# The faint end of the stellar luminosity function

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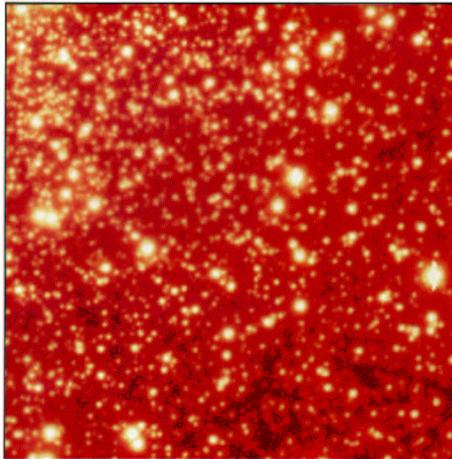
Understanding the MF of globular clusters and its evolution
in collaboration with:
Francesco Paresce (ESO)
Gilles Chabrier & Isabelle Baraffe (ENS - Lyon)
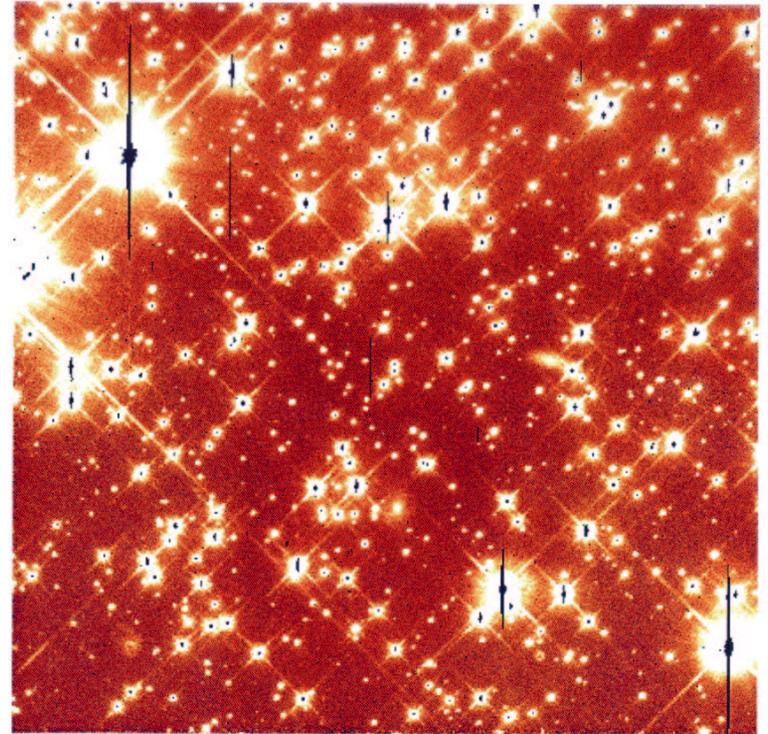
The HST halo globular cluster sample

NGC	[Fe/H]	r/r_h	INSTRUMENT	REFERENCE
104	-0.71	1.6	WFPC2	De Marchi & Paresce 95 Santiago et al. 96
5139	-1.59	0.9	WFPC2 & NIC3	Elson et al. 95, De Marchi 99, Pulone et al. 98
5272	-1.66	3.6	WFPC2	Marconi et al. 97
6121	-1.33	1.3	WFPC2 & NIC3	Pulone et al. 99, Bedin et al. 01 Richer et al. 02, De Marchi et al. 03
6254	-1.60	1.3	WFPC2	De Marchi & Paresce 96 Piotto & Zoccali 99
6341	-2.24	4.5	WFPC2	Piotto, Cool & King 97
6397	-1.91	1.8	WFPC2 & NIC3	Paresce et al. 95, Cool et al. 96, King et al. 98, De Marchi et al 99
6656	-1.75	0.8	WFPC2	De Marchi & Paresce 97
6752	-1.54	1.5	WFPC2	Ferraro et al. 97
6809	-1.82	0.9	WFPC2	De Marchi & Paresce 96 Piotto & Zoccali 99
7078	-2.17	4.6	WFPC2	De Marchi & Paresce 95 Piotto, Cool & King 97
7099	-2.13	4.6	WFPC2	Piotto, Cool & King 97

✔ HST sample is very homogeneous, as most GC in it share a similar, low metallicity, they have been observed near the half-light radius, and the data taken with WFPC and NICMOS were reduced in a uniform, reproducible way, using both magnitude and colour information.

