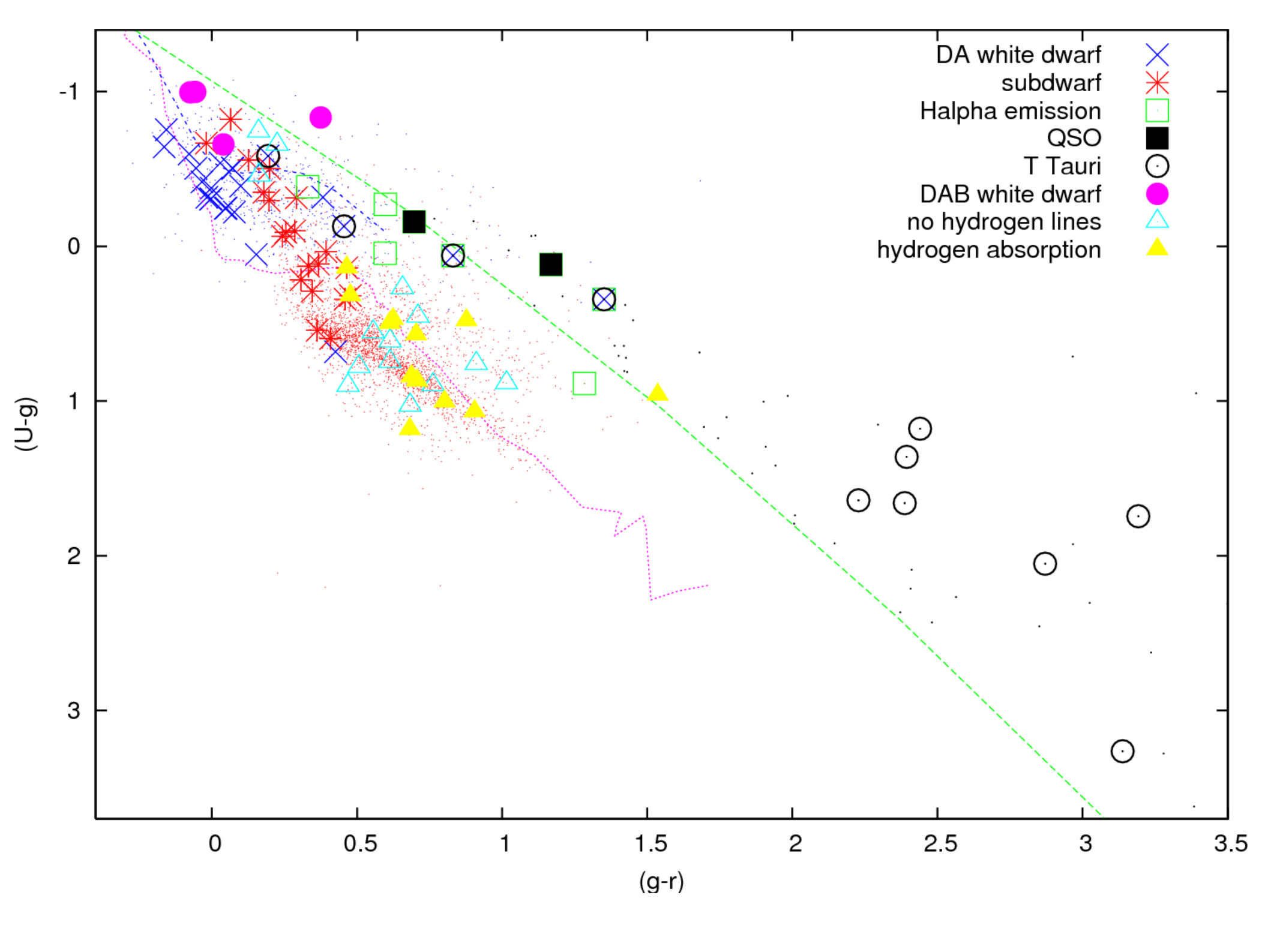


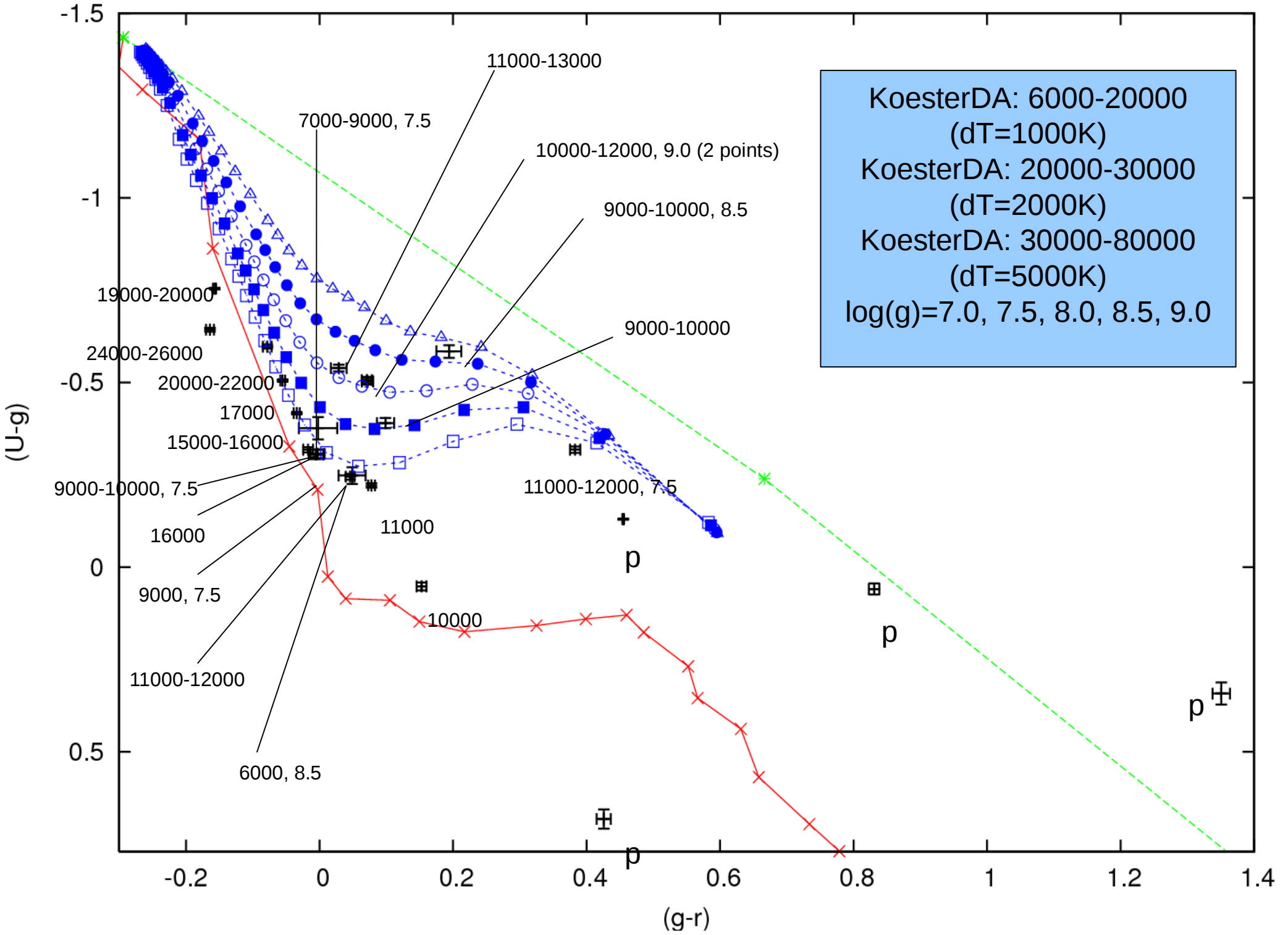





calr1360740 and calr1360741
flux (erg/cm2/sec/Angstrom)
6e-33
5e-33
4e-33
3e-33
2e-33
4000
4500
5000
5500
6000
6500
7000
7500
8000
wavelength (Angstrom)


