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Alexander von Humboldt Stiftung/Foundation

The VMC survey

The VIST A survey of the Magellanic Clouds system

15 institutes worldwide

VMC team

Core: Cioni (PI), Bekki, Clementini, Emerson, Evans, de Grijs, Gibson, Girardi, Groenewegen, Ivanov, Marconi, Miszalski, Moore, Napiwotzki, Oliveira, Ripepi, van Loon, Wilkinson, Wood

Associates: Guandalini, Haberl, Marquette, Piatti, Smart, Zaggia
Postdocs: Anders, Rubele, For, Subramanian
Students: Bagheri, Kasmath, Moretti, Muraveva, Romita, Tatton

http://star.herts.ac.uk/~mcioni/vmc/

>25% complete

VMC survey

- Filters: Y, J, K_s
- Camera: 16 Rayethon detectors
- Sampling: 0.34"/pix
- FOV: 1.65 deg^2
- Area: 218 deg^2
- Sensitivity: YJK_s~22 (5σ Vega)
- Saturation: K_s~10
- Epochs: 3 (YJ) + 12 (K_s)
- Time-scale: 2009+

as VIDEO in Ks

Cioni et al., A&A, 2011, 527, A116

VMC main science

VMC is the most sensitive survey of the Magellanic system in the near-IR and with the best spatial resolution.

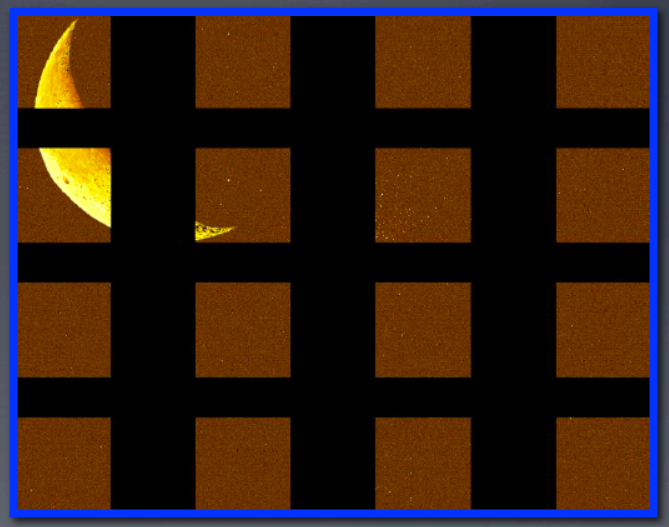
- Spatially resolved star formation history [Girardi's talk]
  - By reaching stars below the old main-sequence turnoff
  - By interpreting colour-magnitude diagrams
- 3D geometry
  - Using Cepheids and RR Lyrae stars
  - Using red clump giant stars

Similar tools as used by the VVV survey but at 60 kpc!

VMC legacy science

- Milky Way
- Star formation
- Individual stars
- Stellar clusters
- Galaxy dynamics
- Quasars

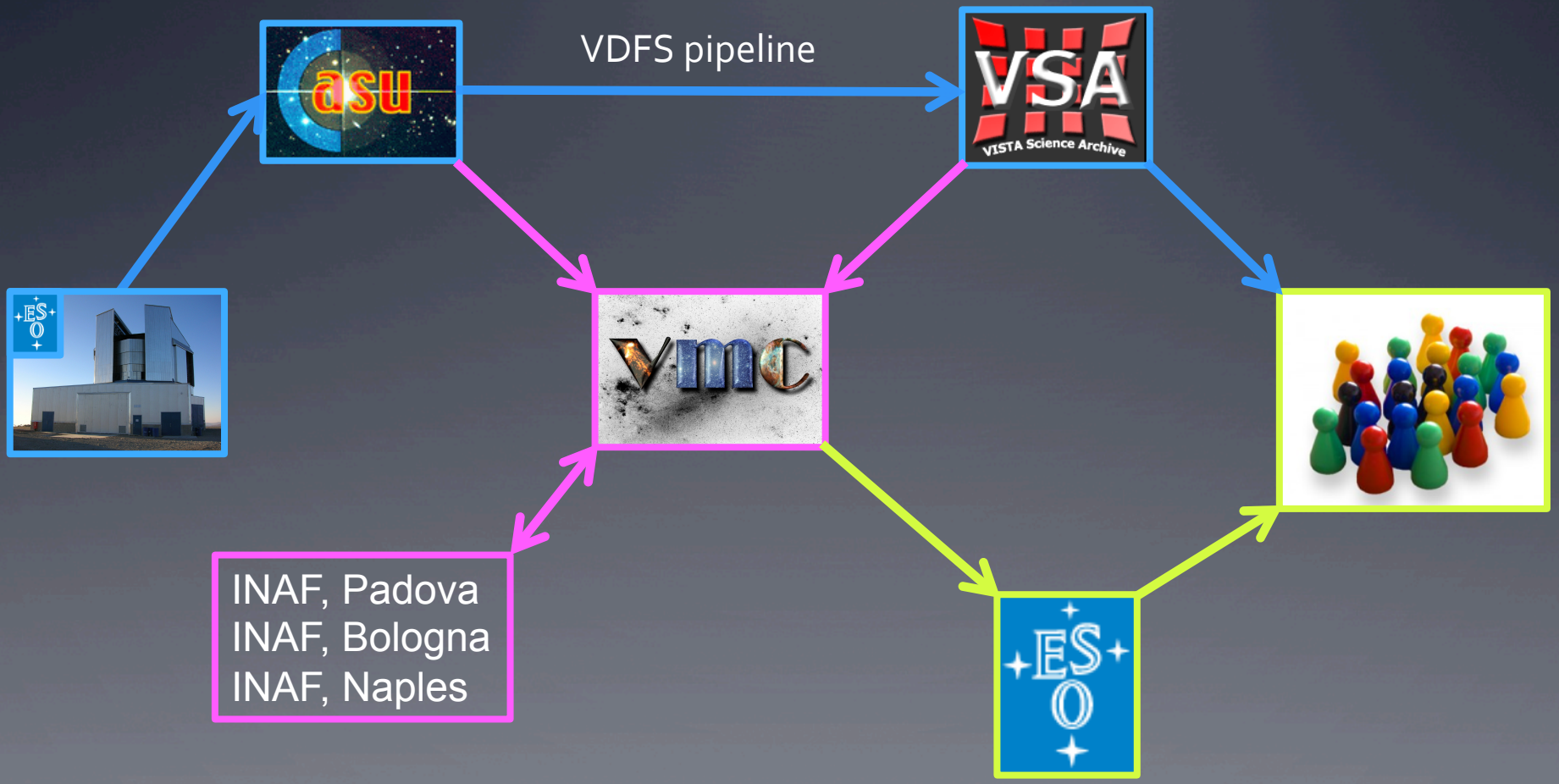
VISTA field of view



Average quality of VMC individual epochs

Filter	FWHM	Ellipticity	Zero-Point	Mag. Limit
Y	0.98 (0.13)	0.06 (0.01)	23.16 (0.22)	20.00 (0.89)
J	0.96 (0.11)	0.06 (0.01)	23.26 (0.33)	19.85 (0.70)
Ks	0.93 (0.10)	0.06 (0.01)	23.02 (0.13)	19.28 (0.26)

