Astrometry to support Gaia-ESO survey observations

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Real Observatorio de la Armada

The automatic meridian circles

Carlsberg Meridian Circle (El Roque de los Muchachos, La Palma)

Círculo Meridiano San Fernando (El Leoncito, Argentina)

CMC: $-30º < \delta < +50º$

CMSF: $-50º < \delta < +30º$

$9 < r' < 17$ $r'_{com} \sim 15$

Strips:

$\Delta\alpha = 2º$ or $\Delta t = 0.5h$ (depends on cluster)

CMC: $\Delta\delta = 25'$

CMSF: $\Delta\delta = 35'$

3-4 strips x 5 transits →

15-20 nights/cluster

Astrometric study

Automatic Meridian Circle of San Fernando CMASF at El Leoncito (Argentina)

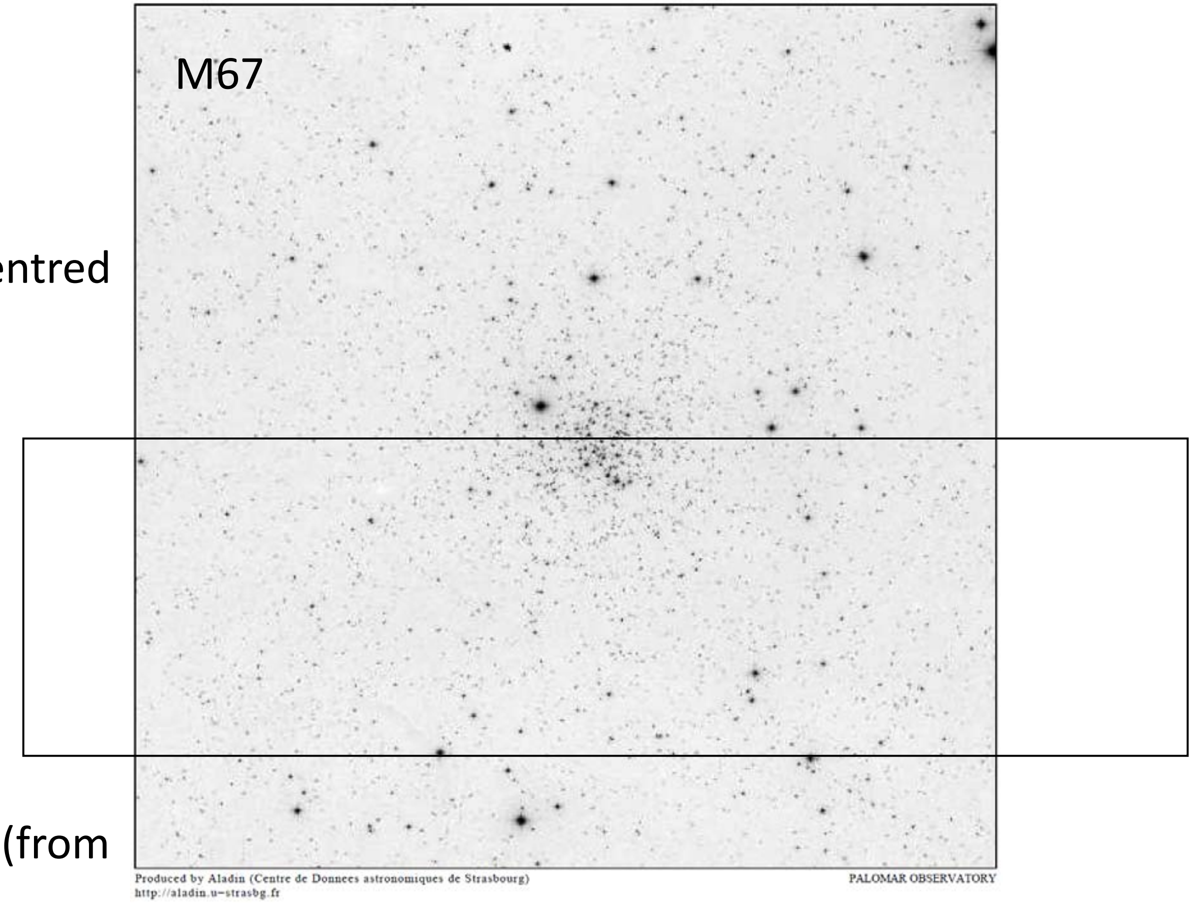
3 strips of $\Delta\alpha = 2^o$ and $\Delta\delta = 35'$ centred at $\delta = 11^o20'$, $11^o40'$ and 12^o observed 10 times each between December-2009 to April-2010

FoV = 2º × 1.3º

2738 stars

r'_{lim}~17 r'_{com}~15

mean of 12 observations per star (from 3 to 20 observations)



