

Identifying CID binaries in SDSS and in Gaia later on

D. Pourbaix

Research Associate

National Fund for Scientific Research (Belgium)

Ž. Ivezić (U.Washington), G.R. Knapp, J.E. Gunn, R.H. Lupton (Princeton)

Old (un)popular idea

- Beckers (1982) suggested the concept of Differential Speckle Interferometry: speckle patterns recorded at two wavelengths.
- Christy et al. (1983) described a two-color (red and UV) refractometer to detect binaries of different colors, differentially referenced to nearby stars.
- Sorokin & Tokovinin (1985) designed a chromatic micrometer for the same purpose.
- Bailey (1998): detection of pre-main-sequence binaries with *spectro-astrometry*.

Binary detection limited by the centroiding precision rather by the aperture and Δm . e.g.: **Hipparcos** (30cm), single transit precision: ~ 5 mas, RP: $\sim 0.15''$.

Unresolved binaries & unseen secondaries

Wielen (1996) suggested two ways of unveiling unresolved binaries

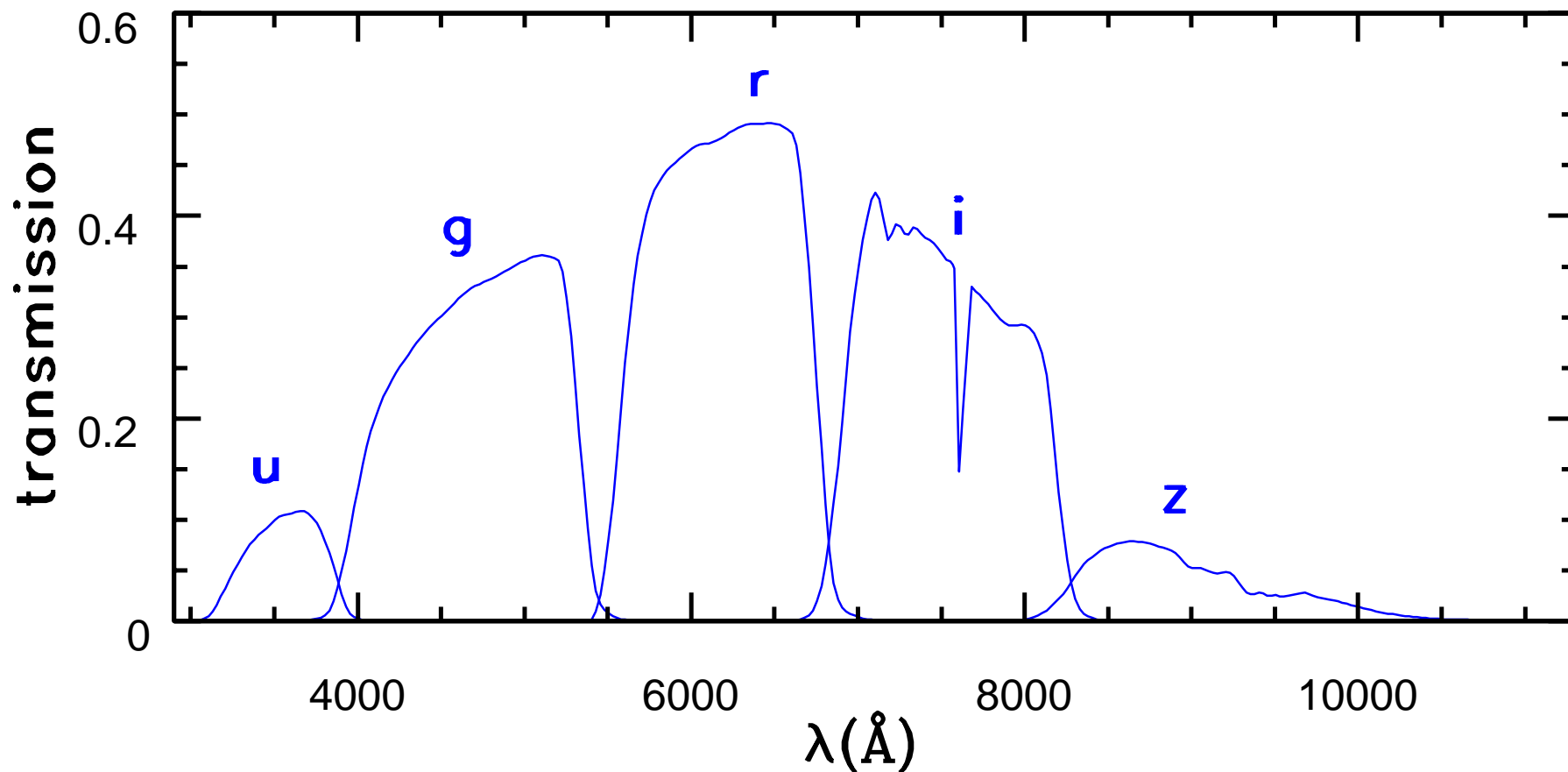
- Variability-Induced Movers
- Color-Induced Displacement binaries