"calr1360482.txt"
"calr1360483.txt"
QSO with redshift: z~2.16
Lyα
SiIV
OIV
CIV
CIII
flux (erg/cm2/sec/Hz)
wavelength (Angstrom)
2e-27
1.8e-27
1.6e-27
1.4e-27
1.2e-27
1e-27
8e-28
6e-28
4e-28
2e-28
4000
4500
5000
5500
6000
6500
7000
7500
8000

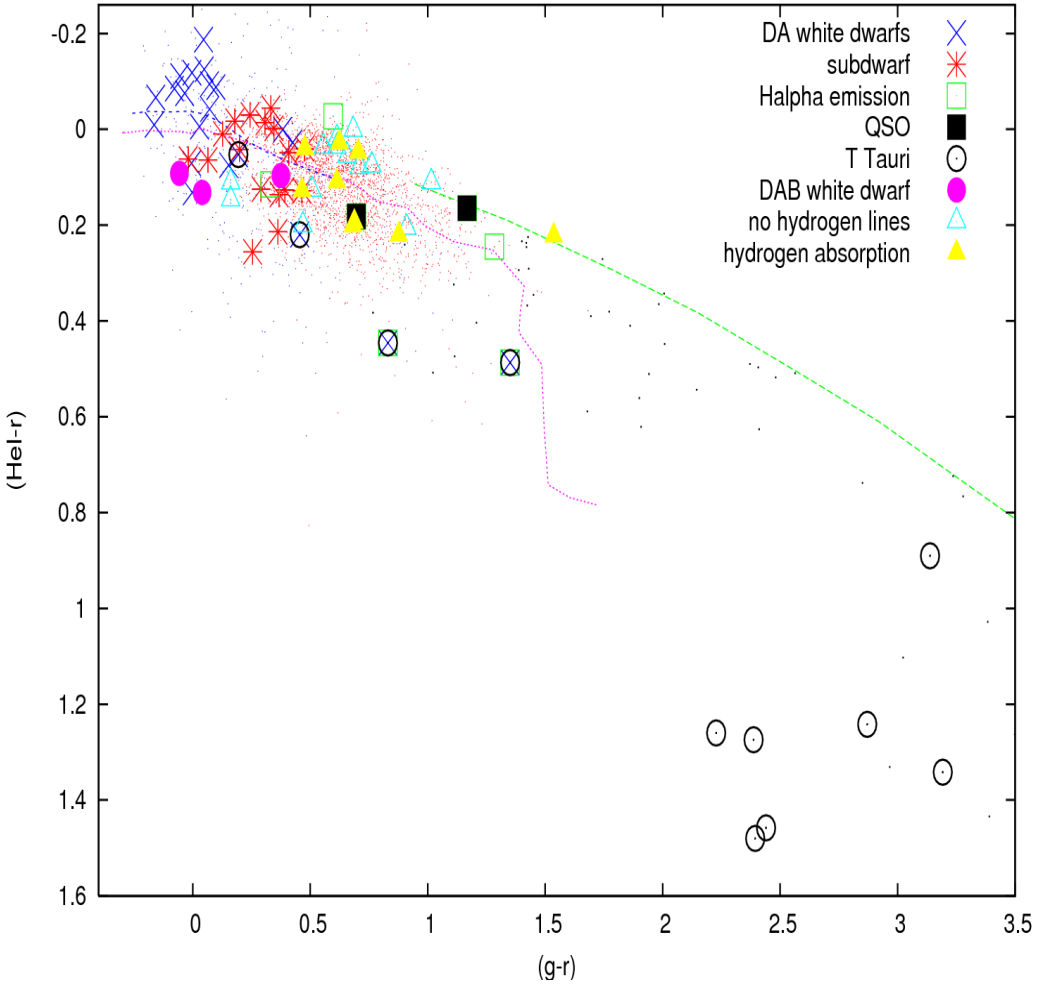

DA white dwarf
subdwarf
Halpha emission
QSO
T Tauri
DAB white dwarf
no hydrogen lines
hydrogen absorption
(U-g)
(g-r)
-1
0
1
2
3
0
0.5
1
1.5
2
2.5
3
3.5

