Exploiting multi-wavelength surveys for compact object science

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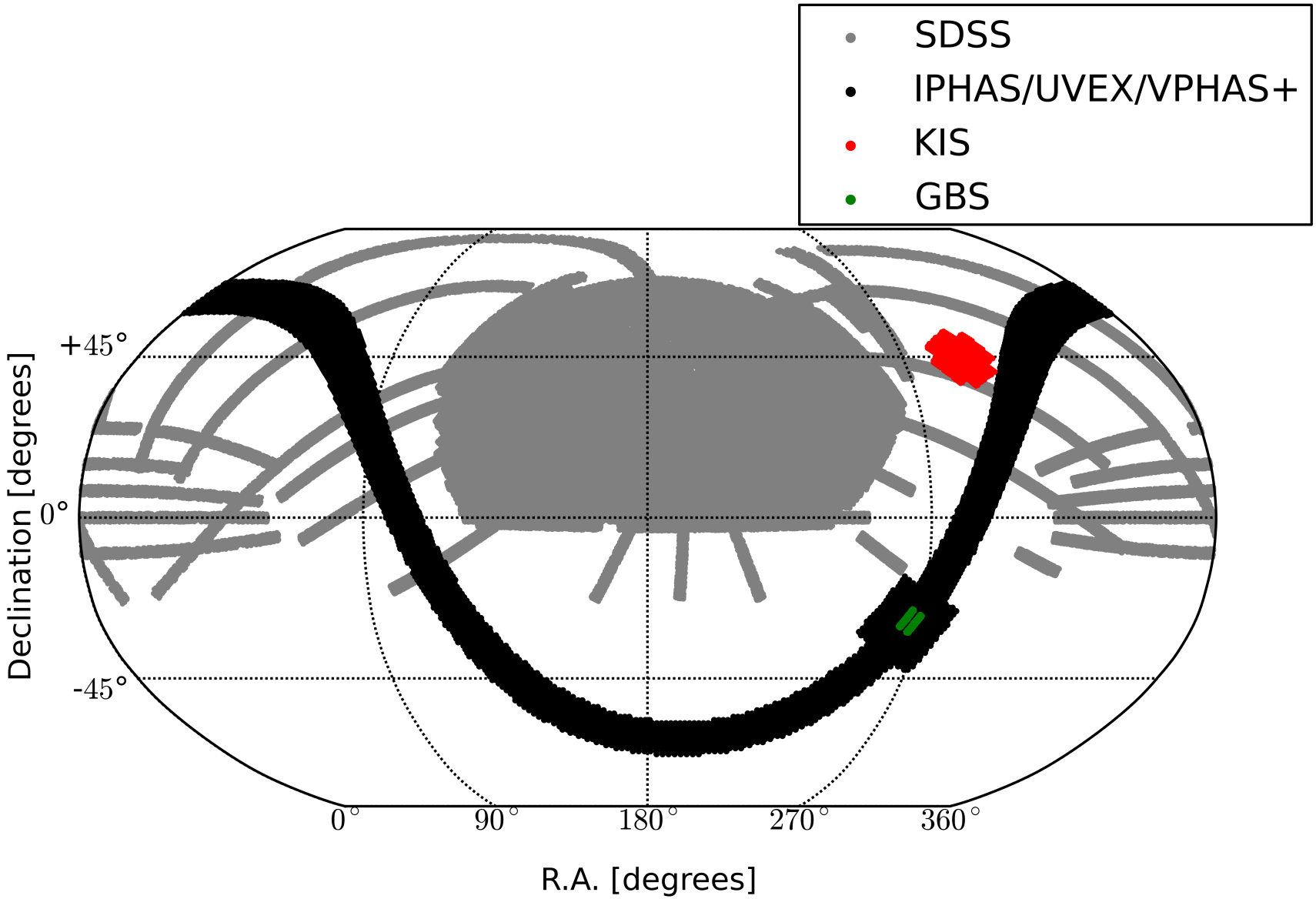
Motivation

- WDs are a fossil imprint of the galactic star formation history
- Accreting WDs are progenitors of Type Ia SNe
- NSs and stellar-mass BHs are remnants of Type II SNe
- XRBs formation and evolution + CE phases are not well understood
- Stellar-mass BHs are an important benchmarks to supermassive BHs at the core of galaxies
- Compact binaries are also gravitational sources

How can we find them?