VIM require several observations of the position of the photocenter and the total brightness of the source.

CID binaries rely on the color difference of the components and the subsequent shift of the photocenter depending on the adopted filter. They can be detected instantaneously

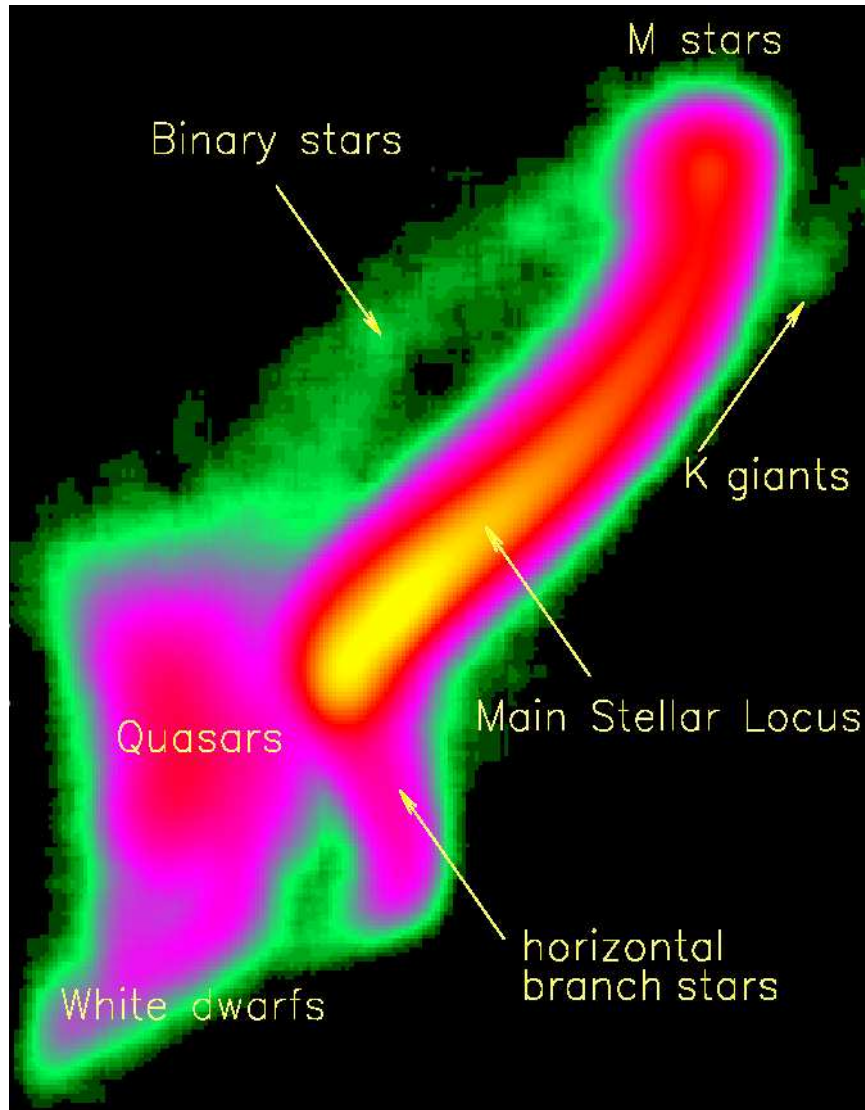
Hipparcos only detected some VIM.