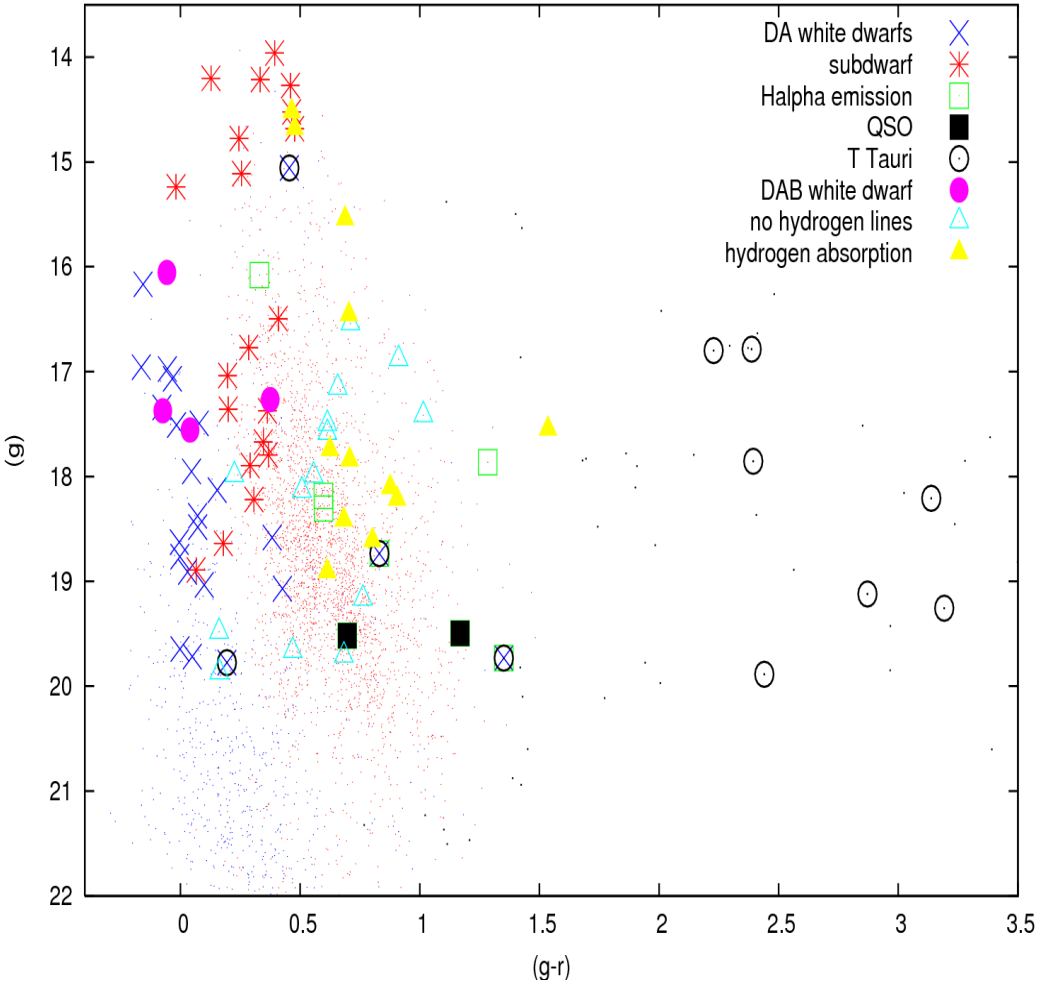

KoesterDA: 6000-20000
(dT=1000K)
KoesterDA: 20000-30000
(dT=2000K)
KoesterDA: 30000-80000
(dT=5000K)
log(g)=7.0, 7.5, 8.0, 8.5, 9.0
11000-13000
7000-9000, 7.5
10000-12000, 9.0 (2 points)
9000-10000, 8.5
19000-20000
9000-10000
24000-26000
20000-22000
17000
15000-16000
9000-10000, 7.5
11000-12000, 7.5
16000
11000
9000, 7.5
10000
11000-12000
6000, 8.5
p
(U-g)
(g-r)
-1.5
-1
-0.5
0
0.5
-0.2
0
0.2
0.4
0.6
0.8
1
1.2
1.4

Classification of the UVEX WHT/ISIS spectra:

The spectra contain DA and DAB white dwarfs, Cataclysmic Variables, T Tauri stars, subdwarfs, red dwarf-white dwarf binaries and a QSO at redshift z~2.16. These are all genuine UV-excess sources.