NGC 6397
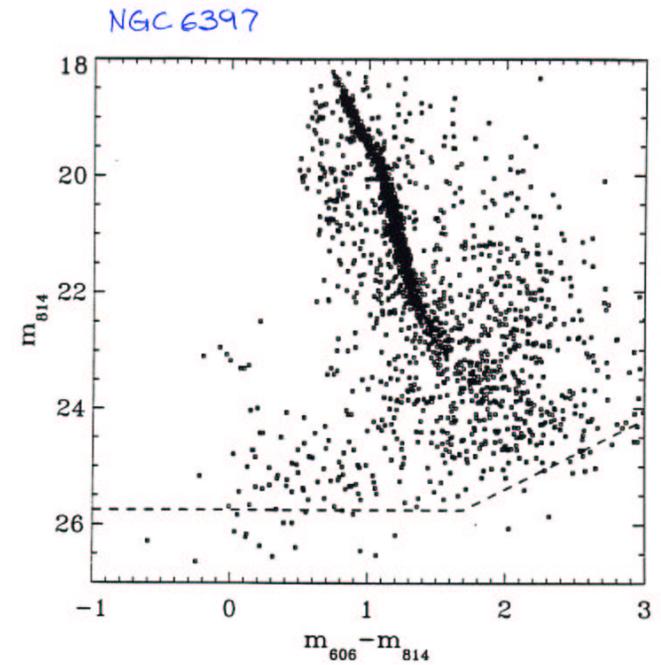
Paresce, De Marchi & Romaniello, 1995, ApJ, 440, 216

Figure 3.— Cumulative CMD obtained by plotting colors and magnitudes of all ~ 2120 detected stars. The tilted dashed line shows our 5σ detection limit.
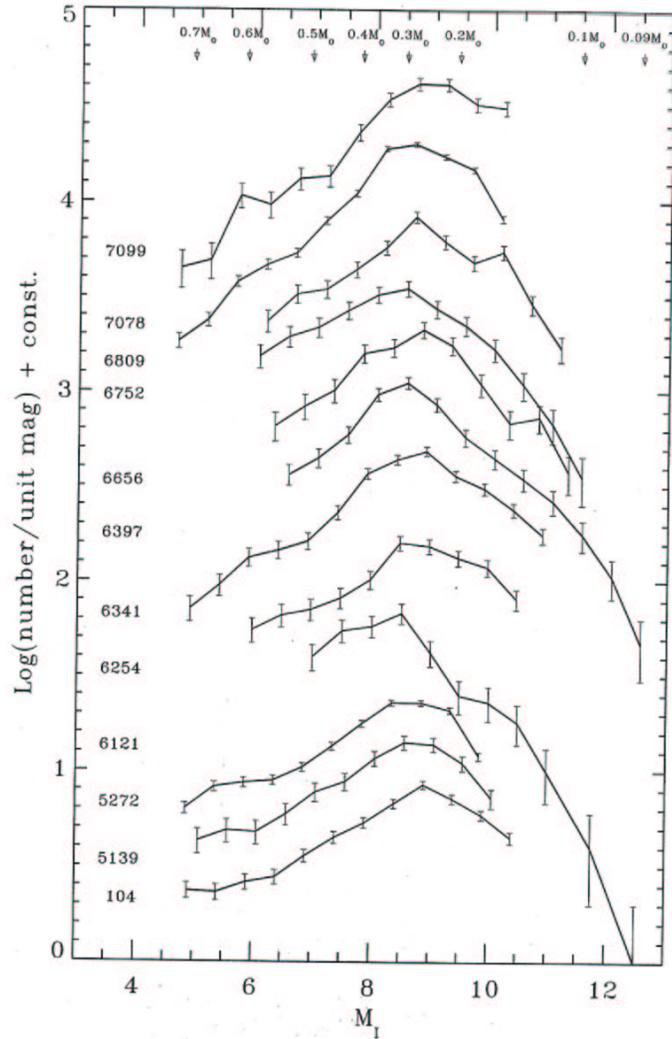
Need Reliable Mass-Luminosity Relation

Pulone et al. '03, A&A, in press

NGC 6496

NGC 6352

Disk objects (Monet et al. – Dahn et al.)

0.7 (T_{eff}=4200K)

0.5 (T_{eff}=3650K)

0.2 (T_{eff}=3300K)

0.1 (T_{eff}=2800K)

BCAH98

new TiO (AMES)

0.08 (T_{eff}=2400K)