SDSS Multi-band photometry



Fukugita et al. (1996), Gunn et al. (1998)

Photometric detection



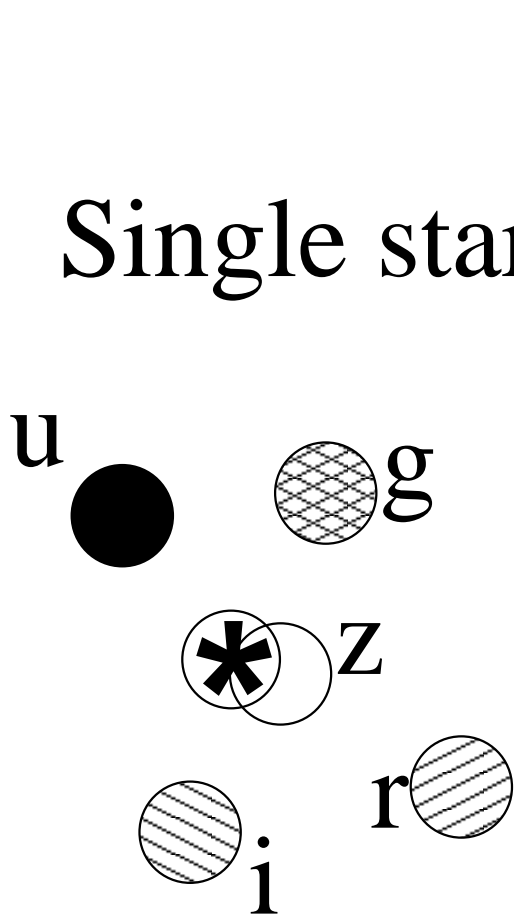
u, g, r color-color diagram.

Smolčić et al. (2004): white dwarf and M dwarf bridge w/ 880 bin. among 1.99M stars.

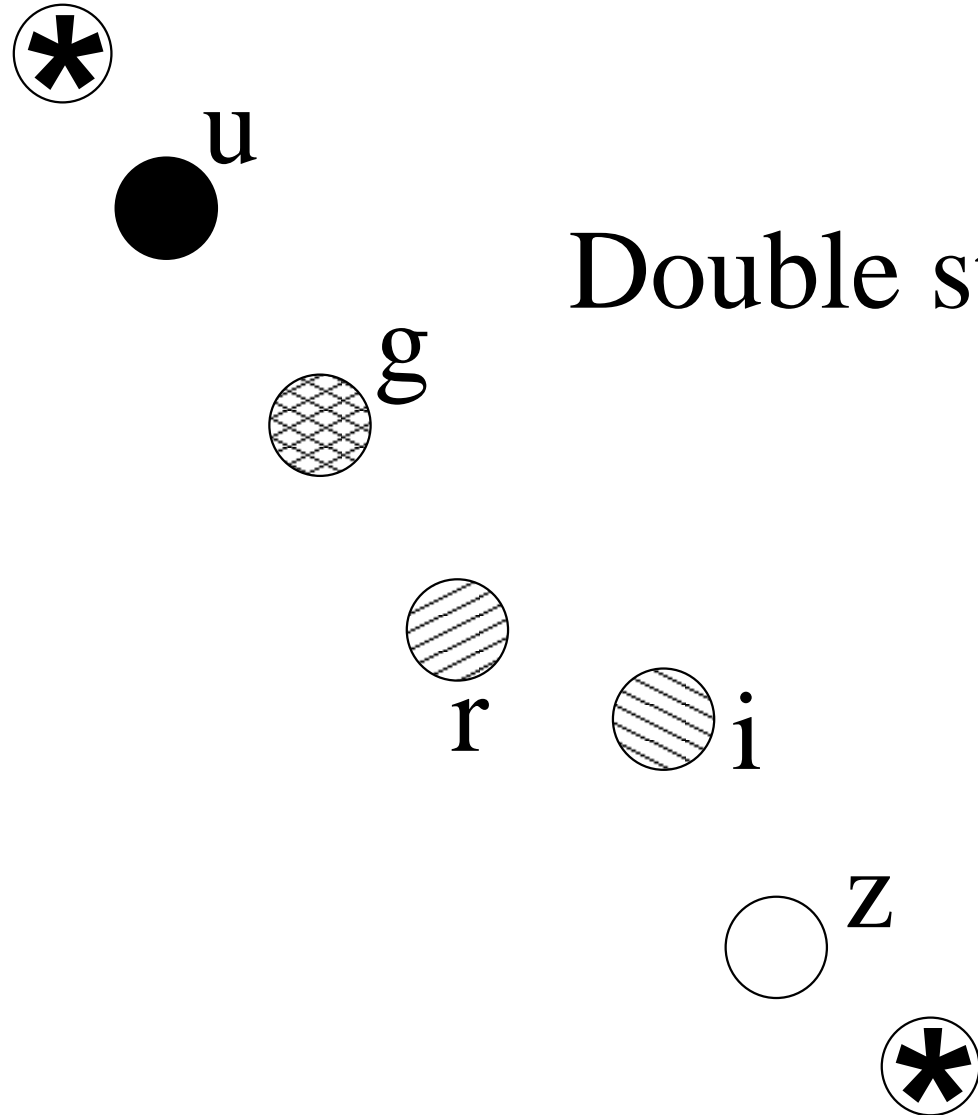
Method limited to color outliers only.