The VMC data path

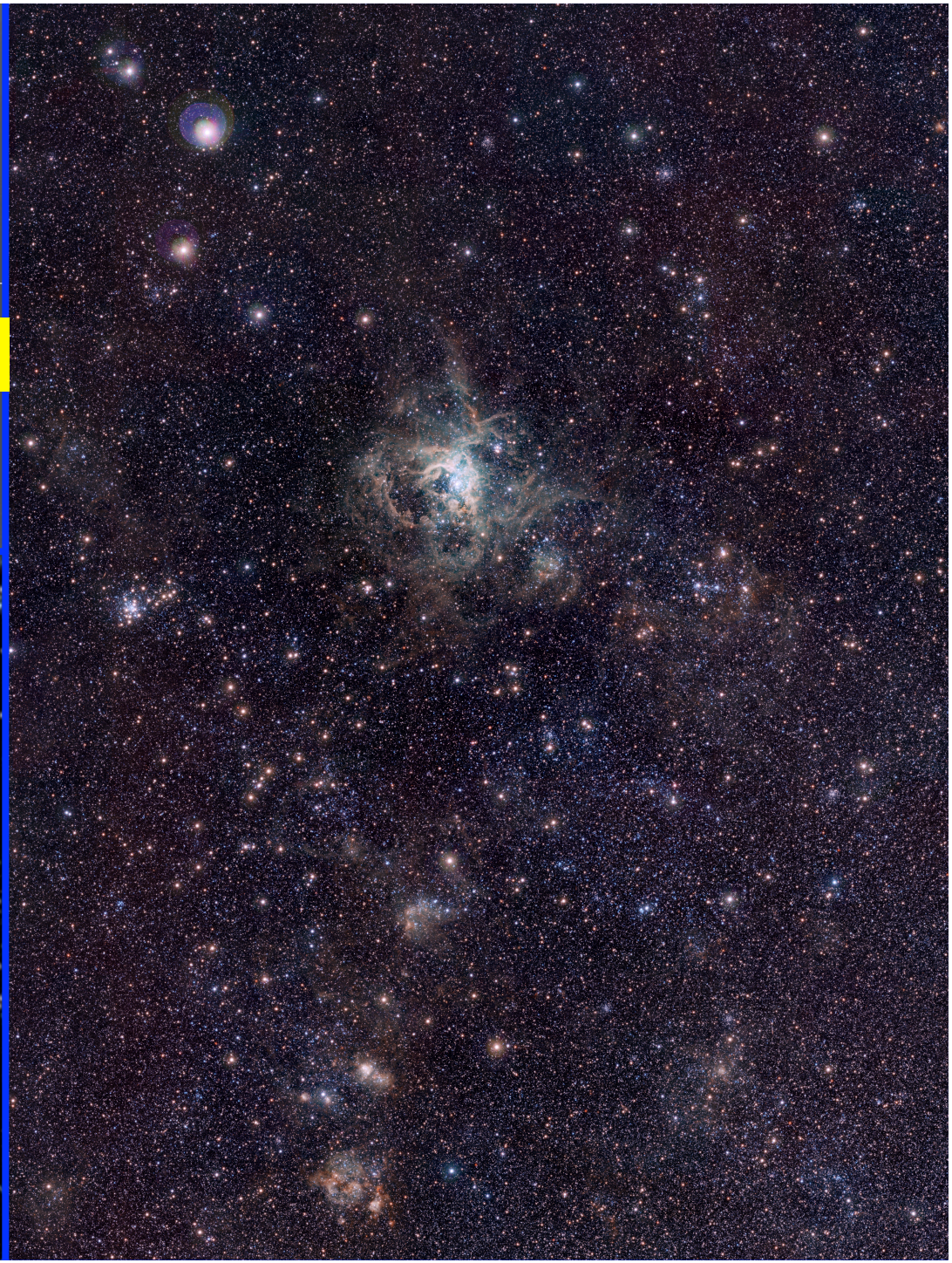


30 Doradus

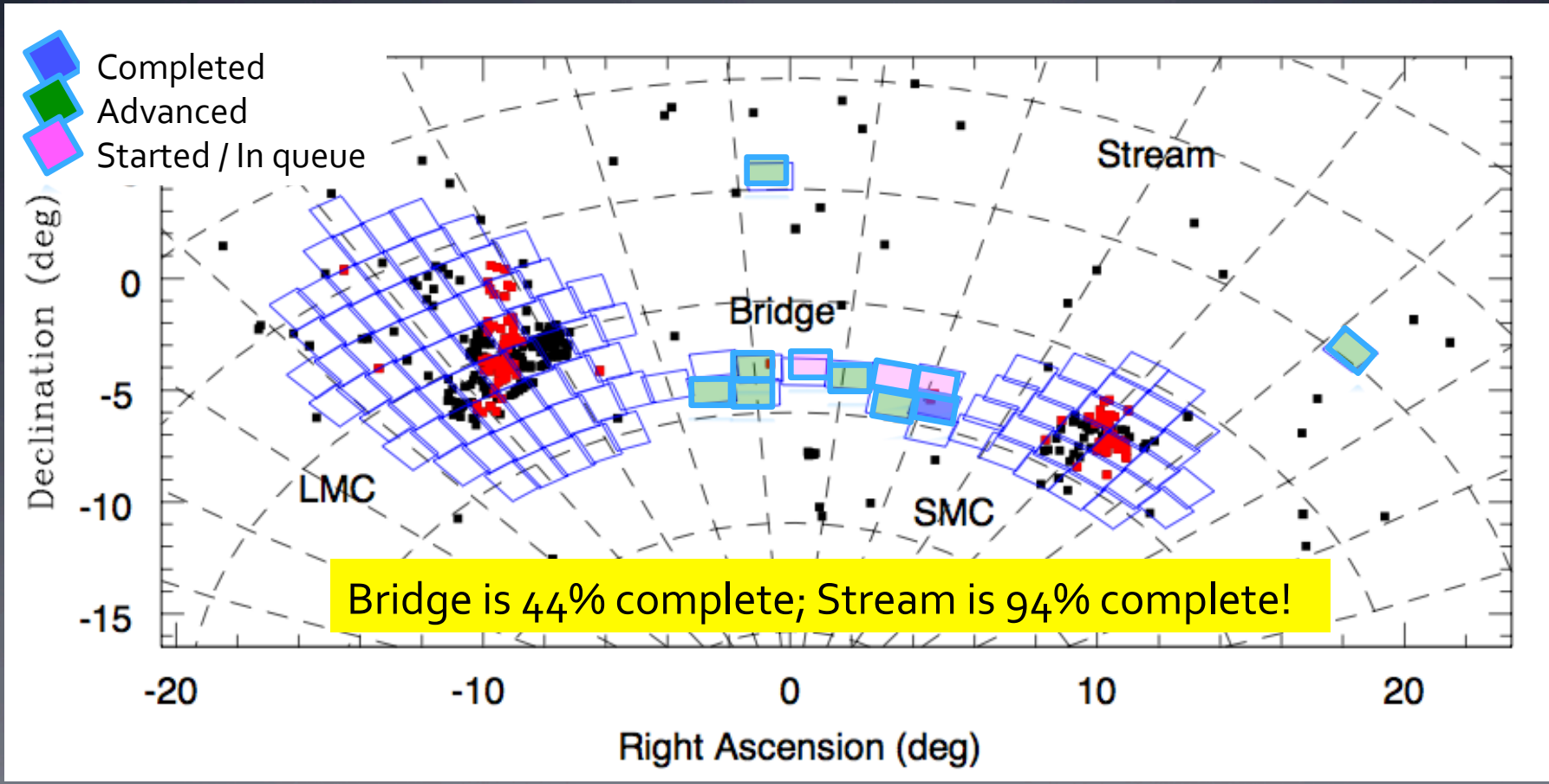
VMC images

http://star.herts.ac.uk/~mcioni/vmc/

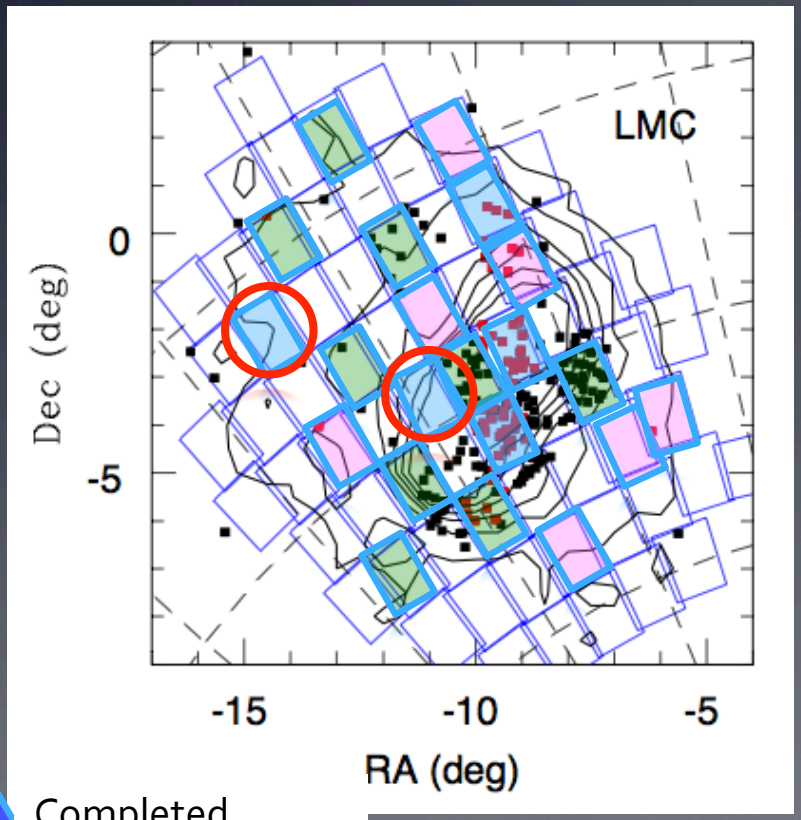
SMC clusters



VMC survey progress



VMC survey progress



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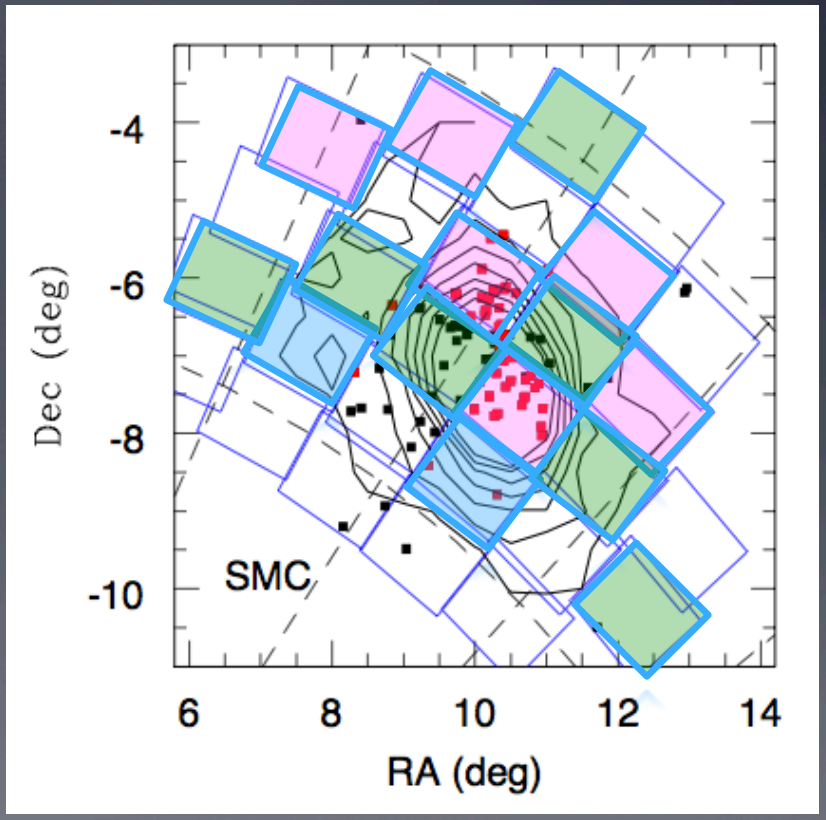