FOV ~1deg x 1 deg

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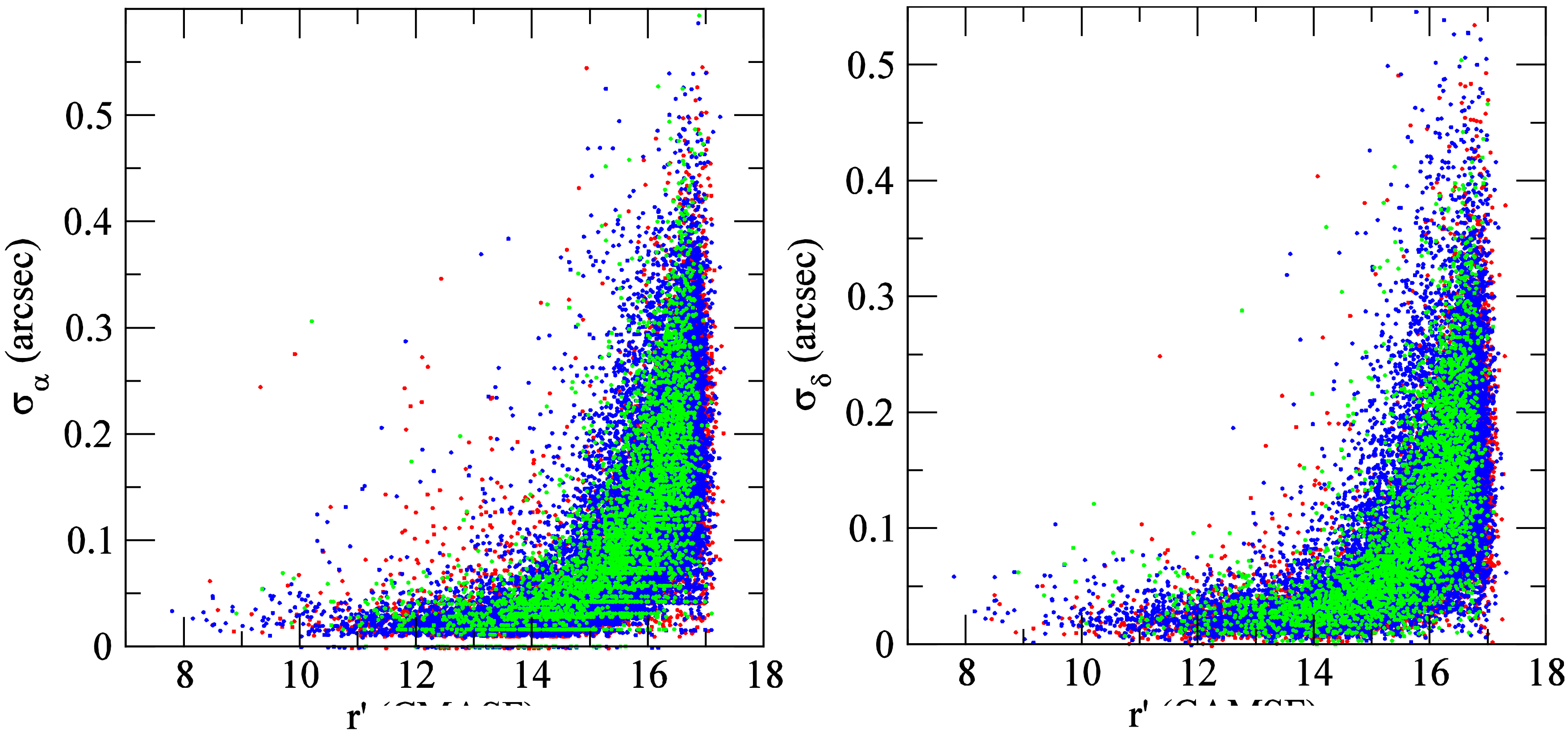
Estimated uncertainties of positions



NGC1817: 9587 stars; NGC2264: 17752 stars; NGC2509: 3333 stars
mean of 12 observations per star (from 3 to 20 observations)

Median internal errors at r′(CMC/CMASF) = 15 mag: σ_α = 0.055”, σ_δ = 0.055”