Multi-band astrometry

Single star



Double star

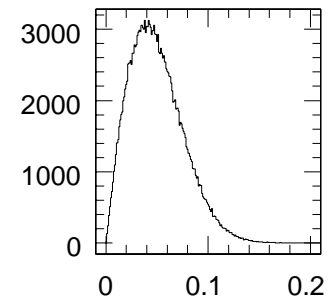
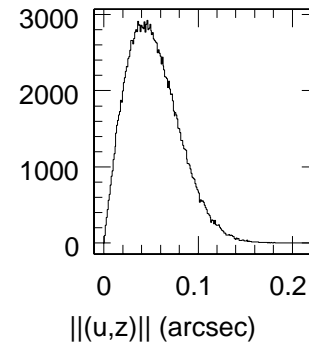
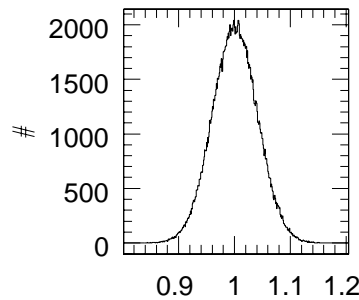
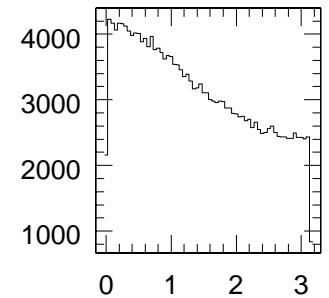
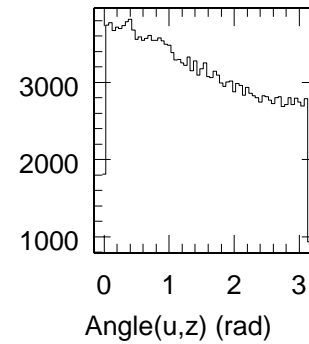
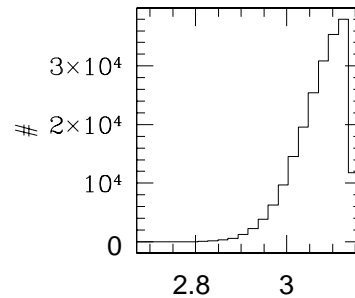
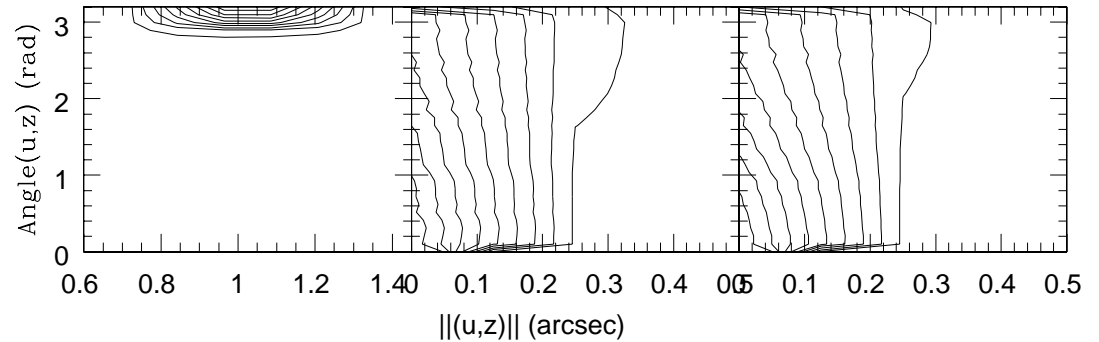