Multi-wavelength surveys

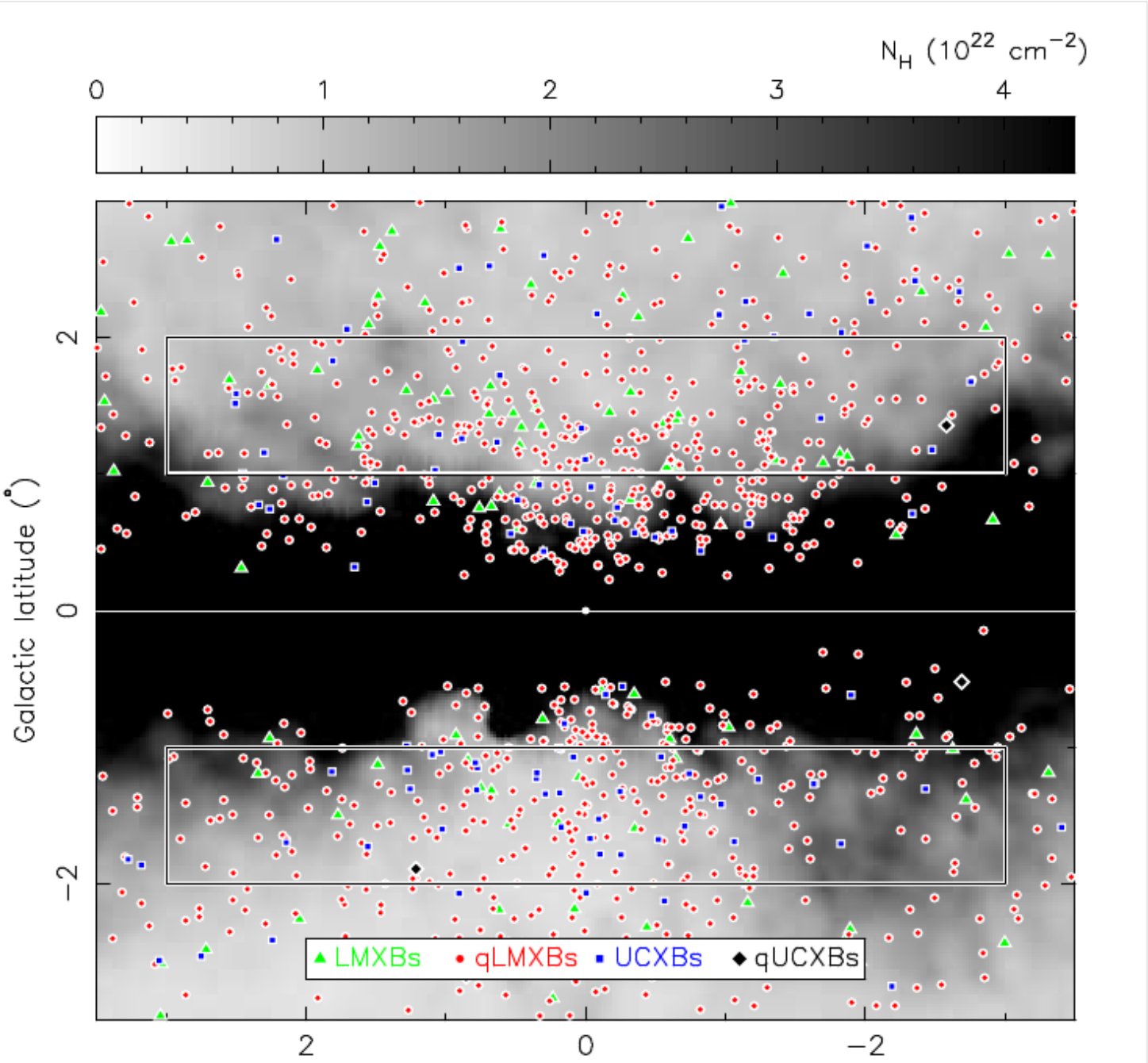
Survey	Filters	Area
Galactic Bulge Survey (GBS)	X-ray + optical *riH*α	12 deg^2
VVV	ZYJHK$_s$	520 deg^2
IPHAS and UVEX	UgriHα	1800 deg^2
VPHAS+	ugriHα	2000 deg^2
Kepler-INT Survey (KIS)	UgriHα	116 deg^2