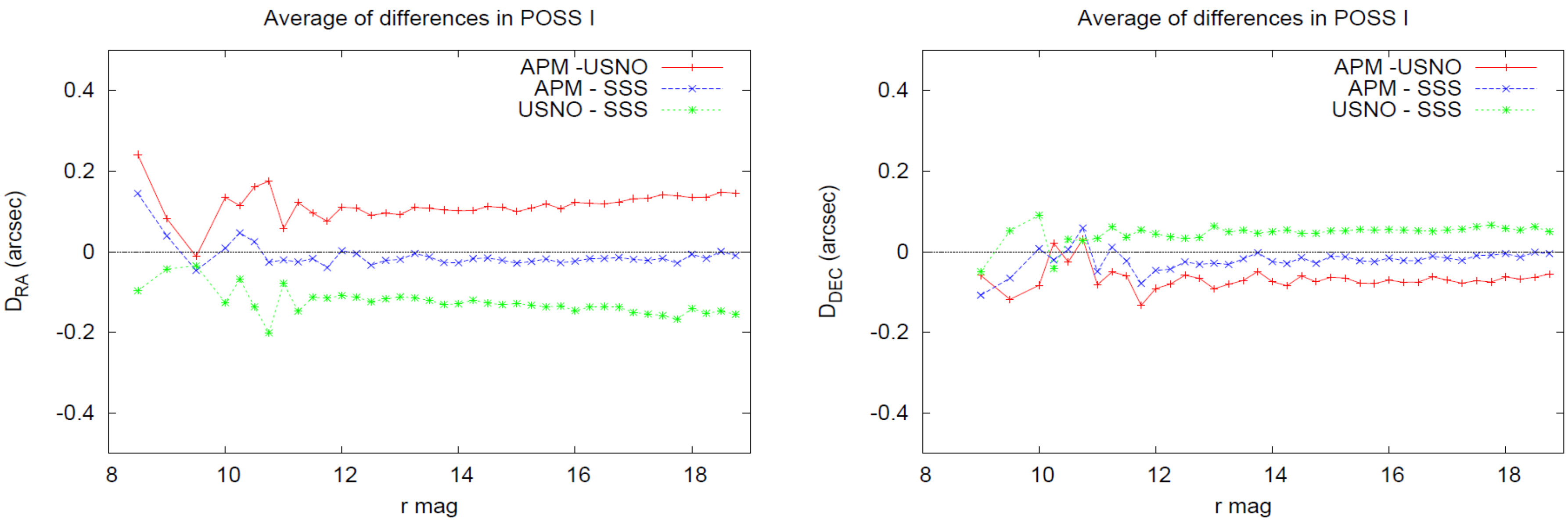
Derivation of proper motions

First epoch positions: plates POSSI (1951.9) measured by three different projects:
APMCAT-POSS1-1.0 (McMahon et al 2000) with median σ_α = 0.27", σ_δ = 0.31"
USNO-A2.0 (Monet et al 1998) with median σ_α = 0.25", σ_δ = 0.29"
SuperCOSMOS Sky Survey (NC. Hambly et al 2001) with median $\sigma_{\alpha,\delta}$ = 0.1-0.3"

Second epoch positions: CMC14 (Carlsberg Meridian Catalog Number 14 2006) (~2001)
r'(CMASF) = 15 mag are σ_α = 0.037" and σ_δ = 0.032"

Third epoch positions: CMC and CMASF (2009-2012).
Median internal errors at r'(CMASF) = 15 mag: σ_α = 0.055", σ_δ = 0.055"

Comparison among POSS-I digitalizations



Differences due to:

- scanning machines
- reference stars (in number and source catalogues)
- plate-to-celestial coordinates transformations

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Comparison between reference catalogues: ACT and Tycho-2:

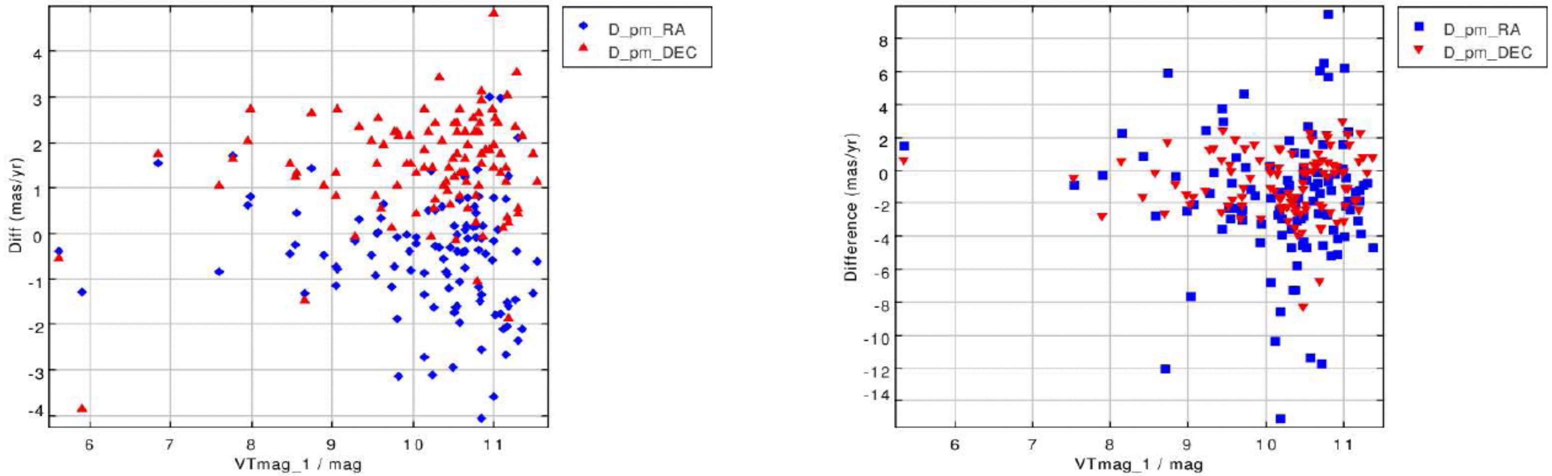

Figure: Differences in RA and DE for M67 & NGC 1817 cluster regions.