Simulated $\|(u, z)\|$

With

- $\sigma_{\alpha,u} = 36$ mas,
- $\sigma_{\delta,u} = 39$ mas,
- $\sigma_{\alpha,z} = 20$ mas,
- $\sigma_{\delta,z} = 22$ mas,
- $\rho = 0.17$,

no detection below
10 mas

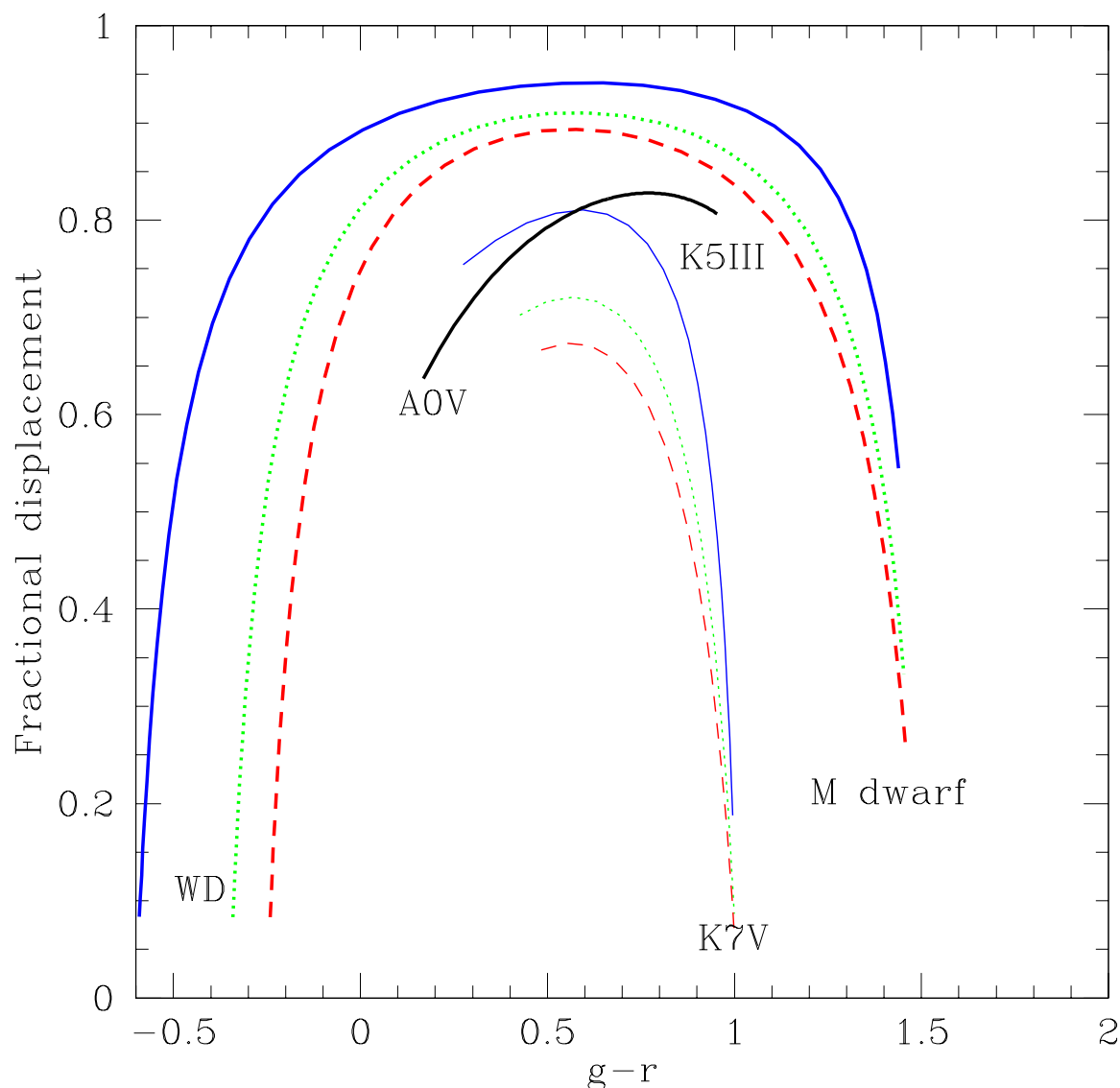


$$\|(u, z)\| / \|A, B\|$$

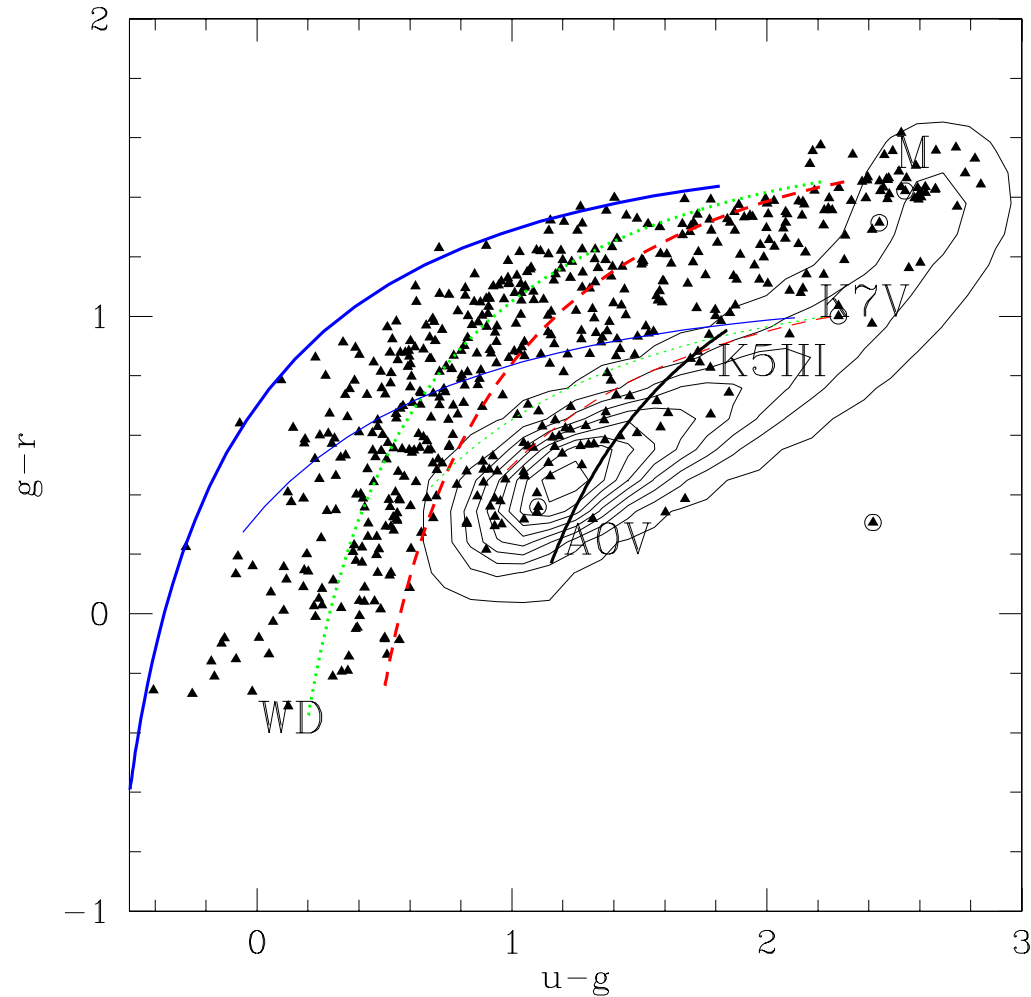
Combinations

- WD+M dwarf,
- WD+K7V,
- A0V+K5III.

A0V+K5III: rather similar colors but the displacement is always quite large.