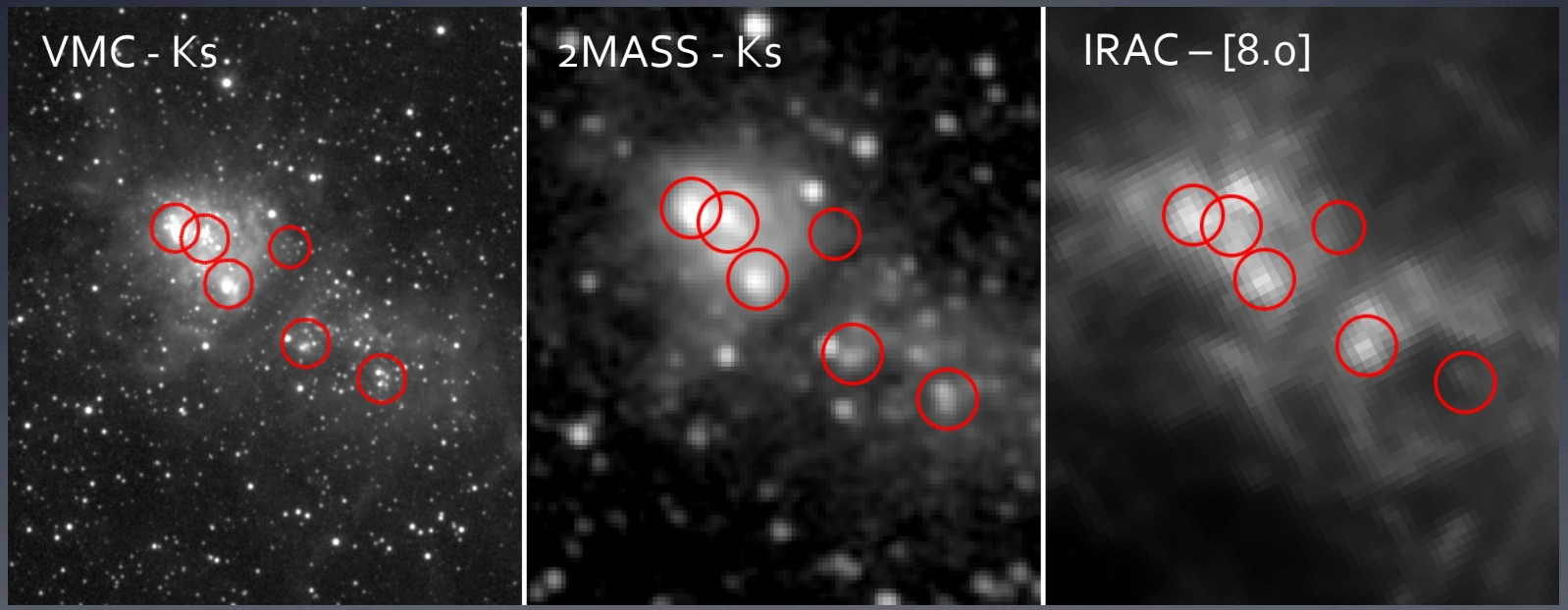
Completed
Advanced
Started / In queue

Public

LMC is 18% complete; SMC is 33% complete!

Science highlights

VMC: embedded clusters

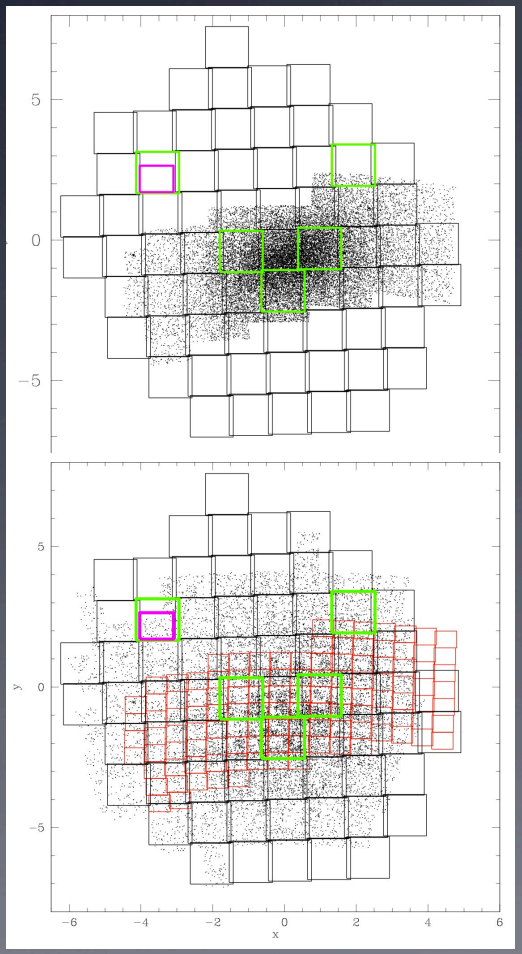


191 clusters identified by eye from VMC 30 Dor image
83 clusters with CO counterparts;
44.5% overlap with YSOs from Spitzer
69 newly discovered!

Cluster luminosity is related to cluster mass: LMC clusters are more luminous than MW ones.

Romita et al., in preparation

VMC: RR Lyrae stars & Cepheids

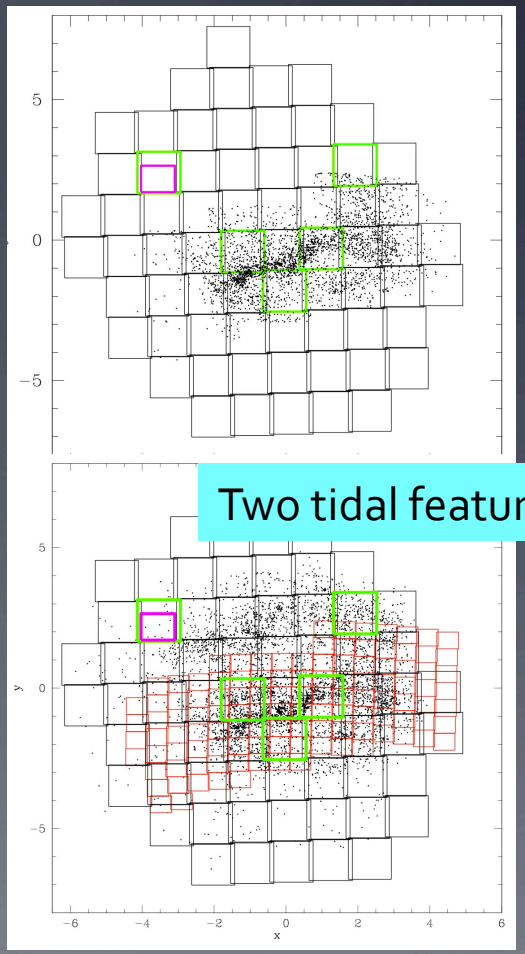


LMC RR Lyrae stars OGLE-III

LMC Cepheids OGLE-III

We use Known objects for 3D geometry.

OGLE-IV will cover LMC and SMC fully plus the Bridge.