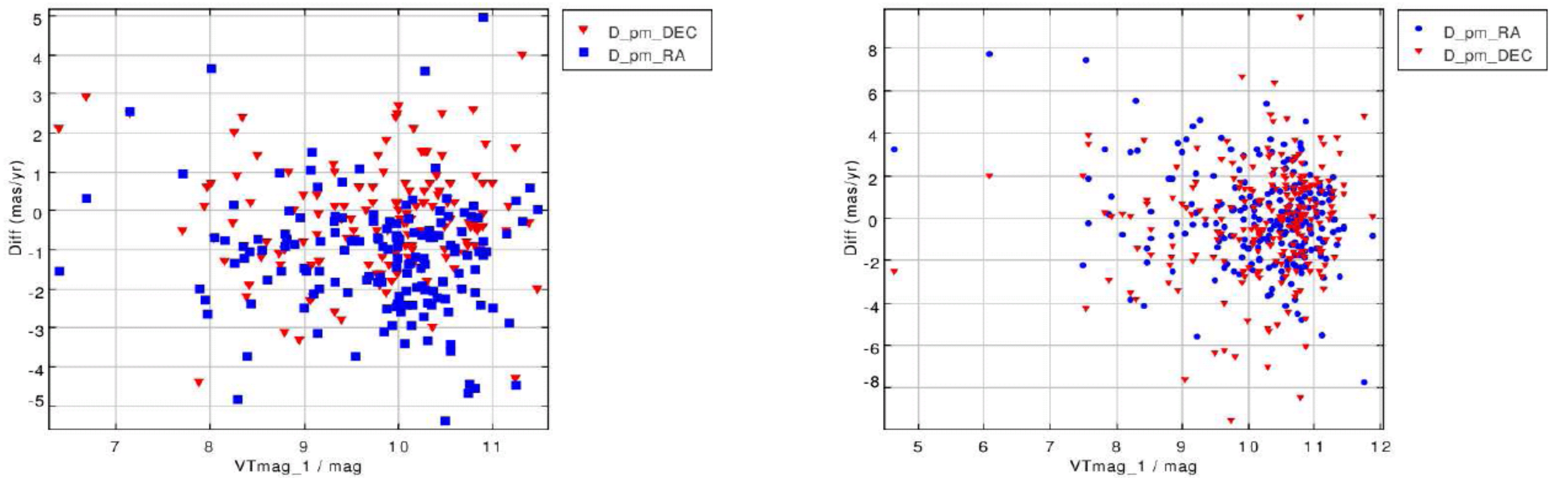

Figure: Differences in RA and DE for NGC 2264 & NGC 2509 cluster regions.