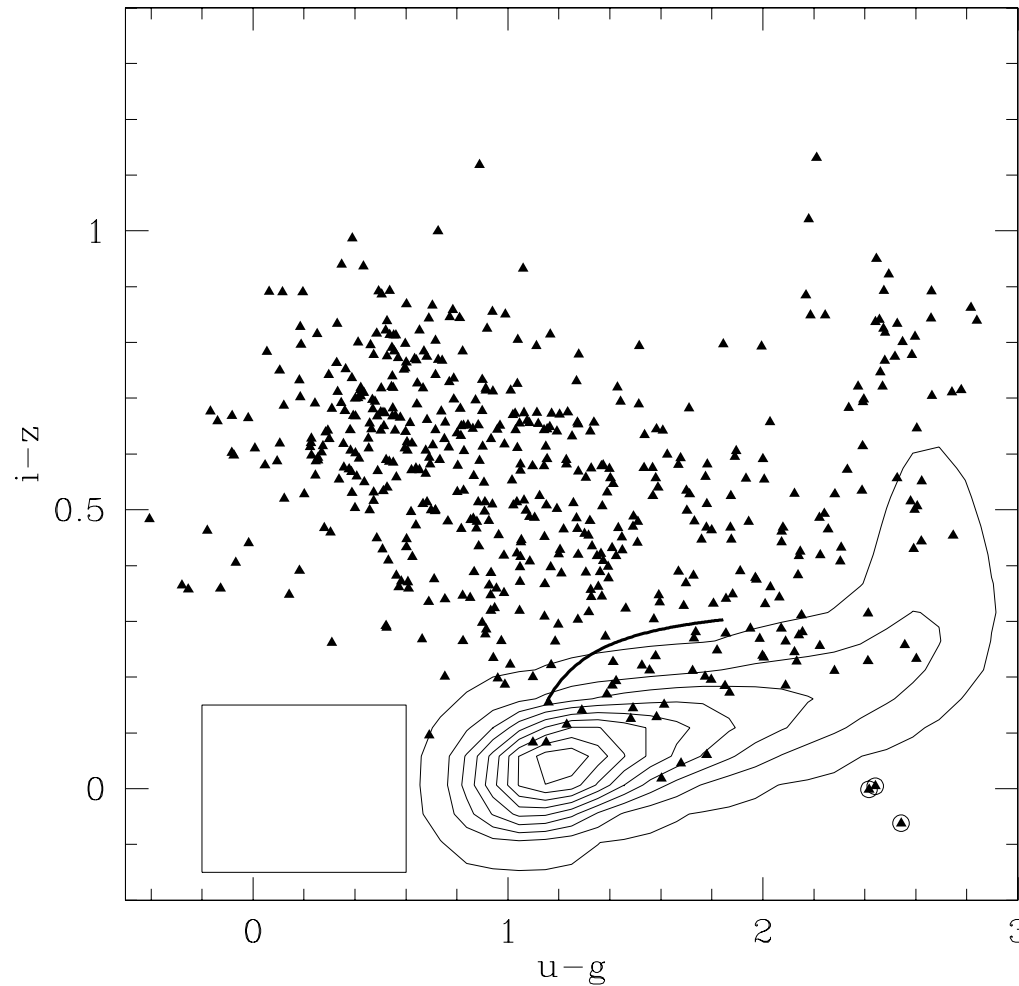


Color-color diagram (DR3)



Results of Smolčić et al. (2004) confirmed. Quasars?

No quasar contamination



Detection of binaries even inside the stellar locus.

SDSS vs. Gaia

SDSS	Gaia
$\sigma_{\text{astrom}} = 30 \text{ mas}$	$\sigma_{\text{astrom, BBP}} = 0.3 - 3 \text{ mas}$
one shot	tens of observations
2D data	1D measurements

- One shot \Rightarrow binary nature *on the fly*
- Several data \Rightarrow Binary modeling (GAIA-AF-02)

Rely upon a very accurate calibration of the chromaticity effects.

Pourbaix et al. (2003) discarded 86% of bright, red VIM!

Conclusions and perspectives

- 542 CID binaries detected in SDSS, 422 match the WD scenario (3113 asteroids) out of $5.5 \cdot 10^6$ *well behaved* star-like objects.
- Good complement to the photometric outlier method (CID binaries inside the stellar locus).
- Much higher precision of Gaia wrt SDSS **but** projection of the separation.
- *On the fly* but will need to wait for the calibration.