M_V

$V-I$

Pleiades (age 120 Myr) – Martin et al. 1999

VLTI Observations of the Radii of four Small Stars

ESO PR Photo 27c/02 (29 November 2002)   © European Southern Observatory

model MF

$dN/dLogm$

$m=m(M_I)$

$dLogm/dM_I$

model LF

$dN/dM_I \propto dN/dLogm \cdot dLogm/dM_I$
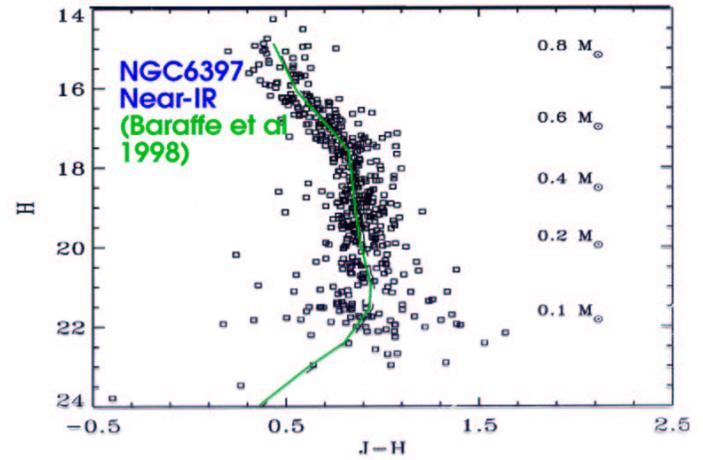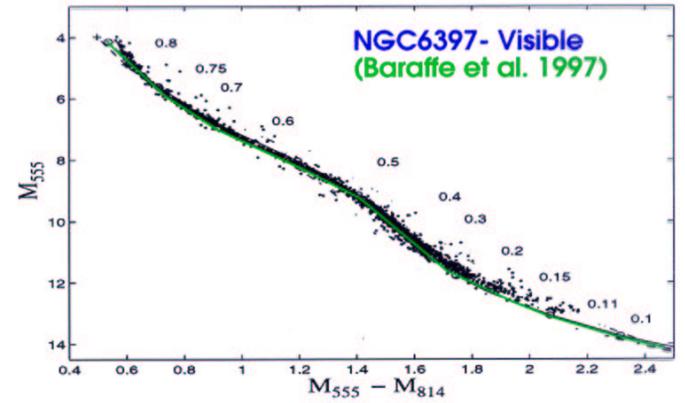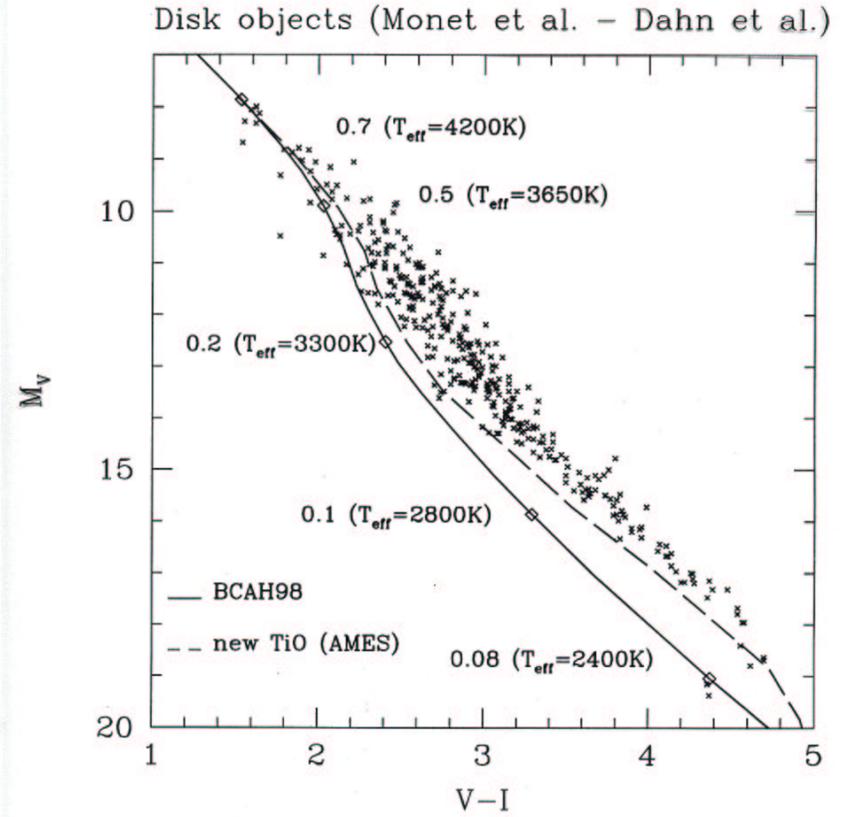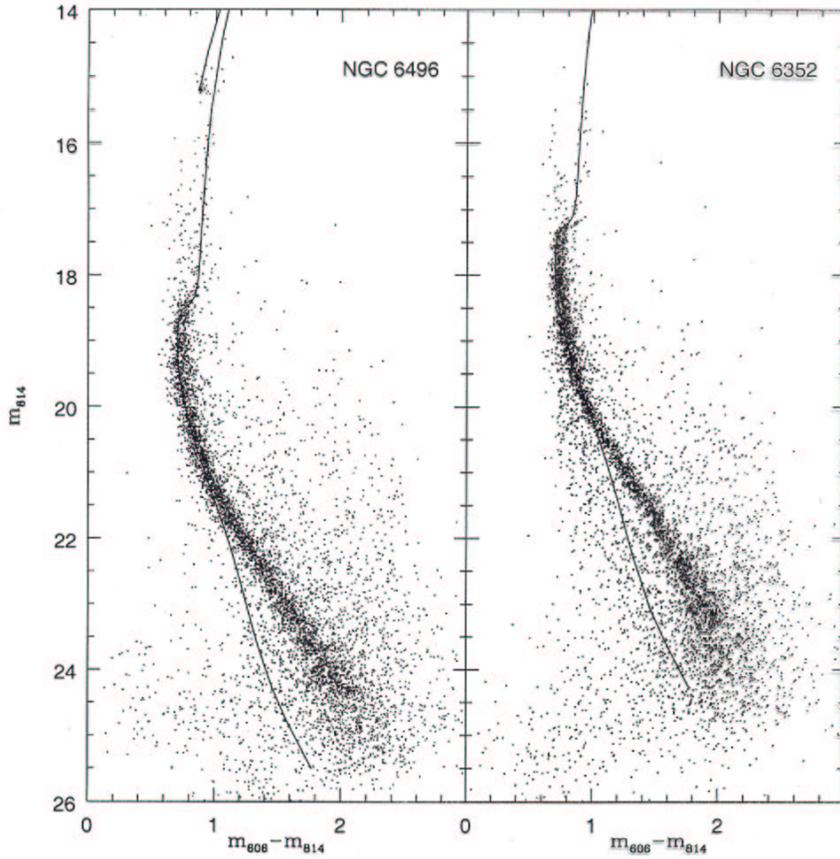