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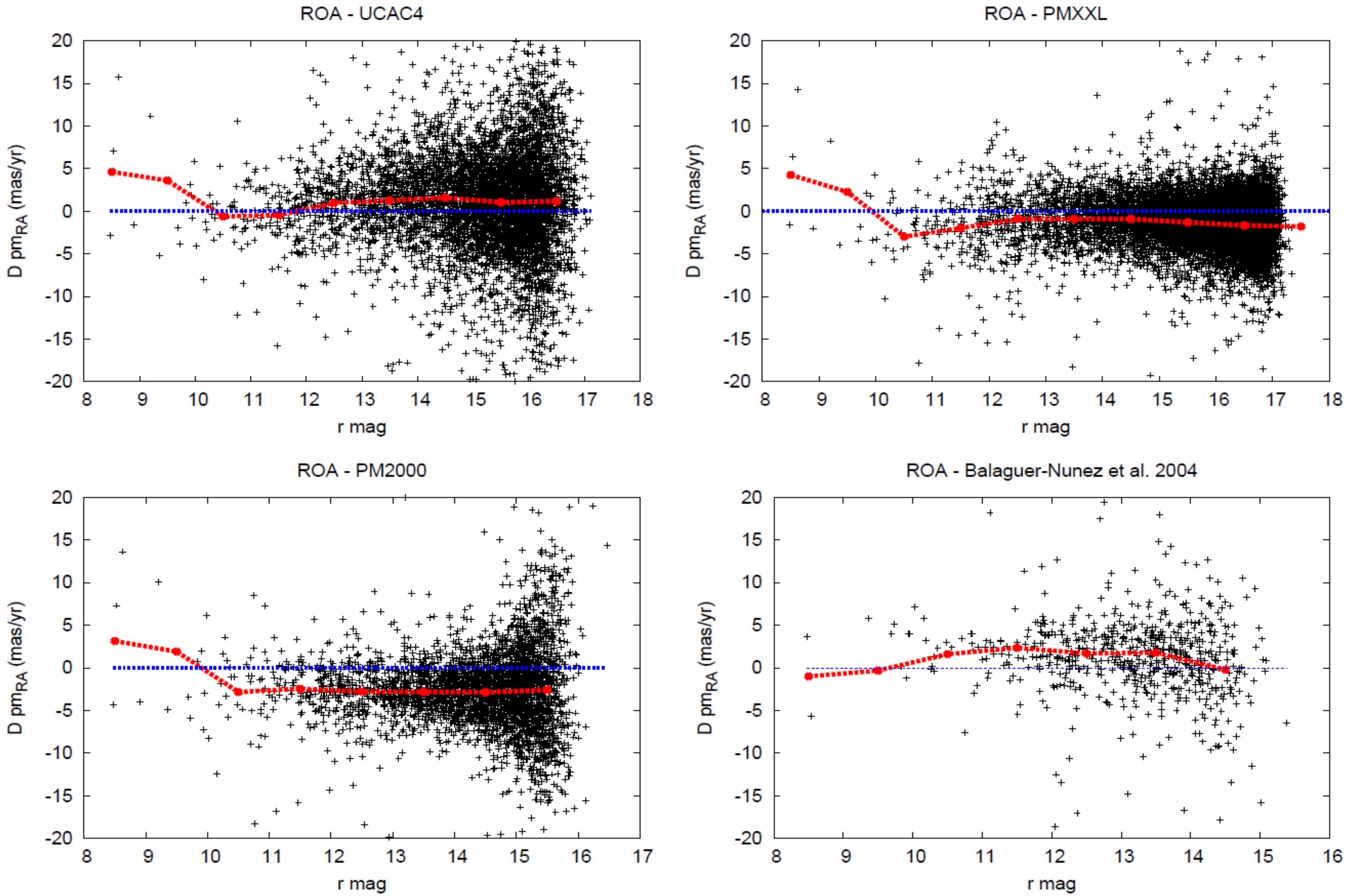
Results

- There are systematic differences between reference stars catalogues: ACT & Tycho-2
- The differences depend on the sky position
- The APM, USNO-2 and SSS differ (≤0.2”) although they are based on the same photographic material

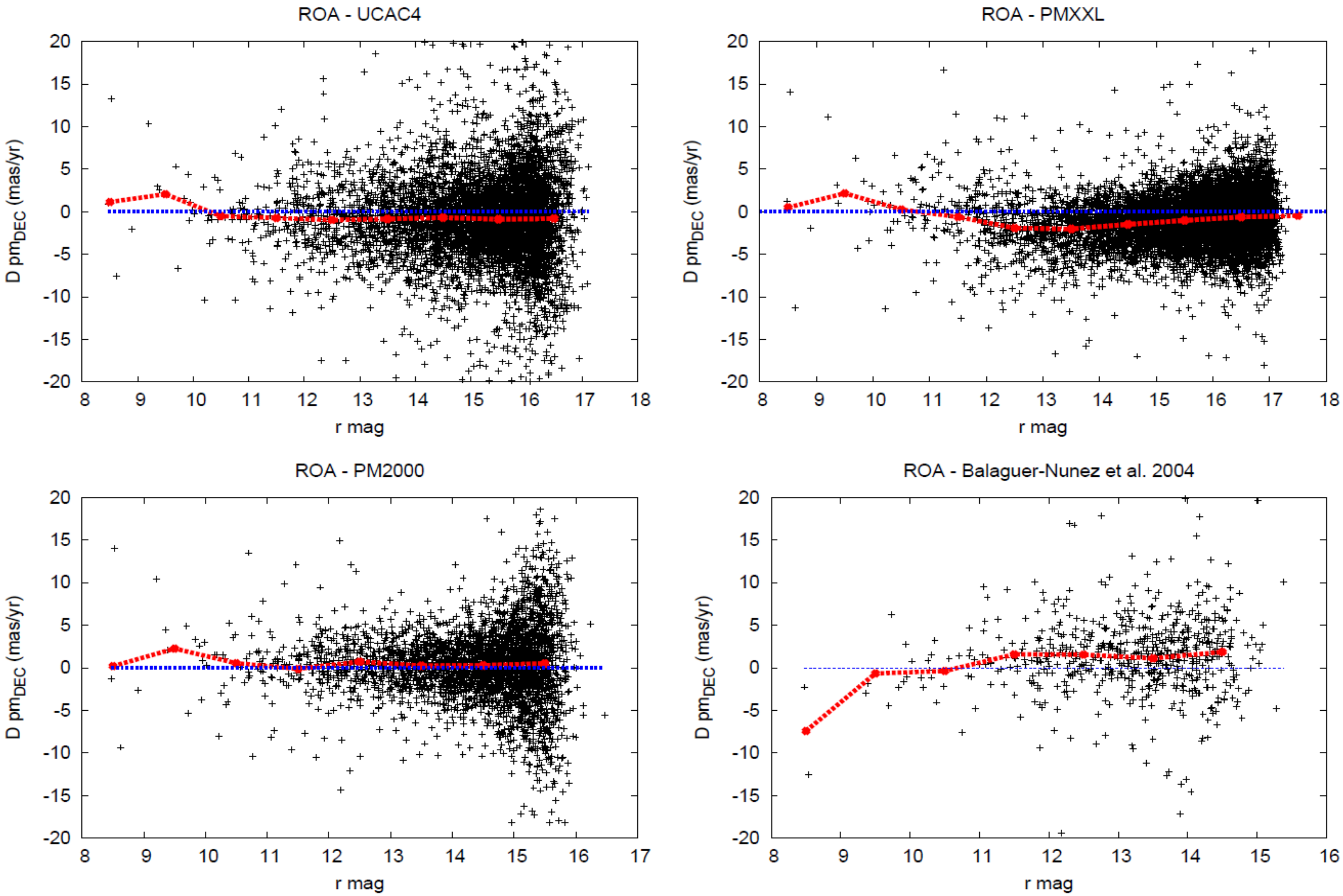
<u>The derived proper motions will depend on the choice of POSS-I digitalization</u>