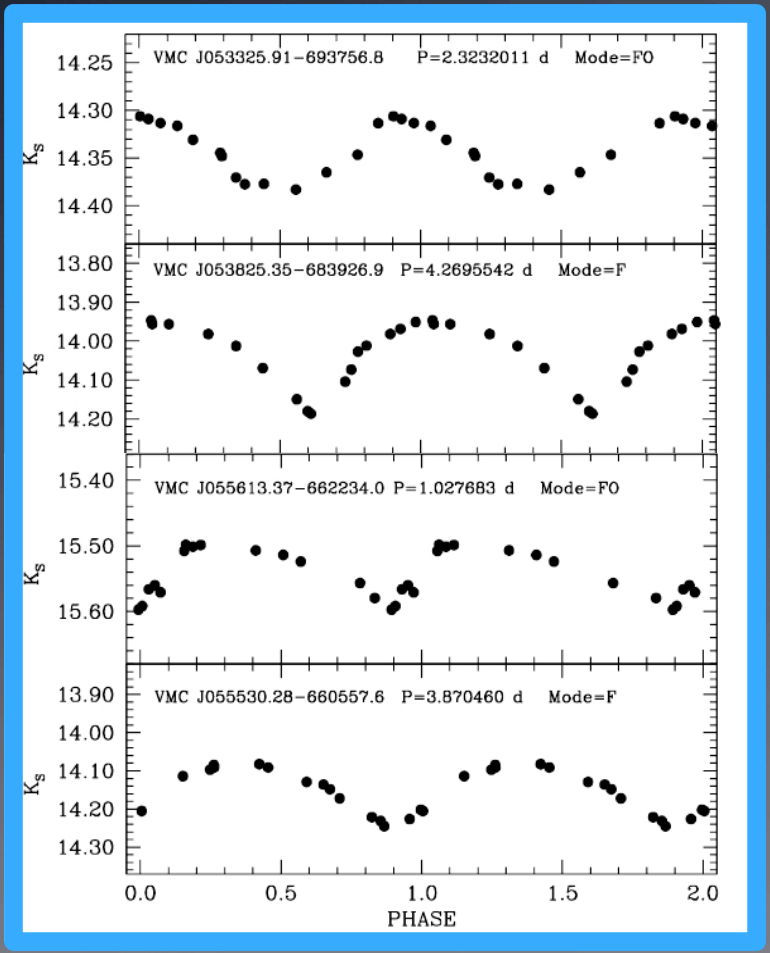
Two tidal features?

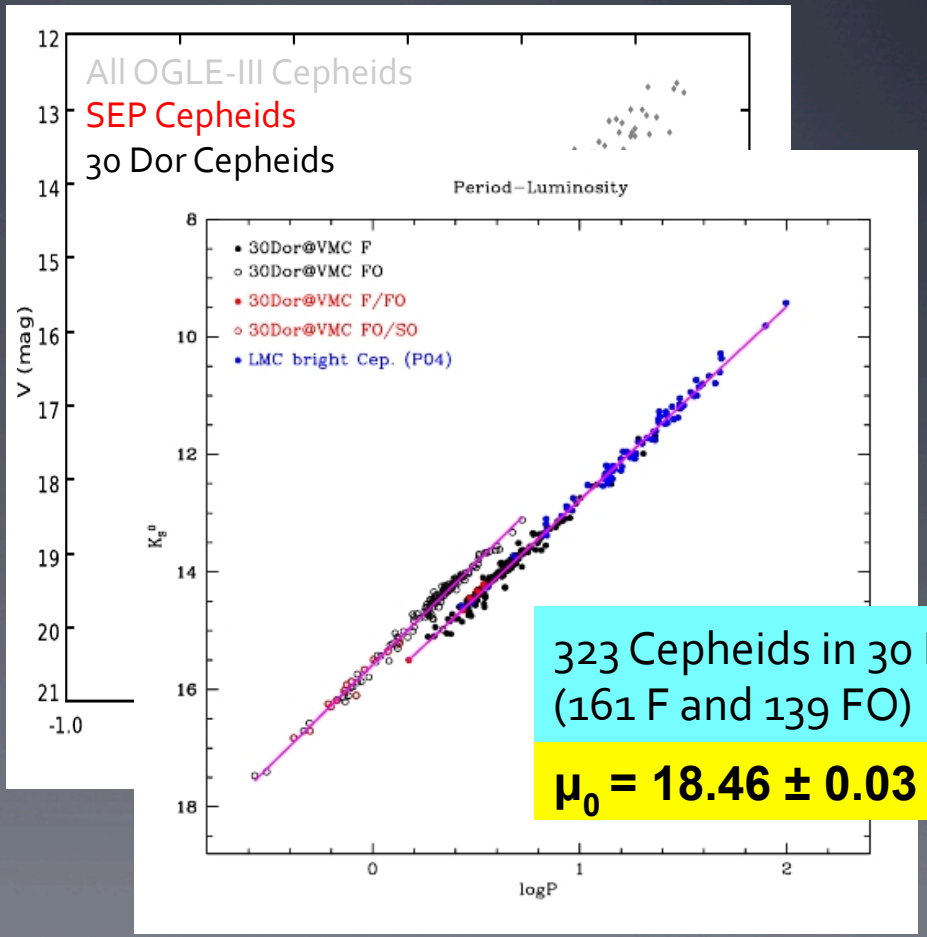
LMC RR Lyrae stars EROS-2

LMC Cepheids EROS-2

Moretti et al., to be submitted

VMC: Cepheids



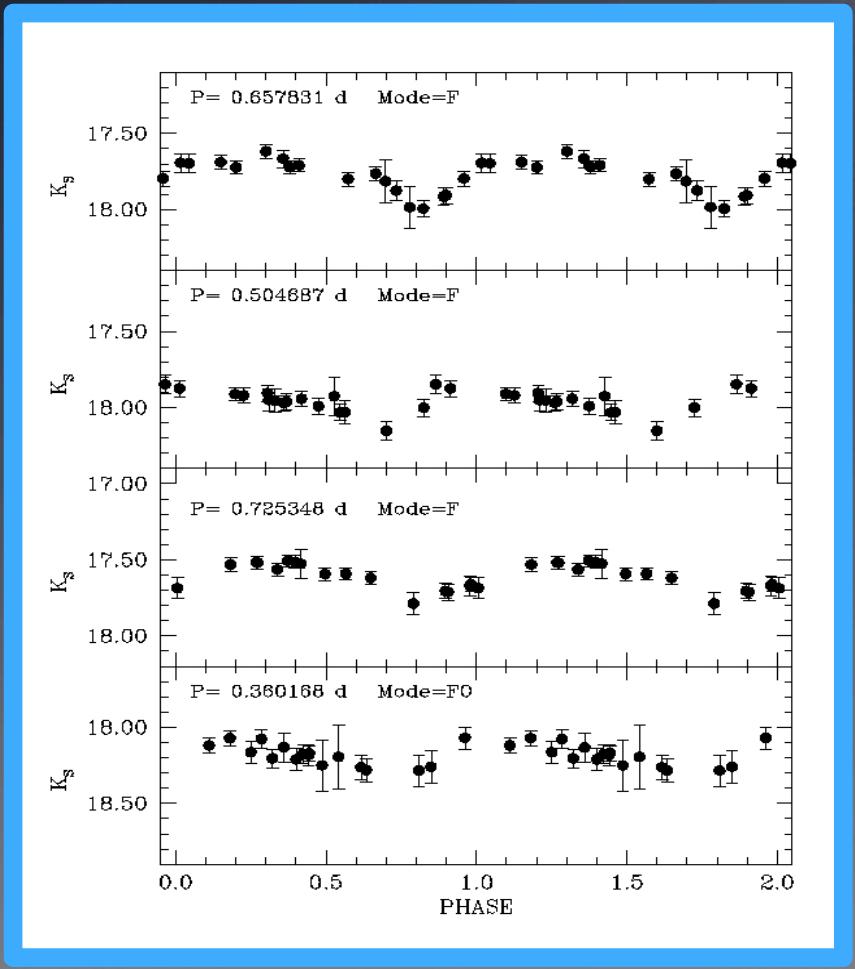


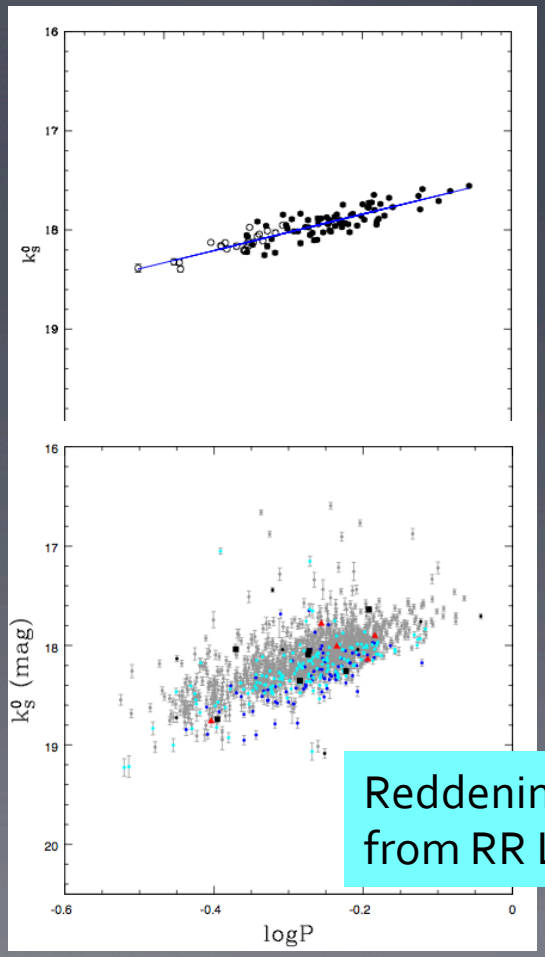
323 Cepheids in 30 Dor (161 F and 139 FO)

μ_0 = 18.46 ± 0.03 mag

Ripepi et al., MNRAS, 424, 1807, 2012

VMC: RR Lyrae stars





PL relation in SEP field.