SDSS
IPHAS/UVEX/VPHAS+
KIS
GBS
+45°
0°
-45°
Declination [degrees]
0°
90°
180°
270°
360°
R.A. [degrees]

GBS (Jonker et al.)

- Shallow X-ray survey of 2×6 deg^2 strips in the bulge
- Chandra observations detected 1658 X-ray sources
- Main goals: determine accurate masses of rare XRBs, study binary formation, select binary candidates for optical spectroscopy (see M. Torres' talk)
- Optical and variability follow-up surveys

Simulation (by G. Nelemans) of expected populations in GBS area



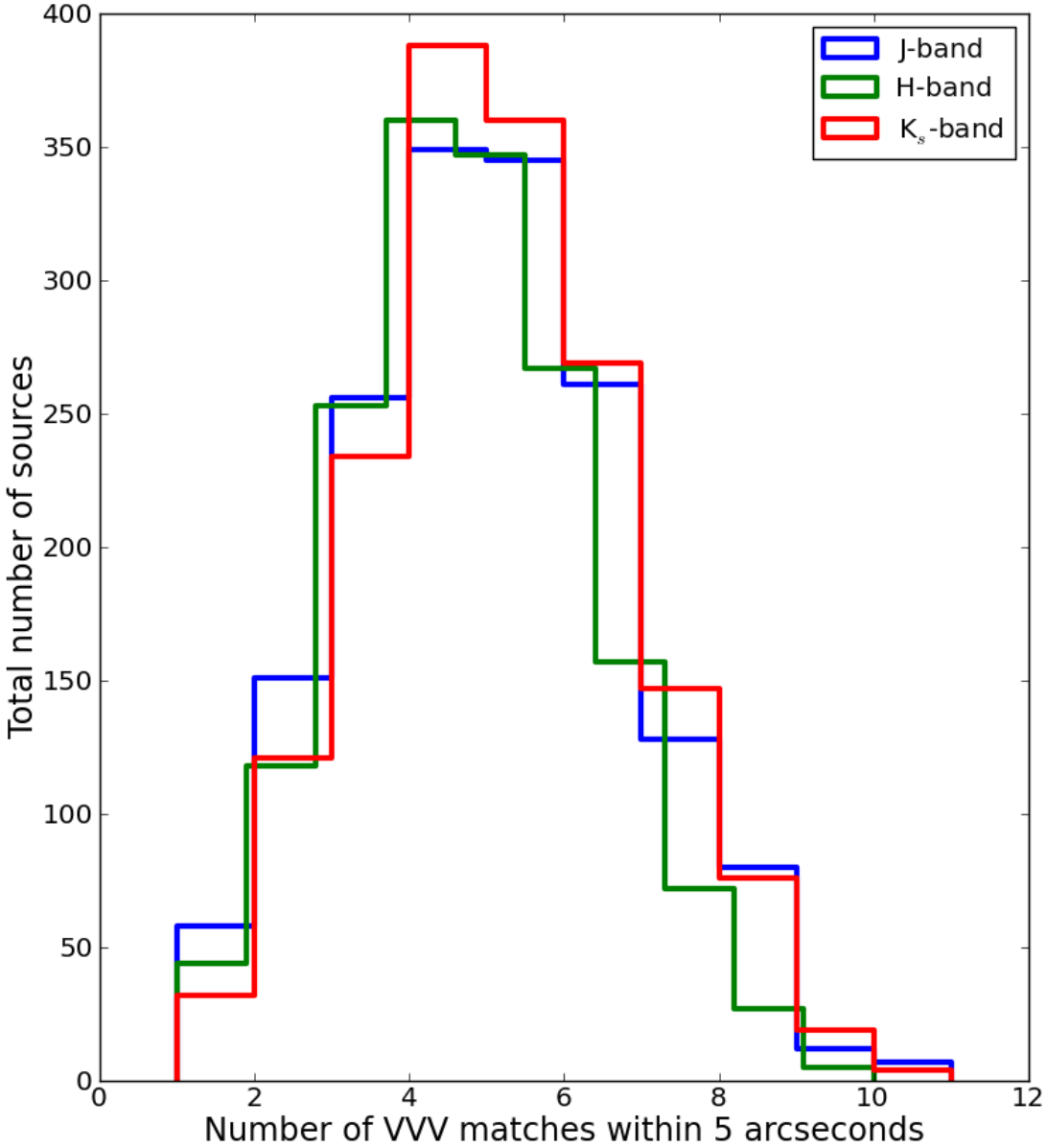
VVV (Minniti et al.)