Our choice USNO-A2.0

Comparison: ROA with general catalogues. NGC1817. RA proper motions:



Comparison: ROA with general catalogues. NGC1817. DE proper motions:



Comparison between ROA and general catalogues

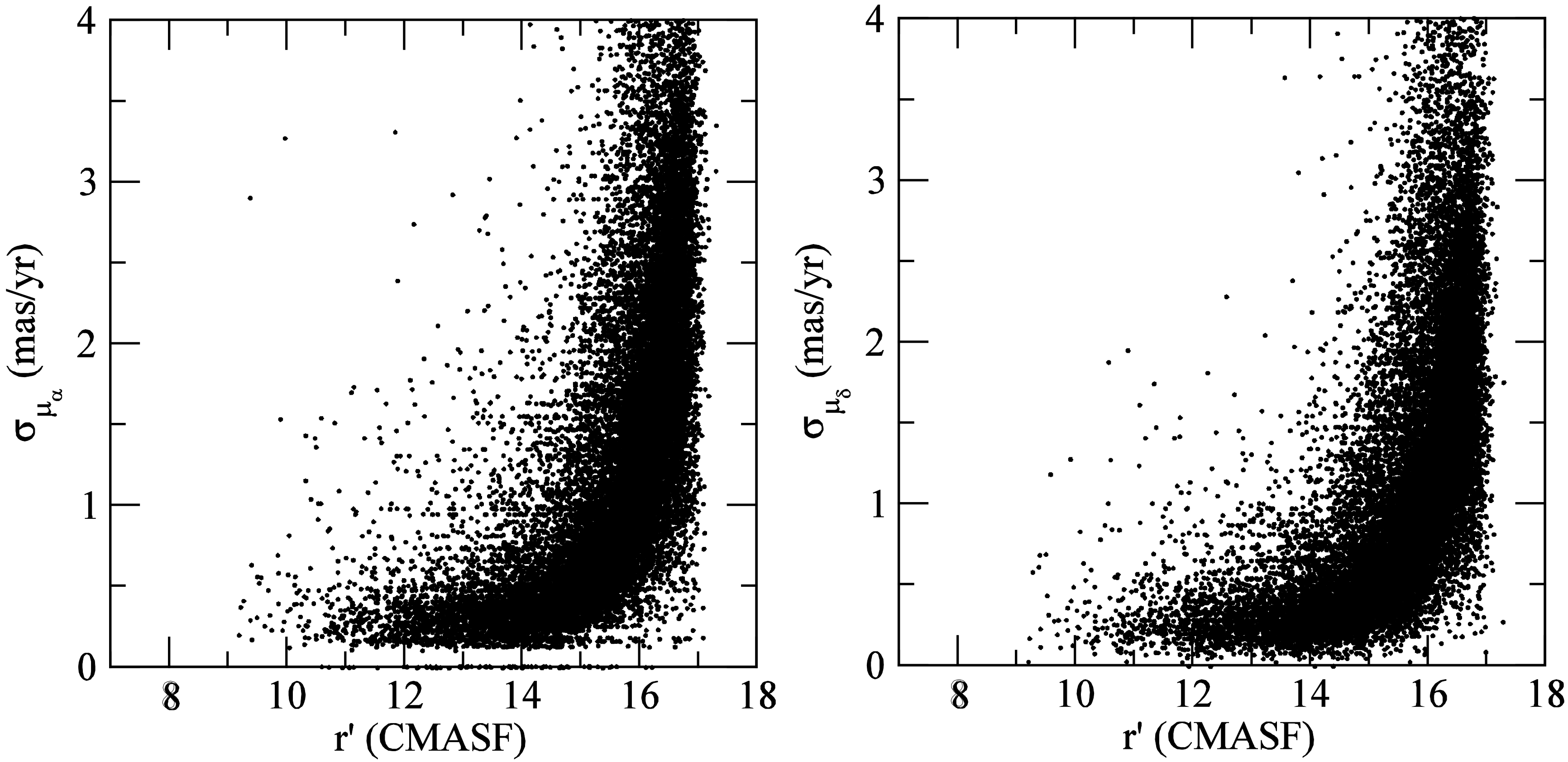
	$\Delta\mu_\alpha$(mas/yr)	$\Delta\mu_\delta$(mas/yr)	N_*	σ_{μ_α}	σ_{μ_δ}
ROA - UCAC-4	1.229 ± 0.092	-0.828 ± 0.081	5887	7.045	6.178
ROA - PPMXL	-1.361 ± 0.046	-0.920 ± 0.050	9067	4.380	4.797
ROA - PM2000	-2.725 ± 0.102	0.368 ± 0.092	3121	5.672	5.158
ROA - Balaguer et al.2004	0.868 ± 0.288	1.484 ± 0.289	405	5.801	5.819
PM2000 - PPMXL	1.979 ± 0.067	-1.692 ± 0.065	7790	5.921	5.701
UCAC-4 - PPMXL	-2.177 ± 0.066	-0.321 ± 0.057	7850	5.891	5.075
UCAC-4 - PM2000	-3.756 ± 0.091	1.251 ± 0.085	4240	5.968	5.531