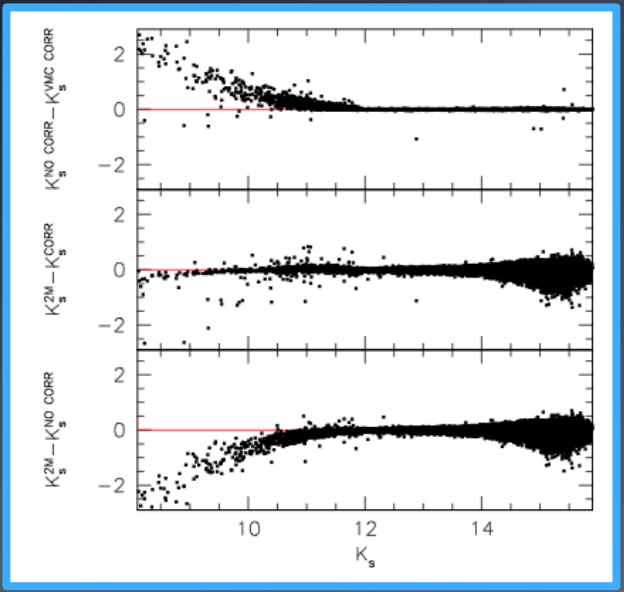
Being updated with recent OGLE-IV data!

PL relation in 30Dor field.

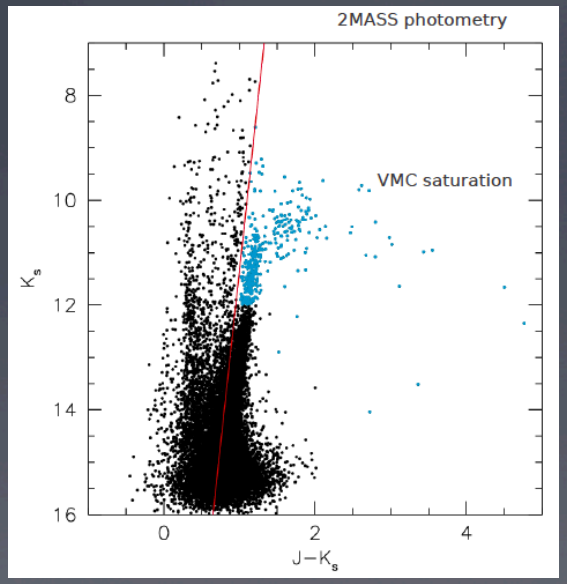
Reddening can be estimated from RR Lyrae stars.

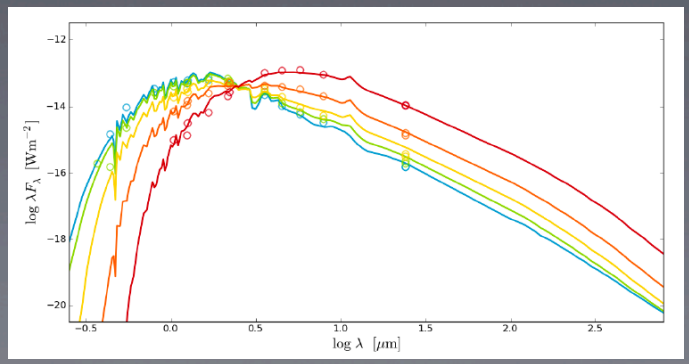
Moretti et al., in preparation

VMC: AGB stars



VMC bright limit is just above the bright AGB branch.





Optical, near- and mid-IR data have been used to:

-build SEDs of AGB stars,

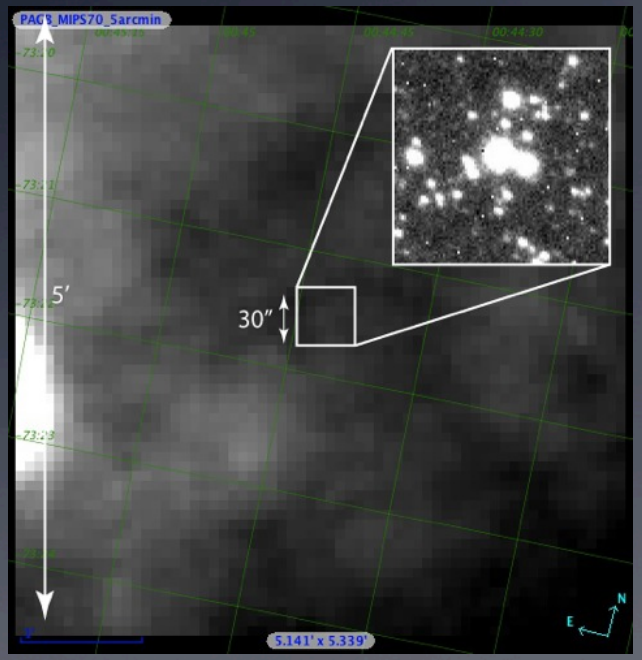
- derive mass-loss rates,

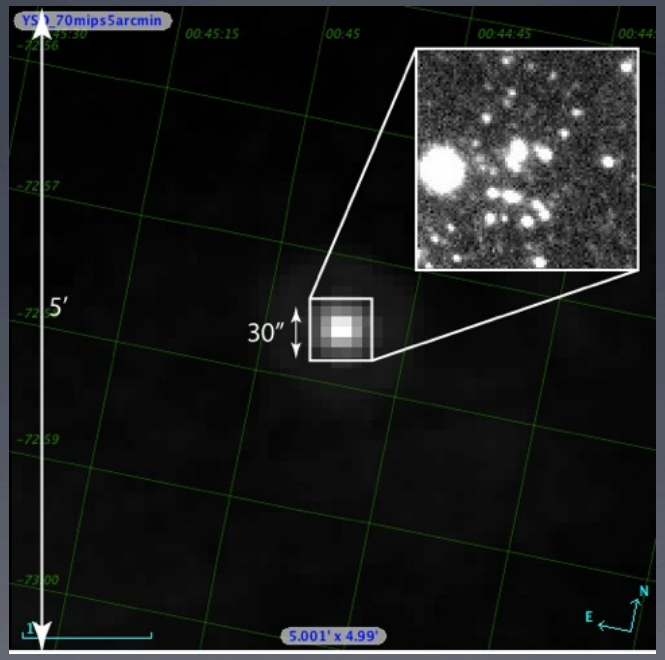
- classify C- and O-rich stars.

Homogeneous study to:
- calibrate stellar population models
- derive dust budget

Gullieuszik et al., A&A, 537, A105, 2012

VMC: post-AGB stars





70 μm image from Spitzer MIPS.

30″ zoomed-in VMC Y image

YSOs as luminous as post-AGB stars are surrounded by dust making them 70 μm bright.

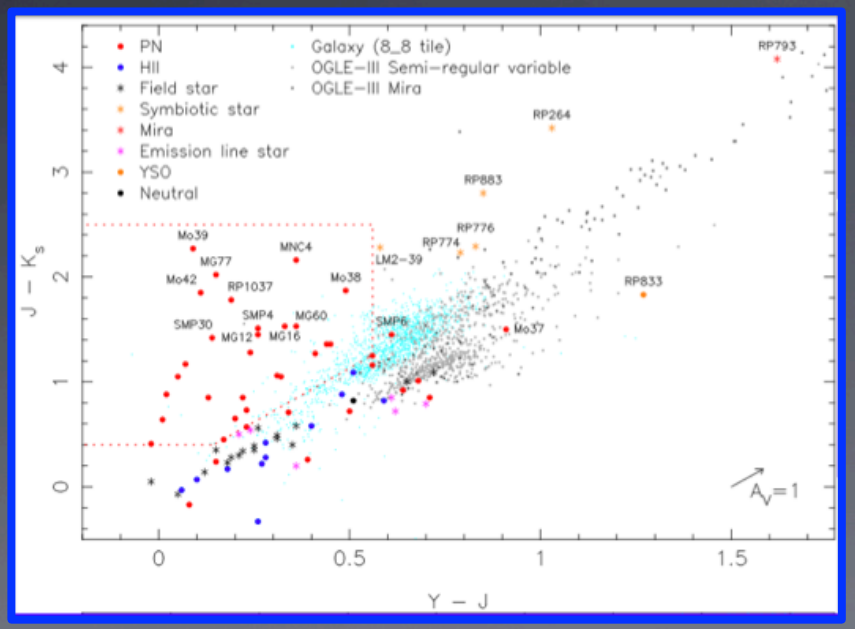
The spatial resolution of VMC data allows us to identify the post-AGB stars even in crowded regions of the Magellanic Clouds.

We can also test other methods of selecting post-AGB stars from YSOs.

Kasmath et al., in preparation

VMC: PNe

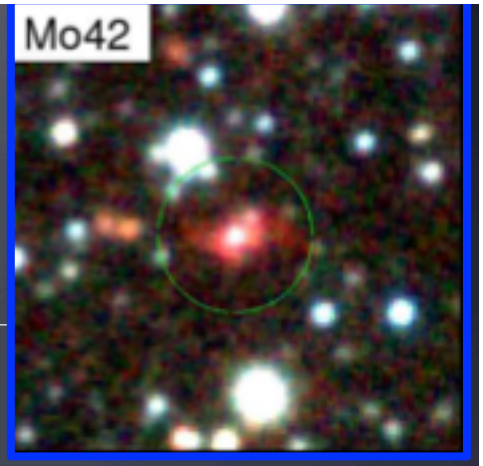
Identify non-PNe to characterize the luminosity function.
Multi-λ approach to identify PNe and symbiotic stars.