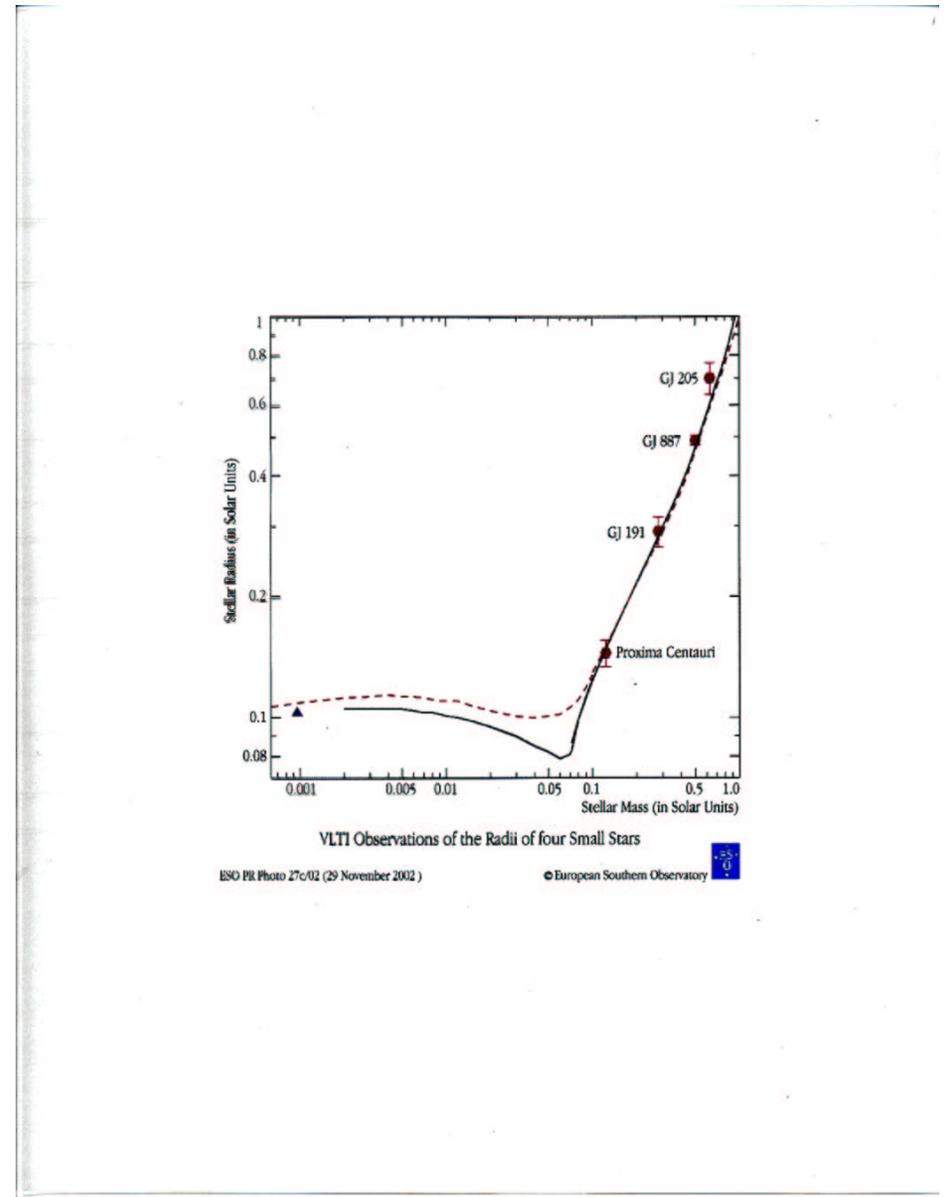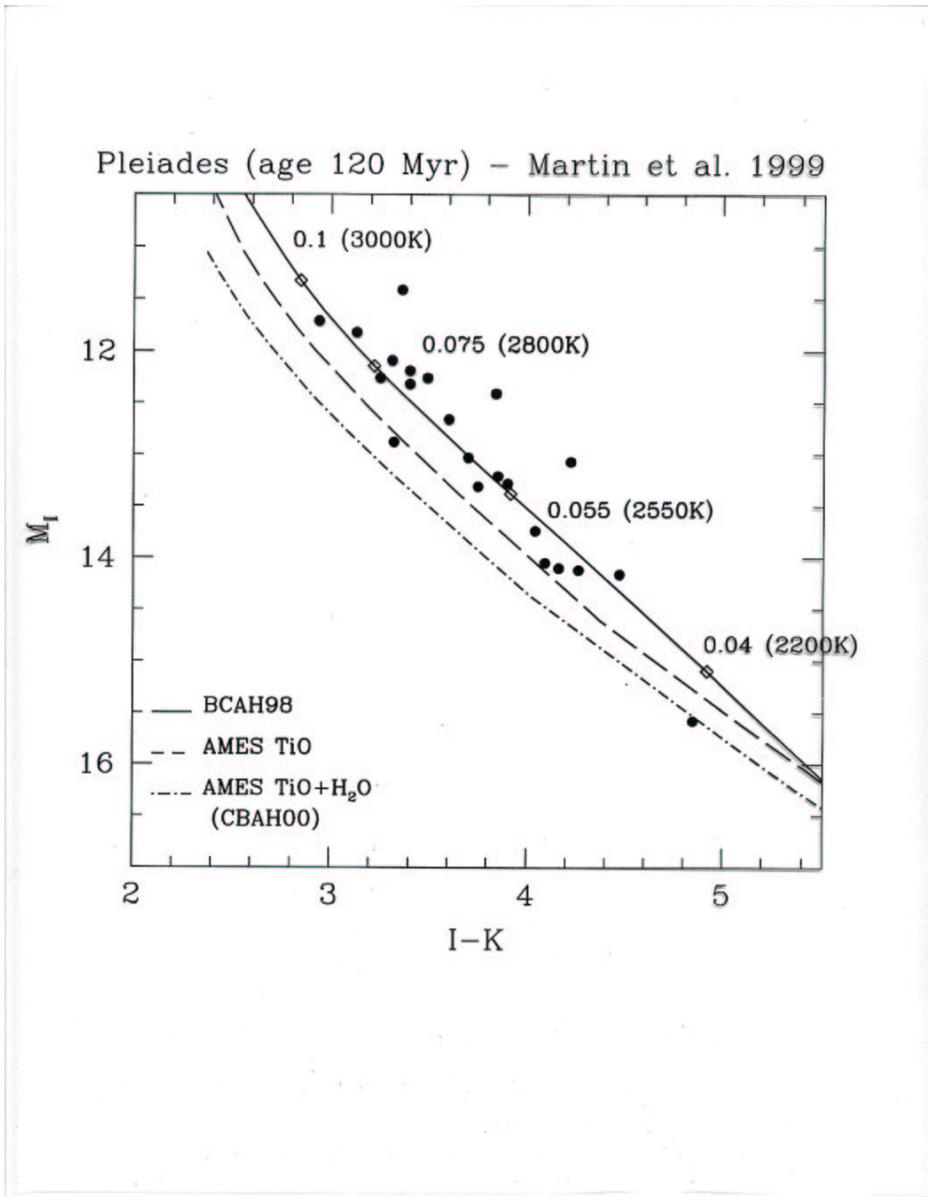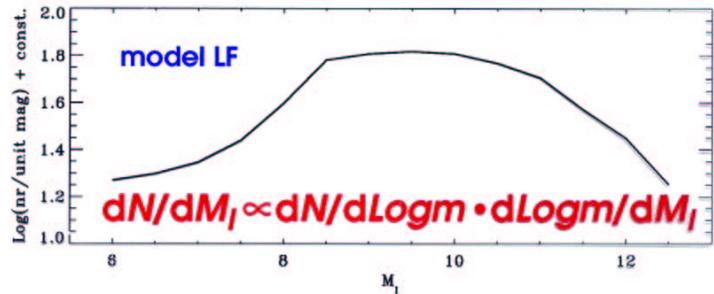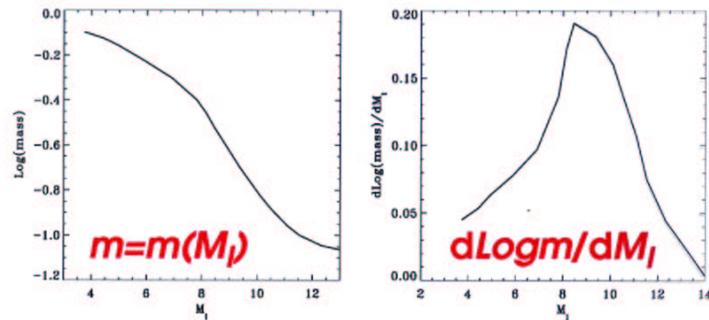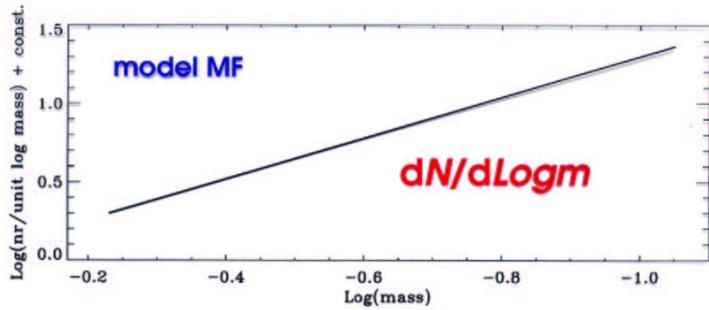
Simple power-law does not work