Table: Up: Differences among ROA proper motions and the other catalogues in μ_α and μ_δ for NGC 1817 cluster region. Down: Differences among general catalogues. Only $r' > 13$ considered. **Take into account** that according to Krone-Martins et al 2010: μ_α is overestimated in PM2000.

Most used catalogues also suffer from same limitations in precision

Accuracy of catalogues around 1 $\sim$ 2 mas/yr

Estimated uncertainties of proper motions



NGC1817: 9587 stars; NGC2264: 17752 stars; NGC2509: 3333 stars
mean of 12 observations per star (from 3 to 20 observations)

Typical $\sigma_{\mu\alpha}$ and $\sigma_{\mu\delta}$ are of 0.8 and 0.7 mas yr^{-1} for a star of r'=15 mag

Results

• The derived absolute proper motions strongly depend on the accuracy of the first epoch position (1951.9)

• The bright stars (r' < 11-12) have large proper motions uncertainties because of saturation in POSS-I plates

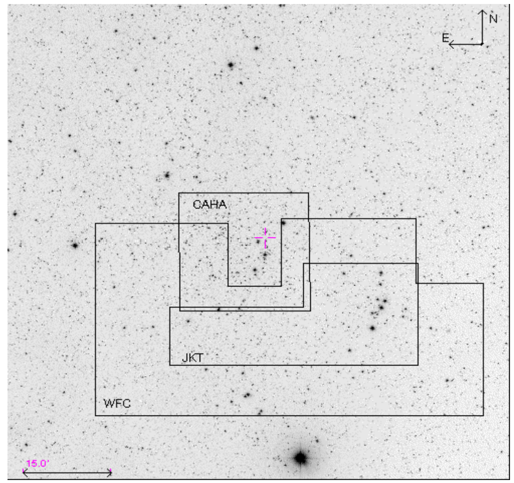
• The differences with other determinations are compatible with differences among other works