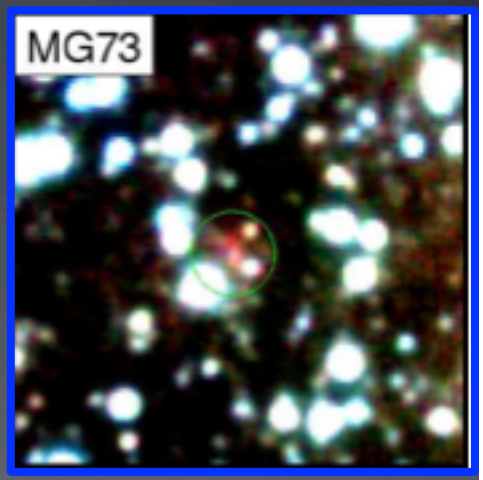


PNe occupy a specific VMC colour space.

VMC detects some PNe morphologies for the first time.

VMC finds new candidate PNe.

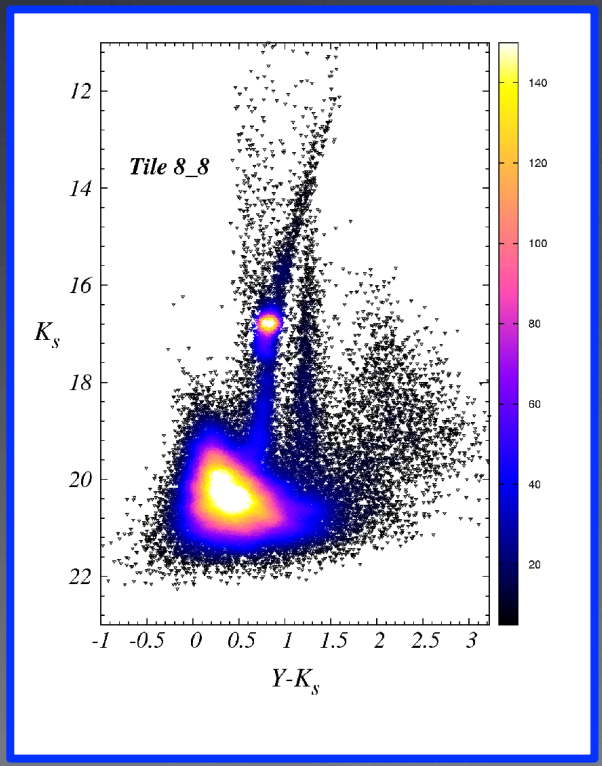




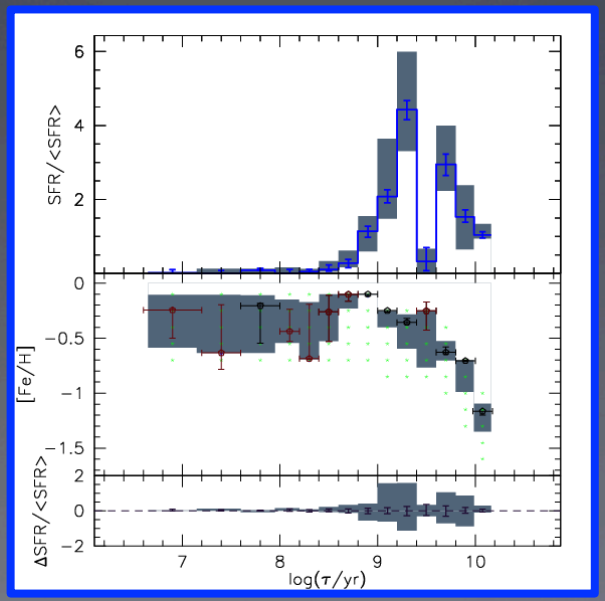
Miszalski et al., A&A, 531, A157, 2011; A&A, 529, A77, 2011

VMC: SFH

See Girardi's talk!



SFH from near-IR data works perfectly well!

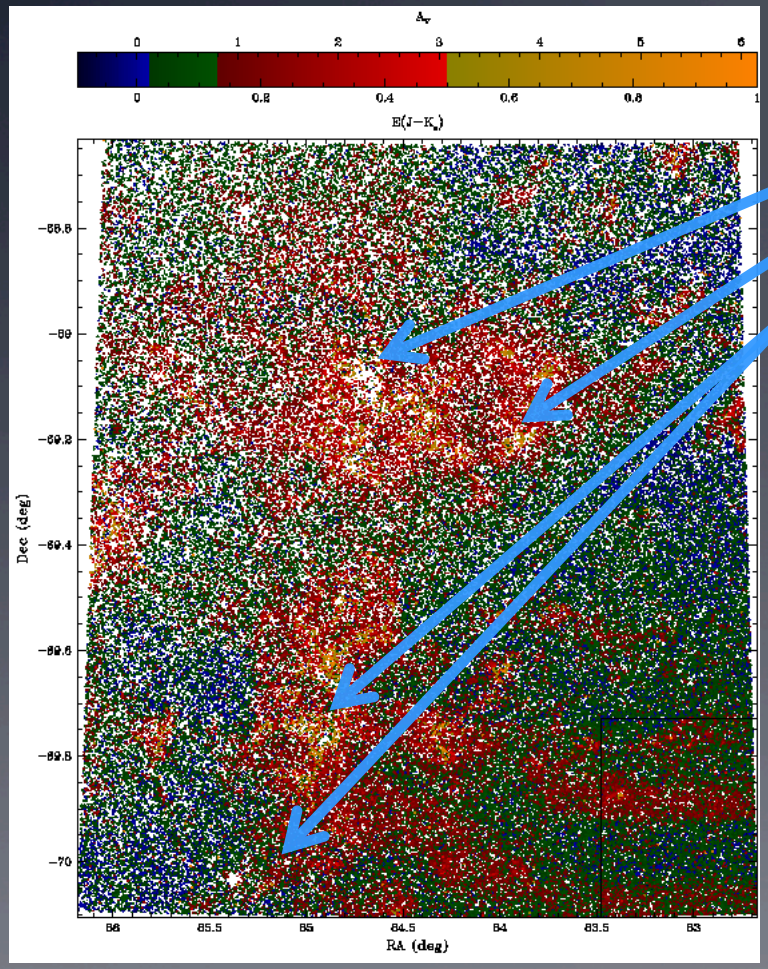


Reddening and distance modulus are also derived.

Systematic errors are reduced if geometry of LMC is taken into account.

Rubele et al., A&A, 537, A106, 2012

VMC: reddening map of 30 Dor



Extinction values for > 150,000 red clump stars. Key regions:

- R136 (Tarantula Nebula)
- SN 1987A
- HII regions (along a molecular ridge)

Highlights:

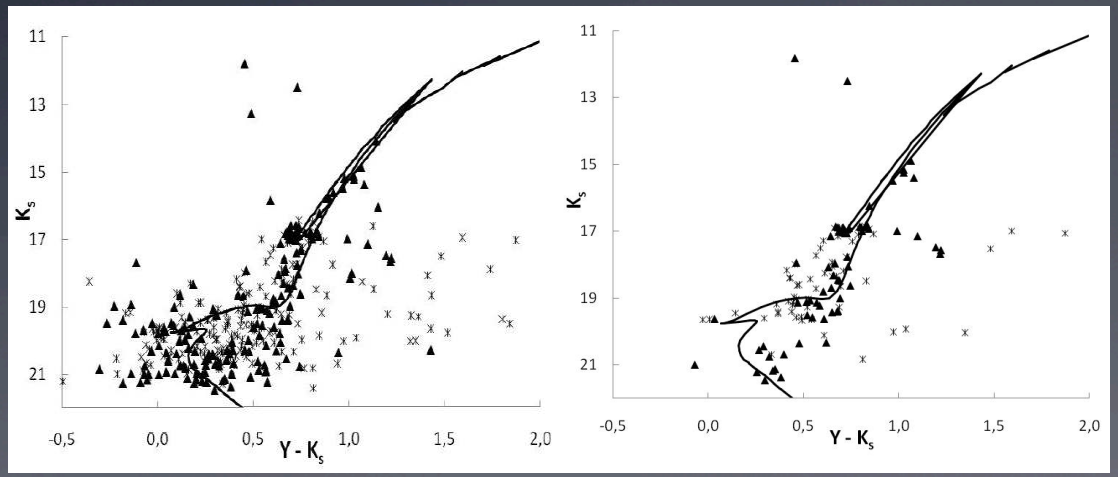
- Probes higher extinctions than optical can,
- A more detailed map than with OGLE-III,
- VMC is the only near-IR survey that resolves stars down to the red clump.

De-reddening RC stars is necessary before using them for tracing 3D geometry.

