These Brown Dwarfs That Gaia Will Not See

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Brown dwarfs are extremely important objects to our understanding of stellar and planetary formation and evolution. Lying at the limit between the coolest stars and the giant planets, they are poorly understood and the atmospheric models of such objects are imprecise. Beyond this population, very cool brown dwarfs (Teff<300 K) were recently discovered of new spectral class (T and Y dwarfs). A precise distance is the fundamental parameter to be able to derive their masses, ages and thus calibrate the atmospheric models in such a regime.

Very few of these objects will fall into Gaia's limits of detection therefore it is of high importance that parallax works continue on such targets as complementary programs of the Gaia mission.

We started a program to measure the trigonometric parallax of several such extreme objects recently detected and which constitute excellent prototypes of cool brown dwarfs. Observations in NIR started in 2012 at the 4,1m SOAR/Spartan telescope and will continue until end of 2014.

Tests of a denoising algorithm applied to images has been performed and performances, repeatability and bias assessed.

Detectability by Gaia

J. M. Sarro et al, 2013, .A&A 550, A44

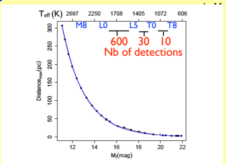


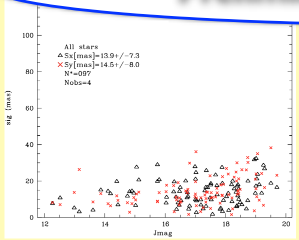
Fig. 3. Maximum distances at which an ultra-cool dwarf can be detected by *Gaia* at the limiting magnitud $G = 20$ as a function of its absolute magnitude in the I band. These have been derived from BT-Settl models (filled circles) and the continuous lines represent the interpolation used in deriving the expected counts per spectral type bin in Table 1. The black continuous line corresponds to $\log(g) = 5.0$ and the blue line to $\log(g) = 3.5$. The top axis shows the effective temperature measured in Kelvin for a $\log(g) = 5.0$ object with the absolute I magnitudes shown in the x axis, according to the BT-Settl models. The $T_{eff} - M_I$ mapping is only bi-valued below 600 K.

Only few ultra cool dwarf should be detected by Gaia

Our list of targets

Ident.	Right Ascension	Declination	J	Stype
WISE J0254+0223	02:54:09.00	+02:23:59.00	15.82	T8.0
UGPS J0722-0540	07:22:27.00	-05:40:30.00	16.52	T9
2MASS 08354256-0819237	08:35:42.00	-08:19:22.00	13.17	L5
2MASS 15394189-0520428	15:39:42.00	-05:20:42.00	13.92	L3.5
WISE 1541-2250	15:41:00.00	-22:49:55.00	21.20	
2MASS 17054834-0516462	17:05:48.00	-05:16:47.00	13.31	L4
WISE J1741+2533	17:41:24.00	+25:53:20.00	16.53	T9
2MASS J17412462+2553343	17 41 24.62	+25 53 34.36	16.45	T9
2MASS220411-564658	22:04:11.00	-56:46:58.00	11.91	T1

Preliminary parallaxes on the way...



Soar/Spartan Image quality

Estimated errors on position using the detector 3 of the SOAR/Spartan instrument. 6 images of a same field have been cross identified and the dispersion about the mean position is given in this figure. Only stars detected in at least four exposures were considered.
Repeatability of **20 mas** is achieved which can be considered as an estimate of the **measurement error** on a single image.

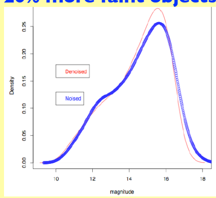
Image treatment : test of denoising

Image treatment

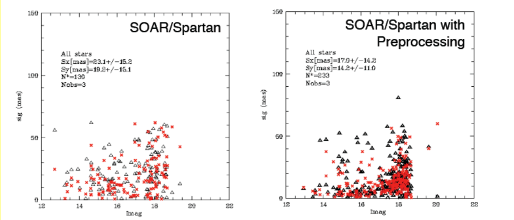
In parallel to the classical treatment, we are testing a **denoising algorithm** applied to our images and analysed the performances of the detection : a gains of 50% in the number of detections, mainly at the faint end. Full simulations of observations were performed and denoised, and then analysed. One of the conclusions is that the measurement errors before the denoising were smaller than 3 millipixels, while after denoising they were reduced to less than 1 millipixel. However, we also notice that there are indications of systematics introduced by the denoising method in the positions of the fainter objects. In the report, a preliminary assessment of real SOAR/Spartan data of the M30 cluster was performed.

20% more faint objects

We compared the detections performances on simulated images (Skymaker by Bertin) that were alternatively noised and denoised. Faint sources are better recovered with the denoising treatment.



Zhang et al., 2008, IEEE Transactions on image processing, 17, 7



Better accuracy ?

6 images of a same field have been cross identified and the dispersion about the mean positions is given in this figure. On the left we consider the 6 original SOAR images. On the right iwe give the dispersion of measurement of the 6 denoised images.Only stars detected in at least four exposures were considered.

Repeatability of **20 mas** is achieved on original images while it drops to **15 mas** on denoised images image.