$dN/dLogm \propto m^{-0.6}$

$dN/dLogm \propto m^{+1.4}$
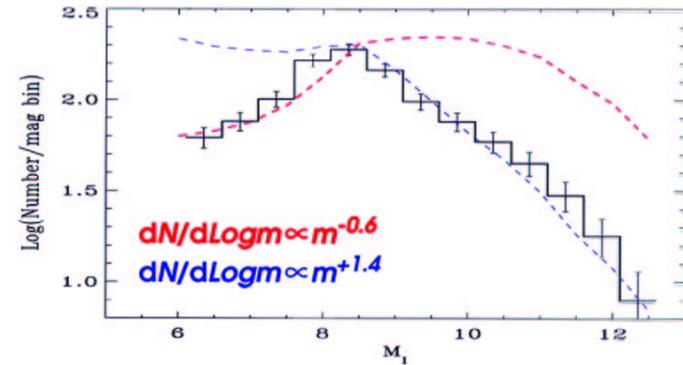
Log-normal or tapered power-law OK

Also well supported on theoretical grounds

(e.g. Zinnecker 83; Adams 97; Elmegreen 97, 99)

$$dN/dLogm \propto e^{-\frac{(log(m/m_c))^2}{2\sigma^2}}$$

$m_c \sim m_p \sim 0.33$ $\sigma = 0.33$ $\beta = 2.7$

$$dN/dLogm \propto m^{-1.35}(1 - e^{-(m/m_0)^\beta})$$
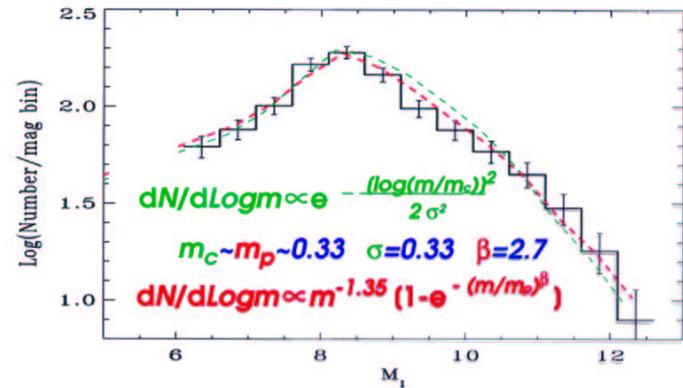
LN: $\ln f(\log m) = A - \left(\dfrac{\log m/m_c}{\sqrt{2}\,\sigma}\right)^2$