Tatton et al., to be submitted

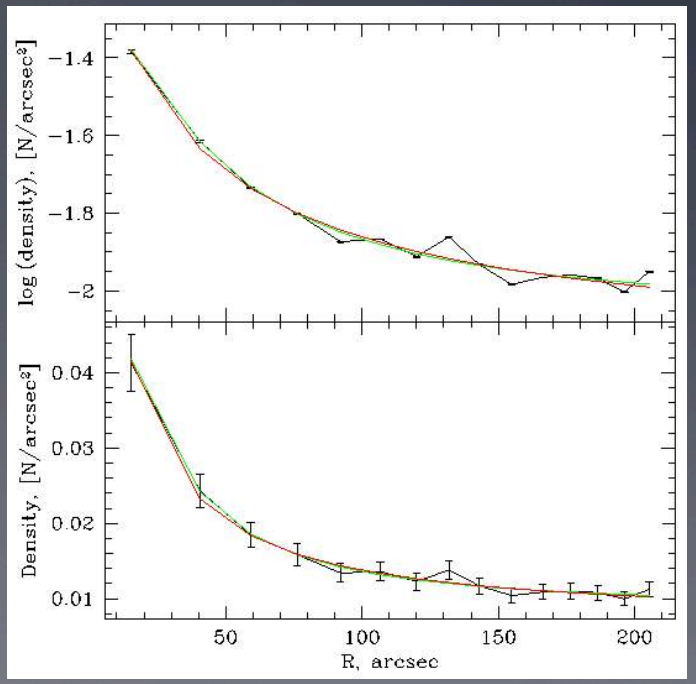
VMC: stellar clusters

I. Derive physical (age and metallicity) and structural (size) parameters homogeneously for all stellar clusters.



With background. Background removed.

Monte carlo simulations are used to quantify uncertainties.



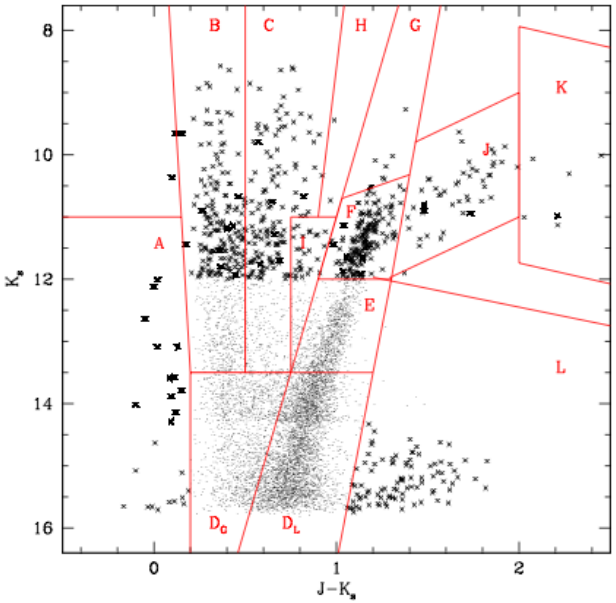
Profile fitting (King's & EEF).

II. Study SFH of clusters vs field.

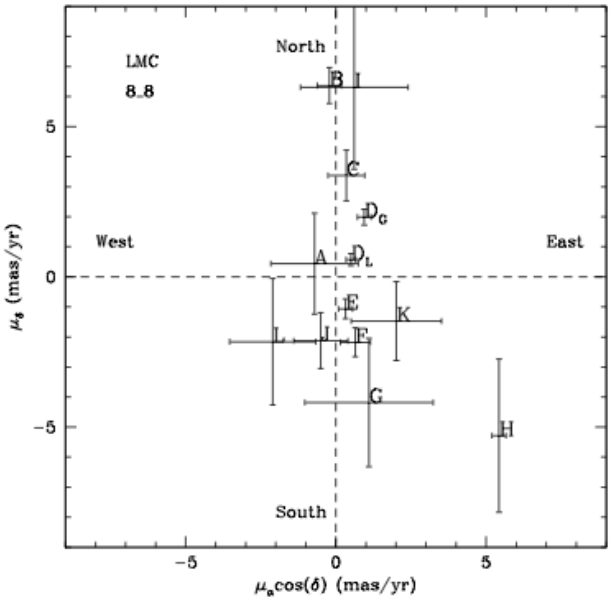
Guandalini et al., in preparation

VMC-2MASS: proper motion

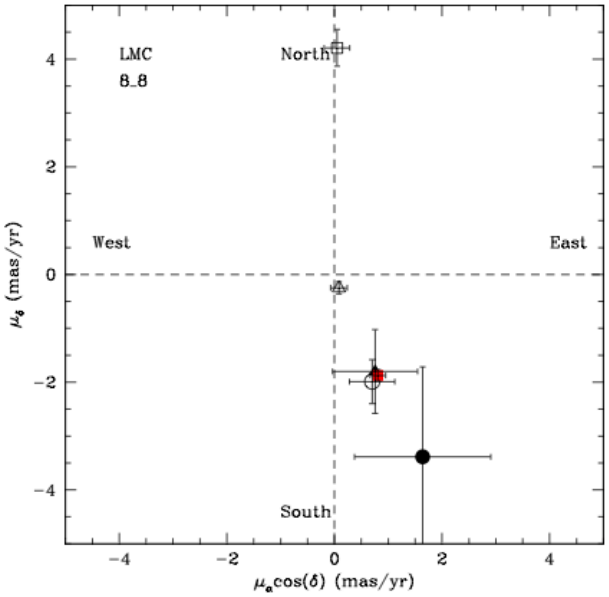
Stellar population boxes*



Proper motion per box



Proper motion per type



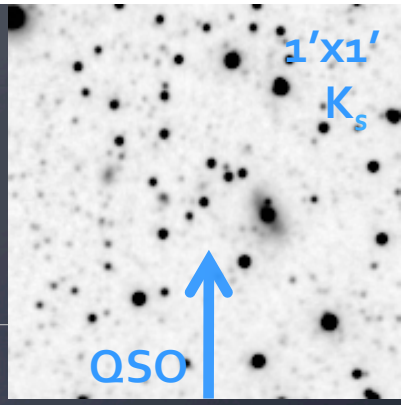
BCD_{MW}	2338	= MW foreground (empty square)
JK	59	= LMC carbon stars (filled triangle)
$D_{LMC}E$	5140	= LMC RGB stars (empty triangle)
AGH	32	= LMC young stars (filled circle)
FJK	228	= LMC AGB stars (empty circle)

Different stars show a different proper motion in tile LMC 8_8 (outer-disk SEP) over a time range of 10 years.

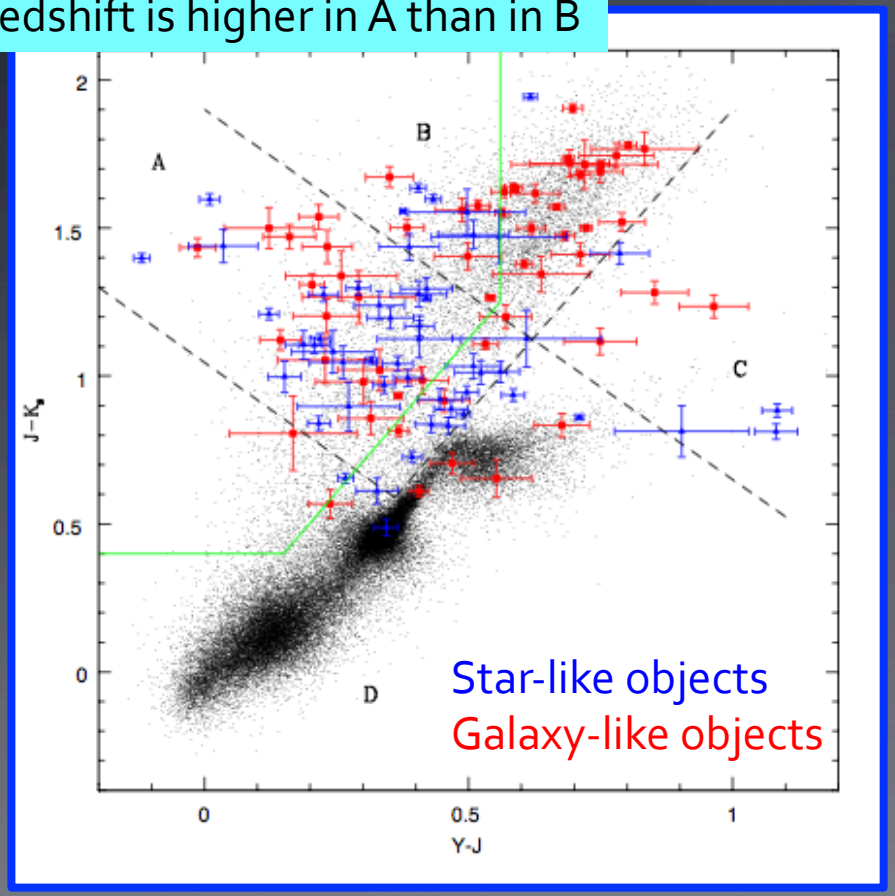
Cioni et al. in prep.