- Main goal: construct a 3-D map of the surveyed region by using distance indicators
- Total area covered: 520 deg^2
- Observations: service mode using VIRCAM on VISTA
- Filters: ZYJHKs
- VVV overlaps with GBS $\Rightarrow$ exploited for NIR data of GBS sources

Cross-matching GBS and VVV

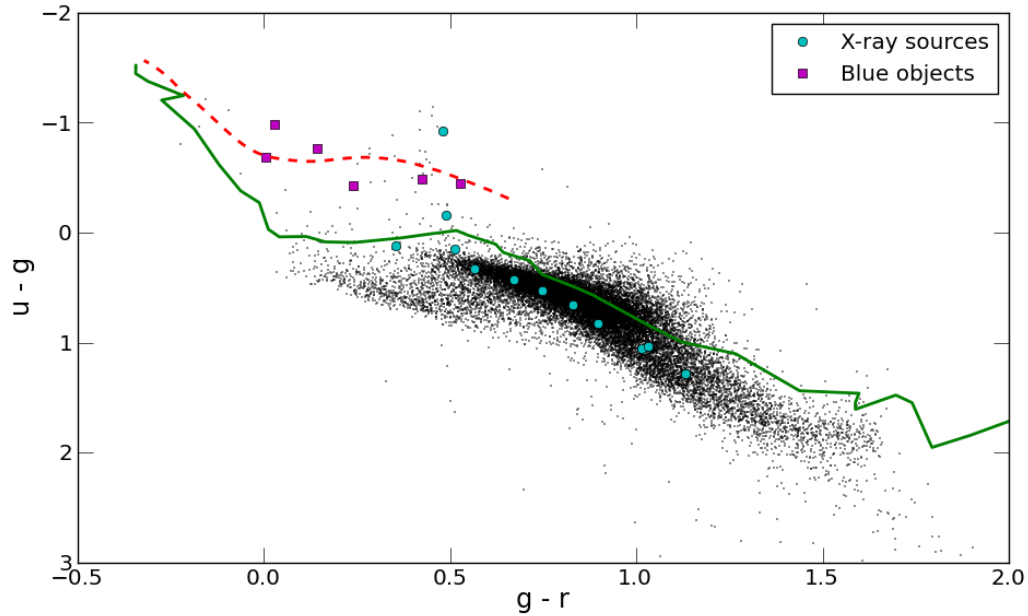
- Search for JHK_s matches in VVV within 5" radius
- Band-merge VVV catalogues
- GBS has 1658 X-ray sources