TPL: $f(m) = m^{-\alpha}\left[1 - e^{(m/m_P)^\beta}\right]$

$\alpha = 2.35$
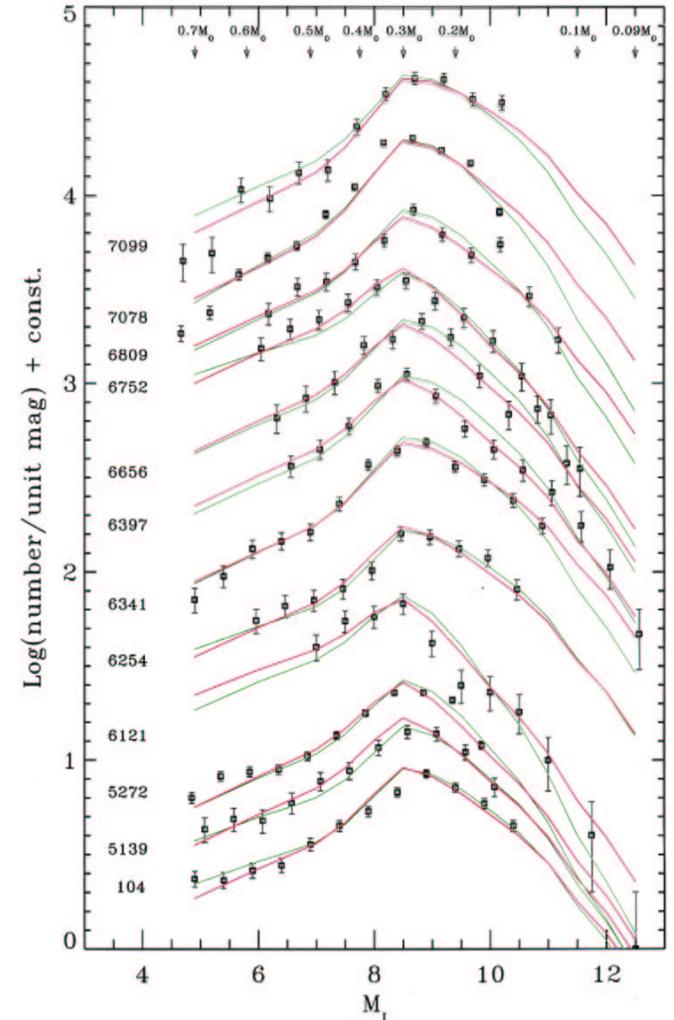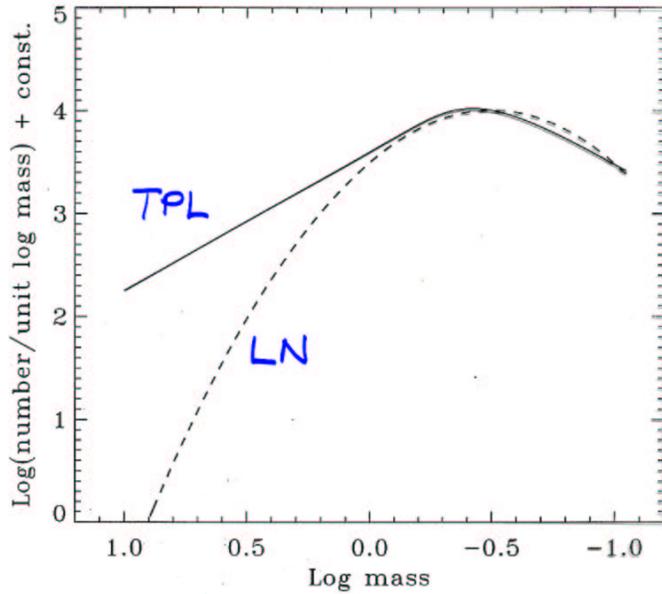
$m_c = 0.32 \pm 0.03,\ \sigma = 0.34 \pm 0.04 \quad m_P = 0.34 \pm 0.03,\ \beta = 2.6 \pm 0.2$
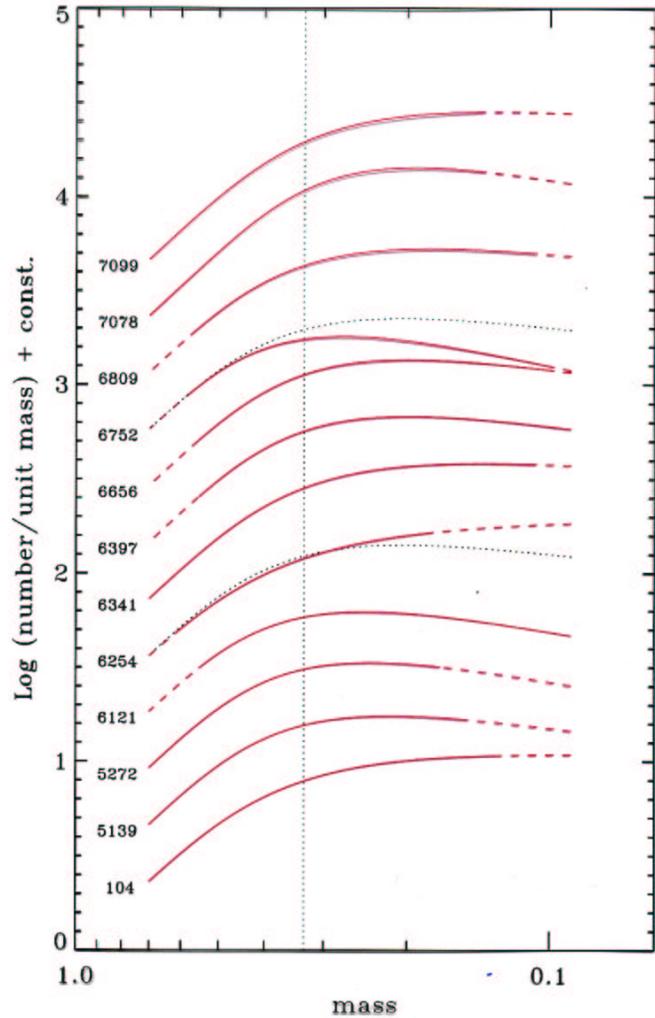
## Dynamical history of clusters in HST sample

NGC	c	R_G	Z_G	P	T_d	ΔN
104	2.48	7.4	3.2	5.3	88	0.13
5139	1.15	6.3	1.3	1.2	40	0.12
5272	1.89	12.0	10.0	5.5	213	0.25
6121	1.53	6.2	0.5	0.7	13	0.21
6254	1.66	4.7	1.7	3.4	22	0.14
6341	1.65	9.1	4.3	1.4	30	0.10
6397	1.69	6.0	0.5	3.1	4	0.24
6656	1.70	5.1	0.4	2.9	31	0.22
6752	2.15	5.1	1.8	4.8	35	0.09
6809	1.27	4.2	1.9	1.8	14	0.25
7078	1.77	10.5	4.8	5.5	48	0.14
7099	2.40	6.8	5.4	3.2	23	0.16