50% of the 55 candidates of the white dwarf sample are indeed white dwarfs.



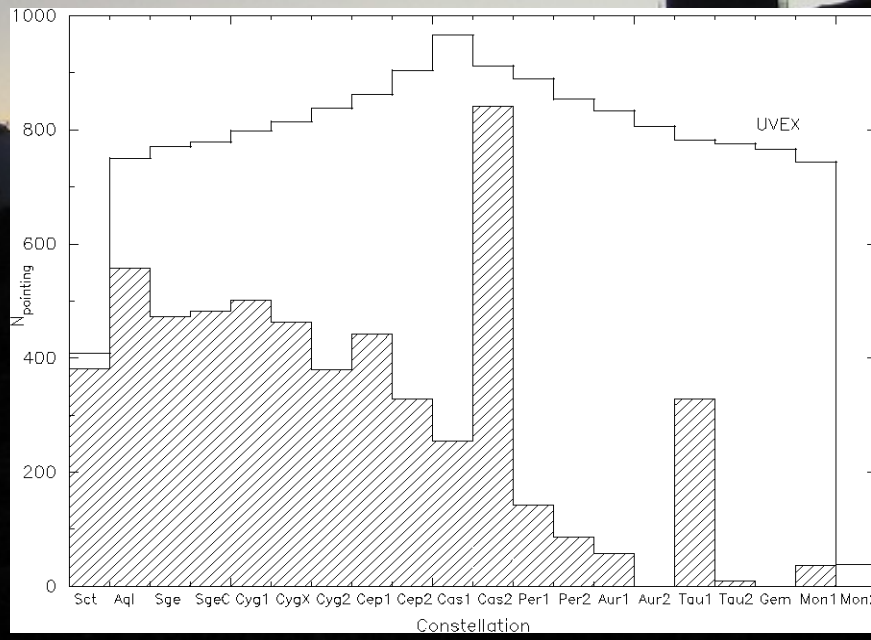


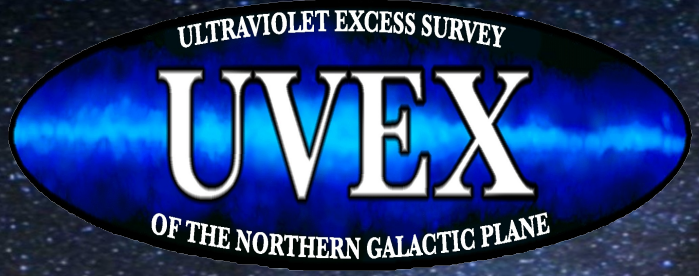
Conclusions:

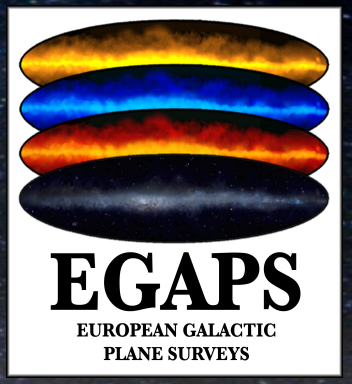
-EGAPS form a full scale optical, multicolour, digital and photon-noise limited survey covering the full Galactic Plane. When finished it will contain information of ~1 billion objects in our Milky Way.

-We find ~13 UV-excess white dwarf candidates per sq.deg. and ~50% of them are DA white dwarfs (from WHT/ISIS follow-up)

-UVEX started in June 2006, currently 40% complete (see right). IPHAS: 100% is observed, some fields are re-observed.







The End

More info: P.J. Groot et al. 2009 and Verbeek et al. 2010 (in prep.)

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