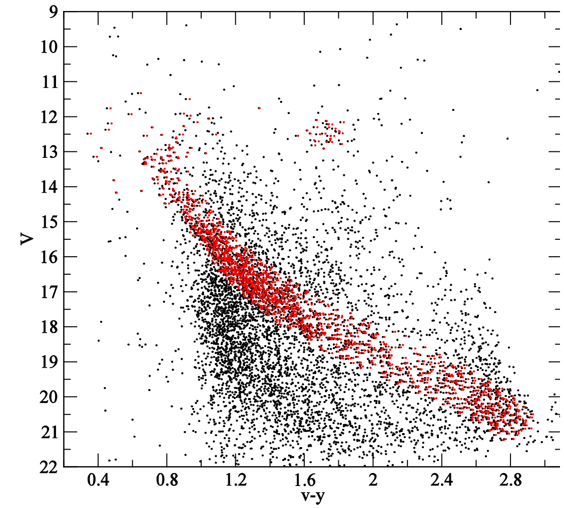
Status of the observational project

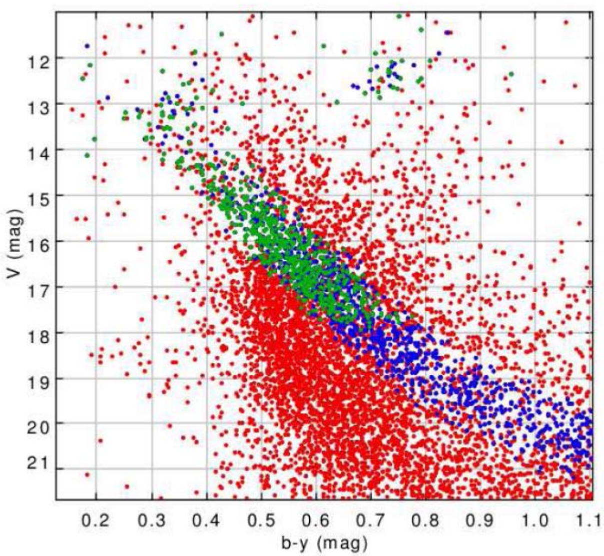
Cluster Name	Distance	logAge	E(B-V)	Z	Area	Obs.
NGC2682 (M67)	900	9.82	0.04	476	90’	CMASF
NGC1817	1972	8.612	0.334	-446.8	95’	CTA/CMASF
NGC 2264	667	6.954	0.051	25.6	115’	CTA/ CMASF
NGC 2509	912	9.9	0.15		35’	CTA
Ruprecht 32	5346	7.08	0.5	-53.5	30’	CTA/CMASF
NGC 6405	487	7.97	0.144	-6.6	90’	CTA/CMASF
King 25	1450	8.8	1.36		30’	CTA/CMASF
NGC 6819	2360	9.174	0.238	348.1	30’	CTA
Bochum 6	2500	7	0.71	-15,1	60’	CTA/CMASF
NGC 1893	3280	7.027	0.581	-96.2	65’	CTA/CMASF
Teutsch 10	2600	7.5	1.01		35’	CTA/ CMASF
NGC 2355	2200	8.85	0.12	450	45’	CTA/CMASF
NGC 2112	850	9.301	0.63	-185.6	108’	CTA/CMASF
Haffner 8	1182	9.15	0.03	27.7	30’	CTA/CMASF
Pismis 3	1394	9.027	1.3	12.2	90’	CMASF
Berkeley 44	1800	9.11	1.4	105.3	30’	CTA/CMASF
NGC 3680	938	9.077	0.066	273	30’	CMASF
NGC 6231	1243	6.84	0.439	25.7	90’	CMASF
Blanco 1	269	7.796	0.01	-264.3	210’	CTA/CMASF

Cluster Name	Distan	logAge	E(B-V)	Z	Area	Obs.
Teutsch 51	2900	8.9	1.01		30’	CTA / CMASF
NGC 6704	2974	7.863	0.717	-115.1	30’	CTA/CMASF
NGC 6694	1600	7.931	0.589	-81.3	50’	CMASF
NGC 6705	1877	8.302	0.426	-90.9	30’	CTA / CMASF
NGC 6633	376	8.629	0.182	54.5	90’	CTA
IC4665	352	7.634	0.174	103.4	210’	CTA / CMASF
Ruprecht 134	550	9.05	0.15	-2.1		CTA / CMASF
NGC1980	550	6.67	0.05	-184.5	75’	CMASF
NGC 6530	1330	6.867	0.333	-30.9	90’	CTA / CMASF
NGC 2477	1222	8.848	0.279	-124.3	90’	CTA / CMASF
NGC 2658	2021	9.152	0.043	213.7	45’	CTA / CMASF
NGC 2244	1445	6.896	0.463	-52.2	90’	CTA
Trumpler 24	1138	6.919	0.418	29.7	210’	CMASF
IC 4756	484	8.699	0.192	44.2	115’	CTA/CMASF
NGC 6802	1124	8.87	0.848	18	30’	CTA/CMASF
NGC 6583	2040	9	0.51	-90	30’	CTA/CMASF
Collinder 421	950	9.06	0.1	42.1	90’	CTA
NGC 6611	1749	6.884	0.782	24.2		CTA
Berkeley 81	3000	9.0	1.0	-108.3		CTA/CMASF

Selection of membership: the case of NGC1817







Final candidates:

		μ_α(mas/yr)	μ_δ(mas/yr)	N_*	σ_α	σ_δ
ROA	Red giants	0.064 ± 0.392	-1.123 ± 0.583	22	1.840	2.733
	Cluster	0.158 ± 0.075	-2.432 ± 0.087	594	1.826	2.122
PM2000	Red giants	2.496 ± 0.489	-2.035 ± 0.629	23	2.346	3.016
	Cluster	2.097 ± 0.164	-2.710 ± 0.182	215	2.410	2.674
UCAC-4	Red giants	-1.879 ± 0.520	-0.832 ± 0.407	28	2.751	2.152
	Cluster	-1.399 ± 0.126	-1.070 ± 0.099	403	2.525	2.006

Tasks are ongoing ...

slowly

Suggestions are welcome

The meridian circles are open to collaborations