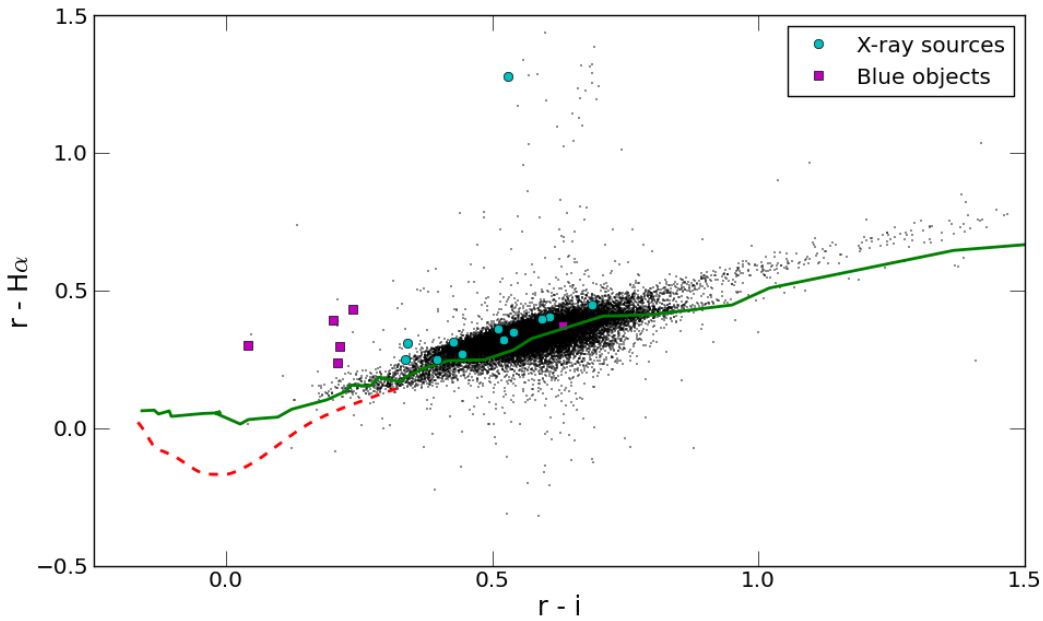
Survey	J	H	K_s	JHK_s
2MASS	1094	1094	1094	1094
UKIDSS GPS	796	796	796	796
VVV	1647	1650	1650	1644


J-band
H-band
K_s-band
Total number of sources
Number of VVV matches within 5 arcseconds
0
50
100
150
200
250
300
350
400
0
2
4
6
8
10
12

VPHAS+ (Drew et al.)

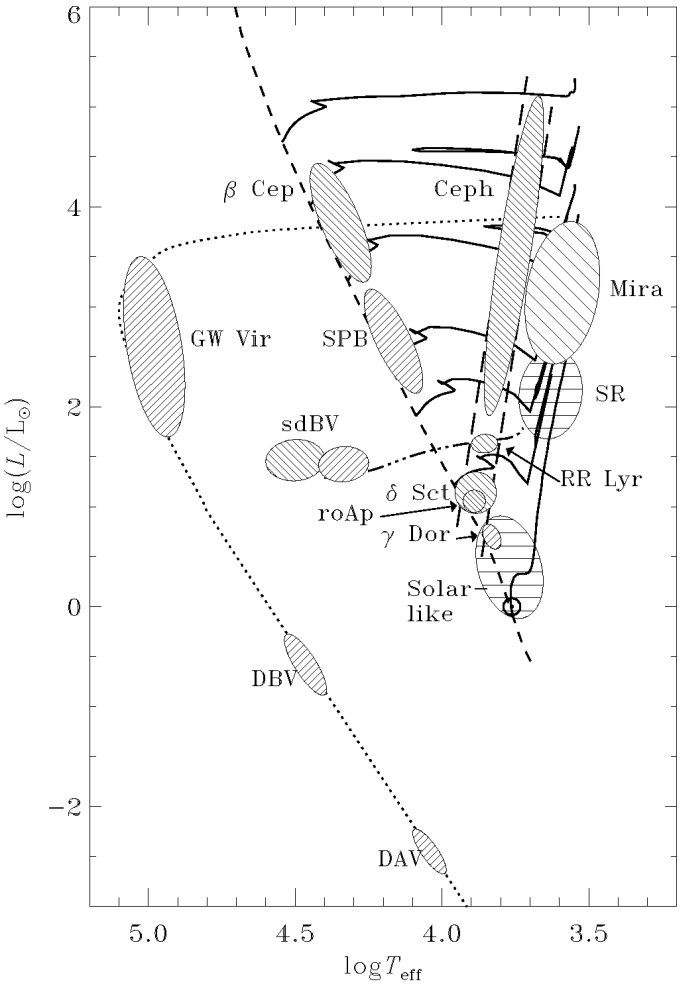
- 2000 deg^2
- Filters used: $u, g, r, i,$ Hα
- Will also overlap with GBS and VVV $\Rightarrow$ disentangle effect of reddening