☞ **If tidal interaction were important at r_h, steepness ΔN of MF should correlate with T_d (e.g.)**
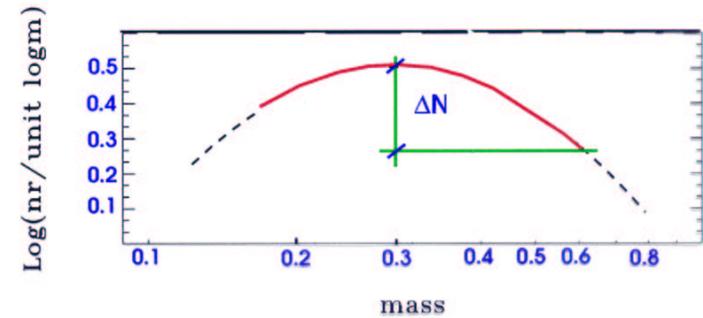
No evident correlation or trend
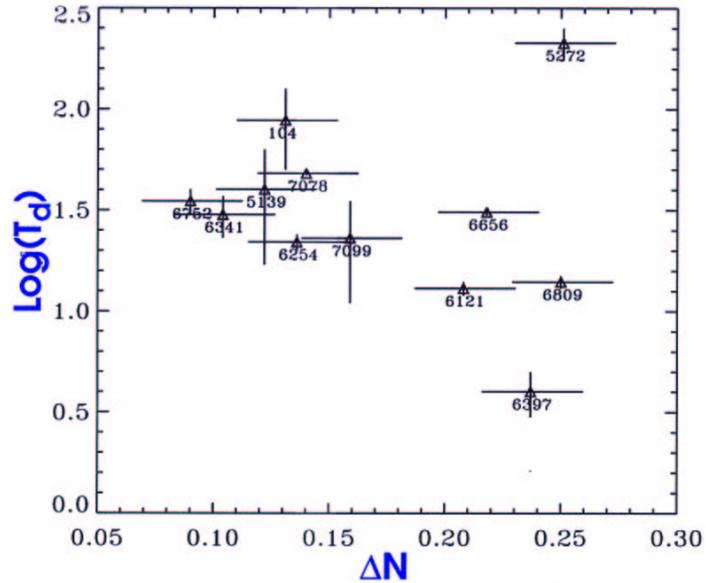
☞ If any effect esists, it is completely masked by current observational uncertainties.

☞ Mass functions measured near half-light radius of clusters in this sample show no evidence of evolution with time, within experimental errors.

☞ These mass functions must reflect the IMF.

Same [Fe/H] in Zinn & West's
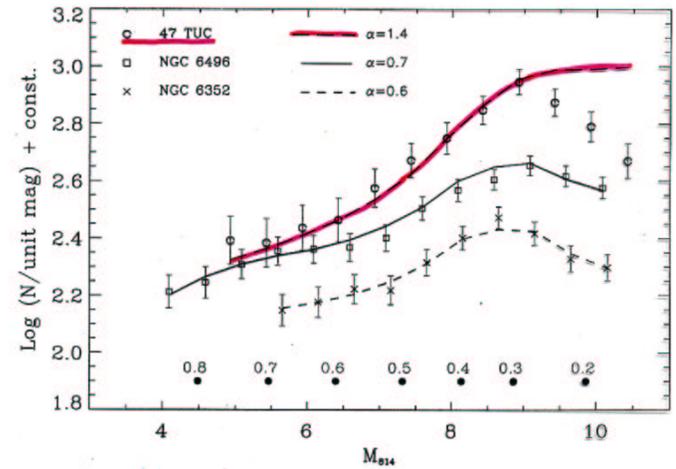
from: Pulone et al. '03 A&A, in press

- 3 -

[M/H] not the same!
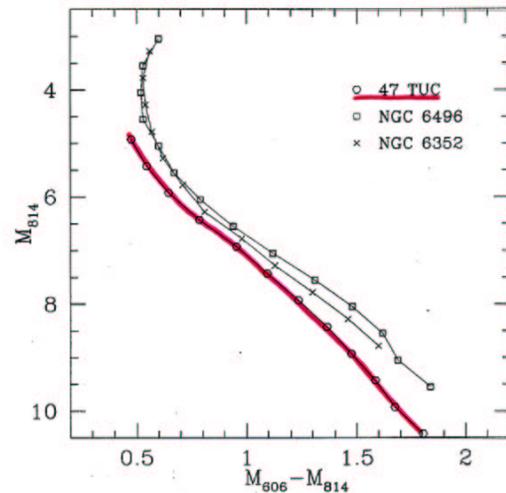
from: Pulone et al. '03
A&A, in press

Summary

✔ Largest and most accurate HST data sample used to measure LF of halo clusters, extending well past peak at 0.3 M_O

✔ LF are not compatible with simple power-law MF: break needed in MF at ~0.3 M_O, consistent with
log-normal: $m_c=0.33\pm0.03$, $\sigma=0.34\pm0.04$
tapered power-law: $m_p=0.33\pm0.03$, $\beta=2.6\pm0.2$

✔ Effects of internal dynamics are found not to be significant or minimal since LF measured near r_h ==> derived MF is global MF for 9 of 12 cluster in sample (very small correction for remaining 3)

✔ No correlation found between shape of MF and external dynamical history of clusters ==> global MF reflects IMF, within observational uncertainties

✔ Considerably flatter MF found in bulge clusters. Dynamics not likely cause. Could be explained if binary fraction were large (~50%).

✔ If metallicity is the key, why is this trend not seen in young disc clusters?