* adapted from Nikolay & Weinberg (2000)

VMC: quasars

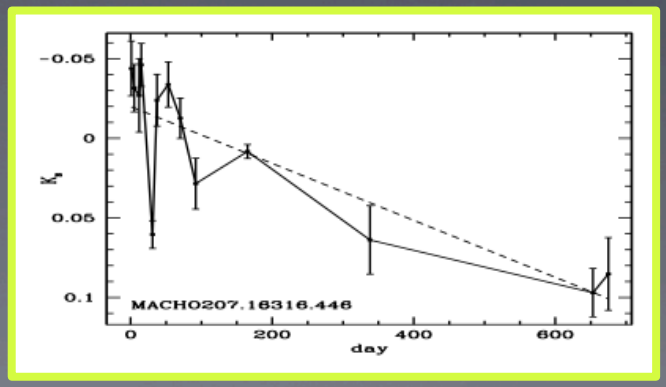


Redshift is higher in A than in B



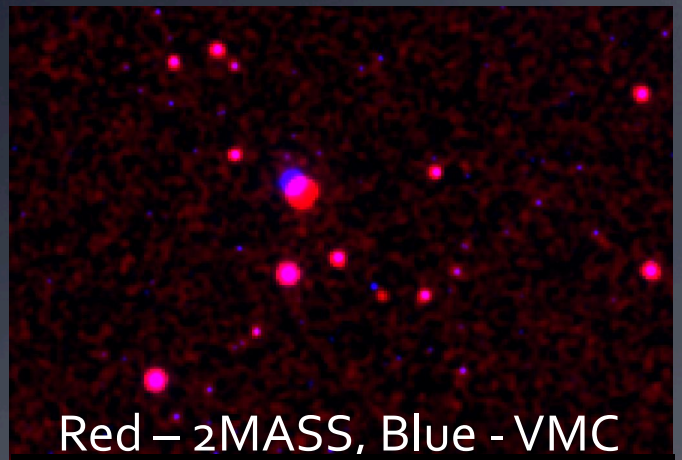
Quasars are mostly confided in region A and B of the VMC colour space.

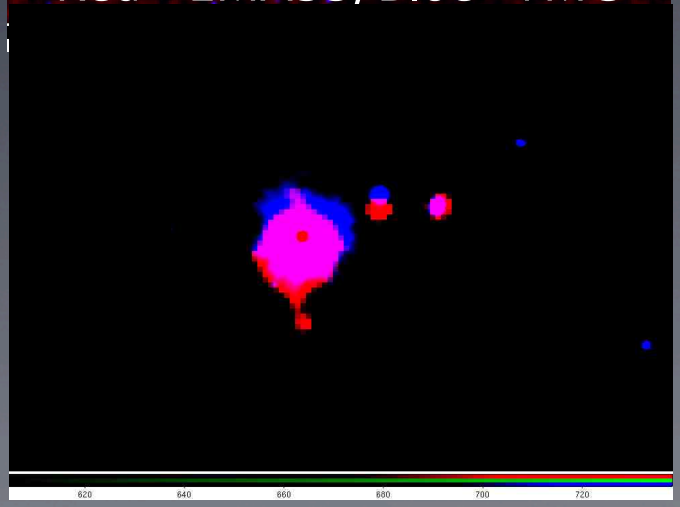
Quasars have a K_s light-curve with a slope > 10^{-4} mag/day.



Cioni et al., A&A, in press, 2012

VMC: high PM MW objects





Search for stars with a positional offset > 1" between 2MASS and VMC (>0.1"/year):

119 objects found of which 73 new!

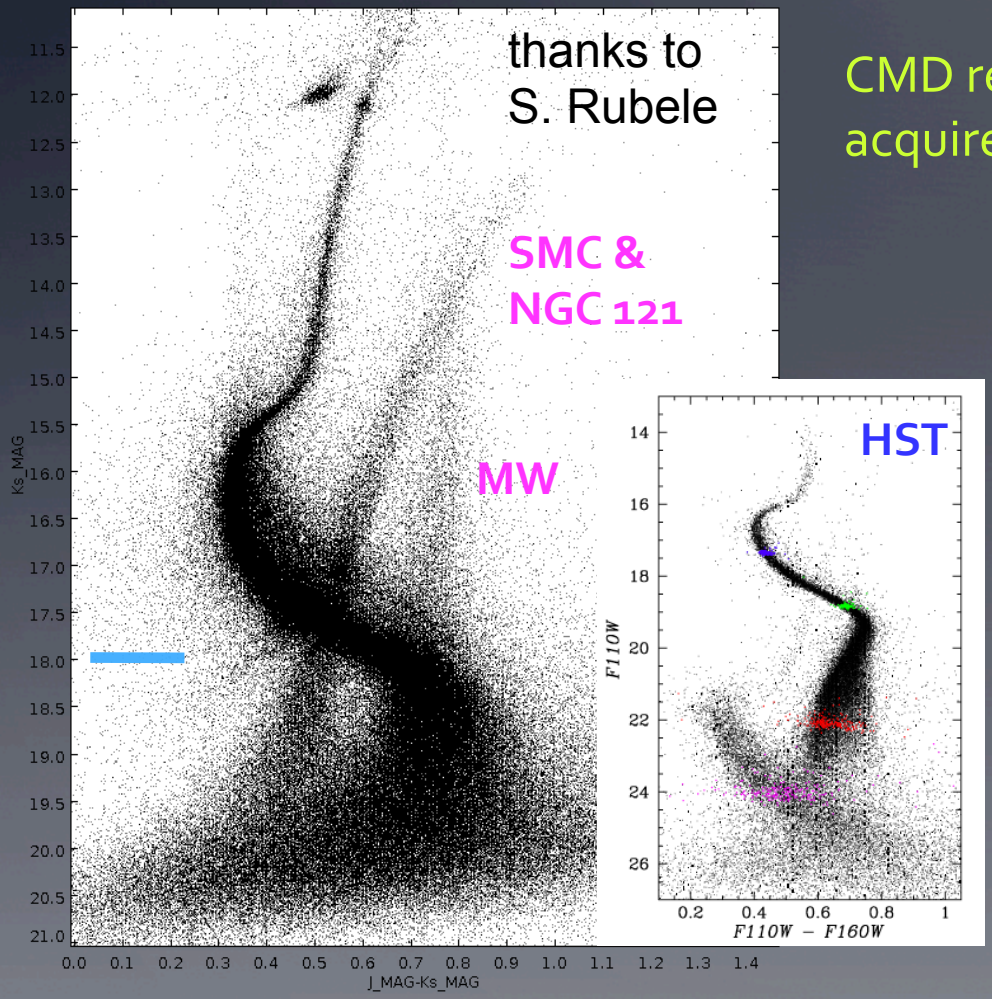
Search for faint co-moving objects:

11 were found of which 1 brown dwarf; follow-up spectroscopy on-going.

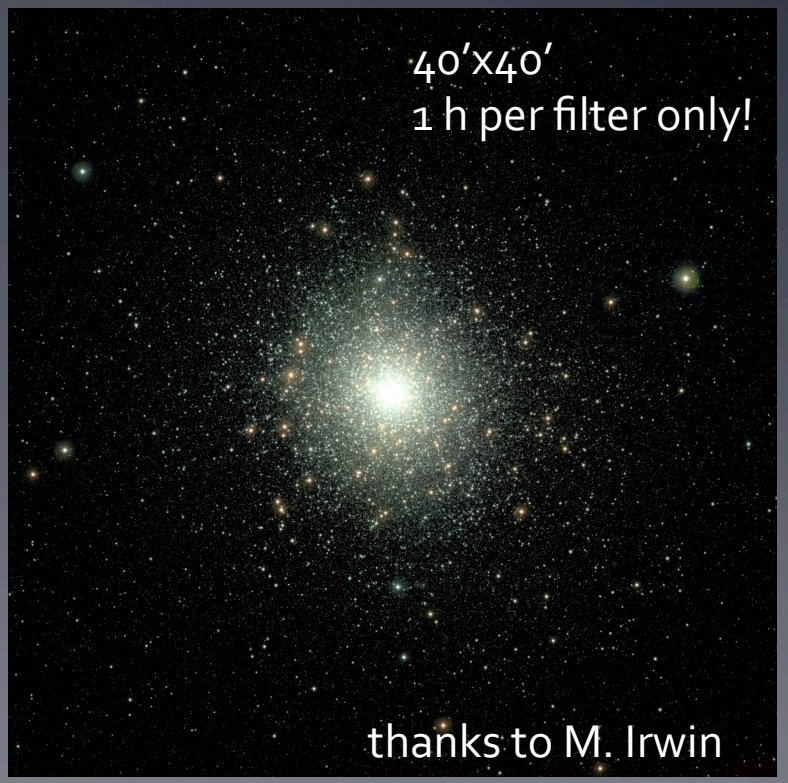
Ivanov et al., in preparation [see Posters at this meeting]

VMC: 47 Tuc

Measure tidal radius.
Investigate outer structure.
Trace tidal streams.
Study multi-pops.



CMD refers to 5h in Ks, but 11 have been acquired at present!



VMC: conclusions & future work

Compared to expectations, 60% of the data have been obtained to date. The VMC survey will therefore last ~7 instead of 5 years.

Based on the first data, several results that span a range of objects and environments have been obtained.

VMC Ks band data is going to remain unique also in the E-ELT era.

Planned facilities, GAIA, Euclid and LSST will provide data for studies of the proper motion and source variability across the Magellanic system.

Follow-up observations with instruments under study, 4MOST and MOONs, will provide the radial velocity and chemical information for many Magellanic objects.