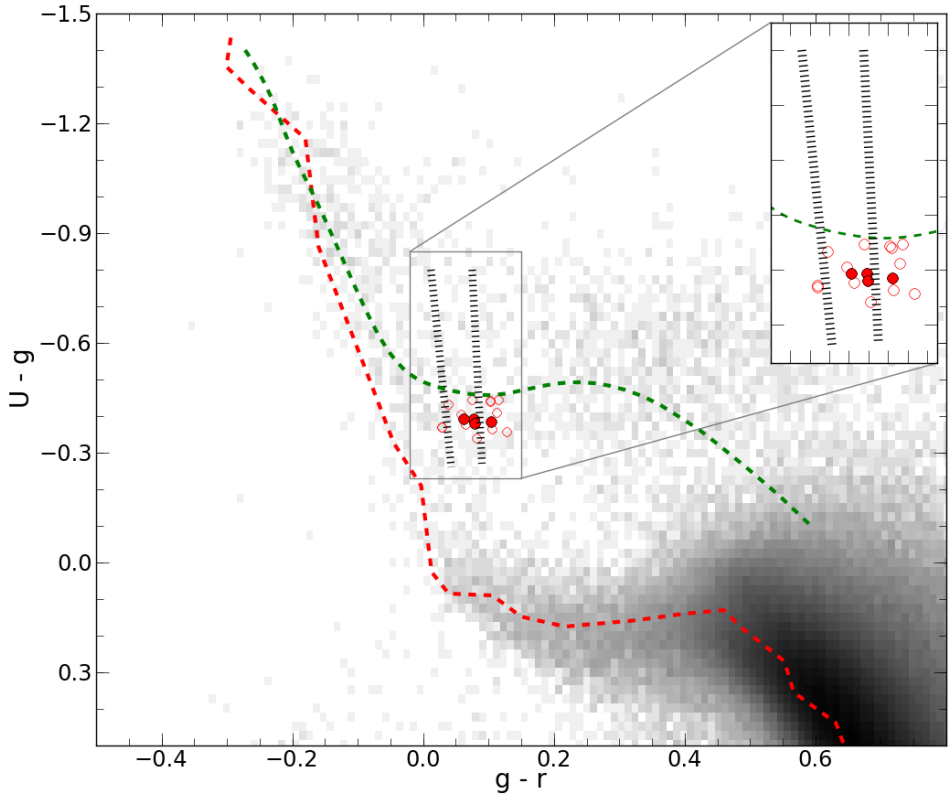


The *Kepler*-INT Survey (KIS, Greiss et al. 2012)

http://www.astro.warwick.ac.uk/research/kis

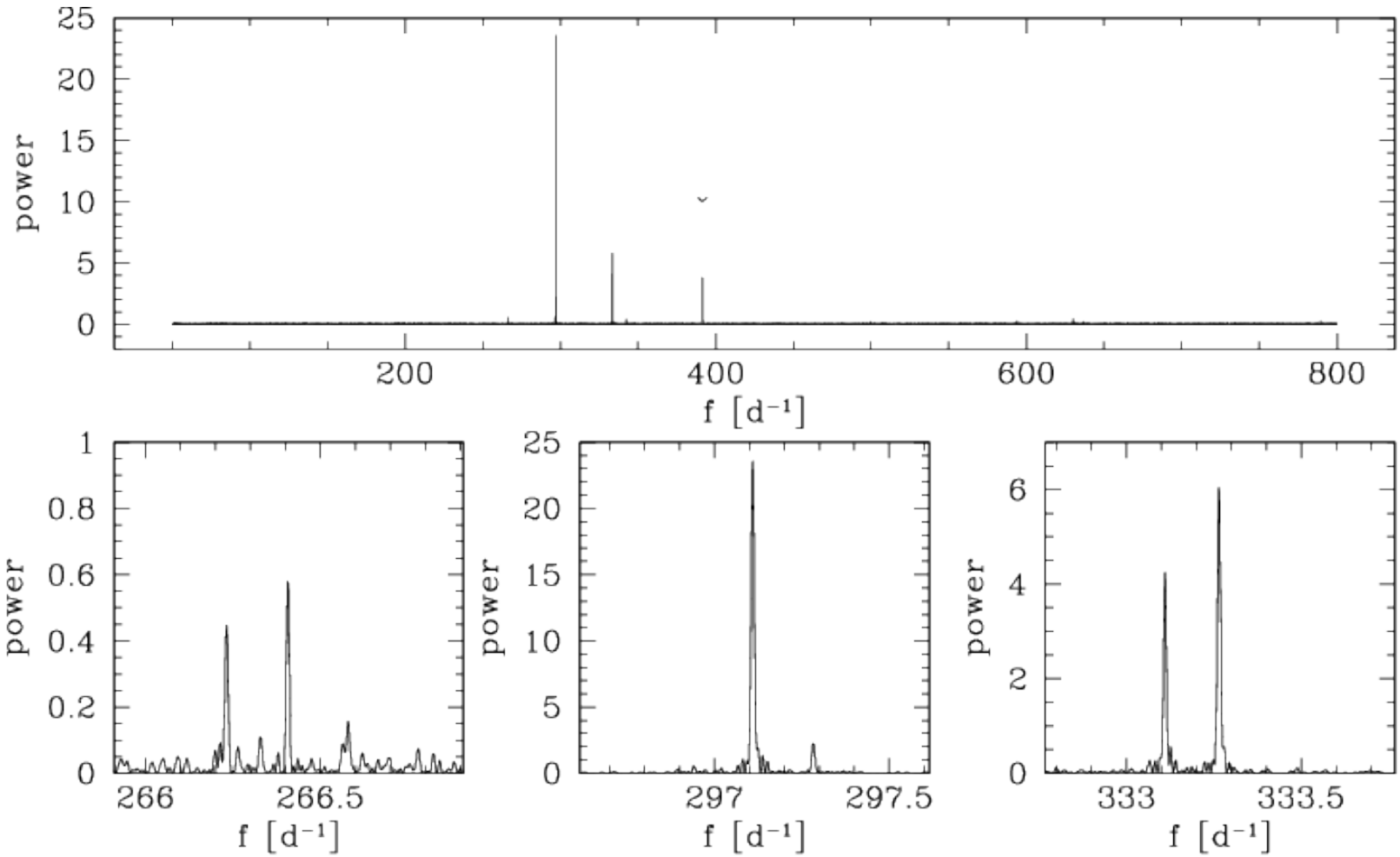


HR diagram by Jørgen Christensen-Dalsgaard.



Colour-colour diagram of pulsating WDs.

Kepler power spectrum of second ZZ Ceti discovered



Conclusions

- We use VVV to search for the counterparts of 1658 X-ray sources in GBS.
- VPHAS+ also overlaps with GBS and will provide information on the NIR counterparts to the X-ray sources.
- Multi-wavelength surveys can be used to develop automated searches for compact objects using combinations of colours (IPHAS, UVEX, KIS, VPHAS, VVV).