

# The connection between structure and stellar population in early-type galaxies

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## ABSTRACT

We have investigated the problem of the connection between structure and stellar population in ETGs using the WINGS (Wide field Nearby Galaxy cluster Survey, <http://web.oapd.inaf.it/wings/>) database (Fasano et al. 2006 A&A 445, 805; Moretti et al. 2014 A&A 564, 138).

This connection is closely related to the problem of the Fundamental Plane (FP) TILT.

### BASIC ASSUMPTIONS

Since ETGs are virialized objects that share a Fundamental Plane (FP):  $\log(R_e) = a \log(\sigma) + b(\mu_e) + c$  tilted with respect to the VP, one can write:

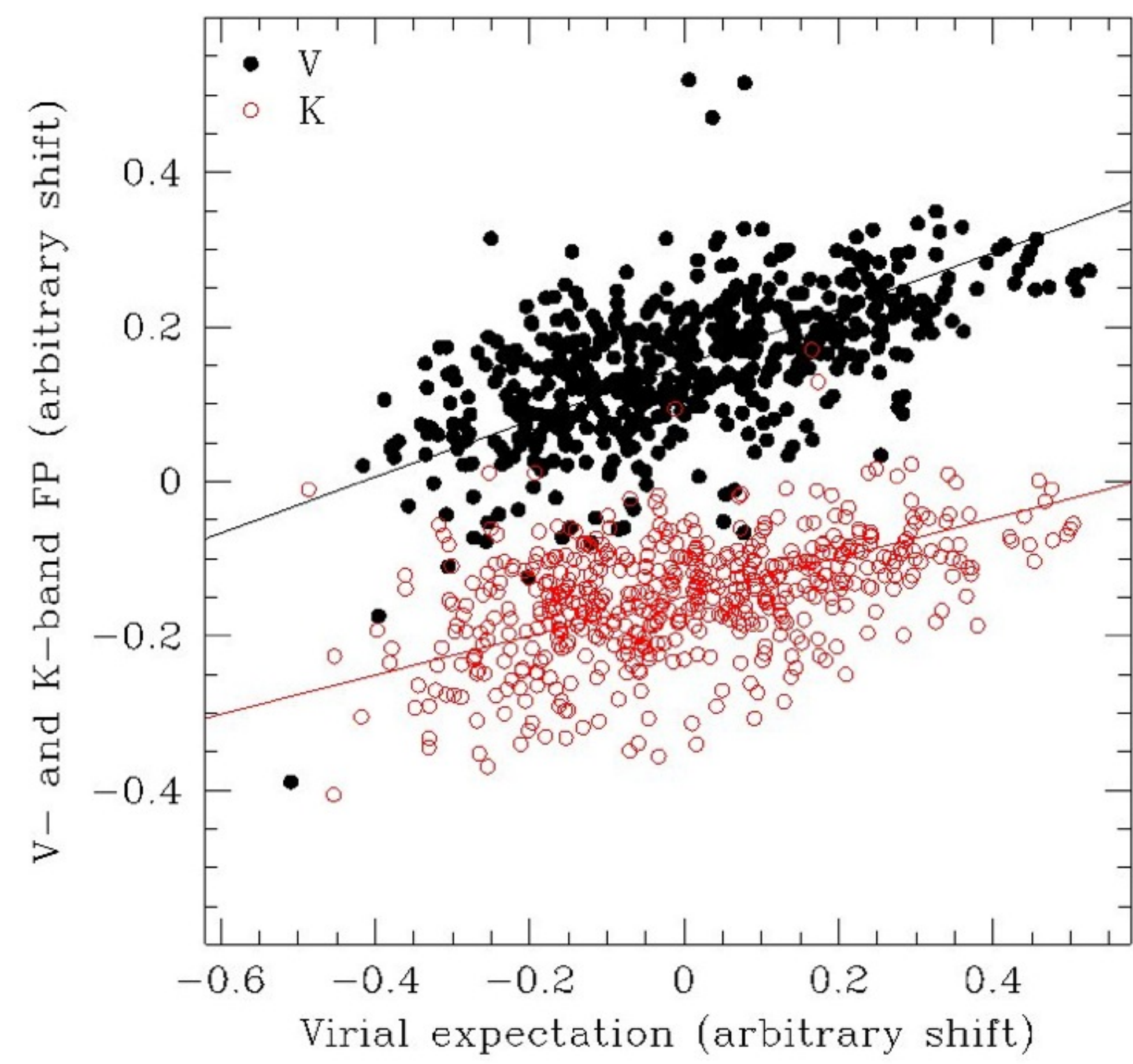
$$\log(M_{tot}/L) - \log(K_V) = (2-a) \log(\sigma) + b(\mu_e - M_\odot^A - 21.572) - \log(2\pi G) - c.$$

$$\uparrow \quad \uparrow \quad \propto \log(n) \quad \uparrow \quad \propto \log(M_{tot})$$

THERE IS A RELATION BETWEEN STRUCTURE AND STELLAR POPULATION IN ETGS

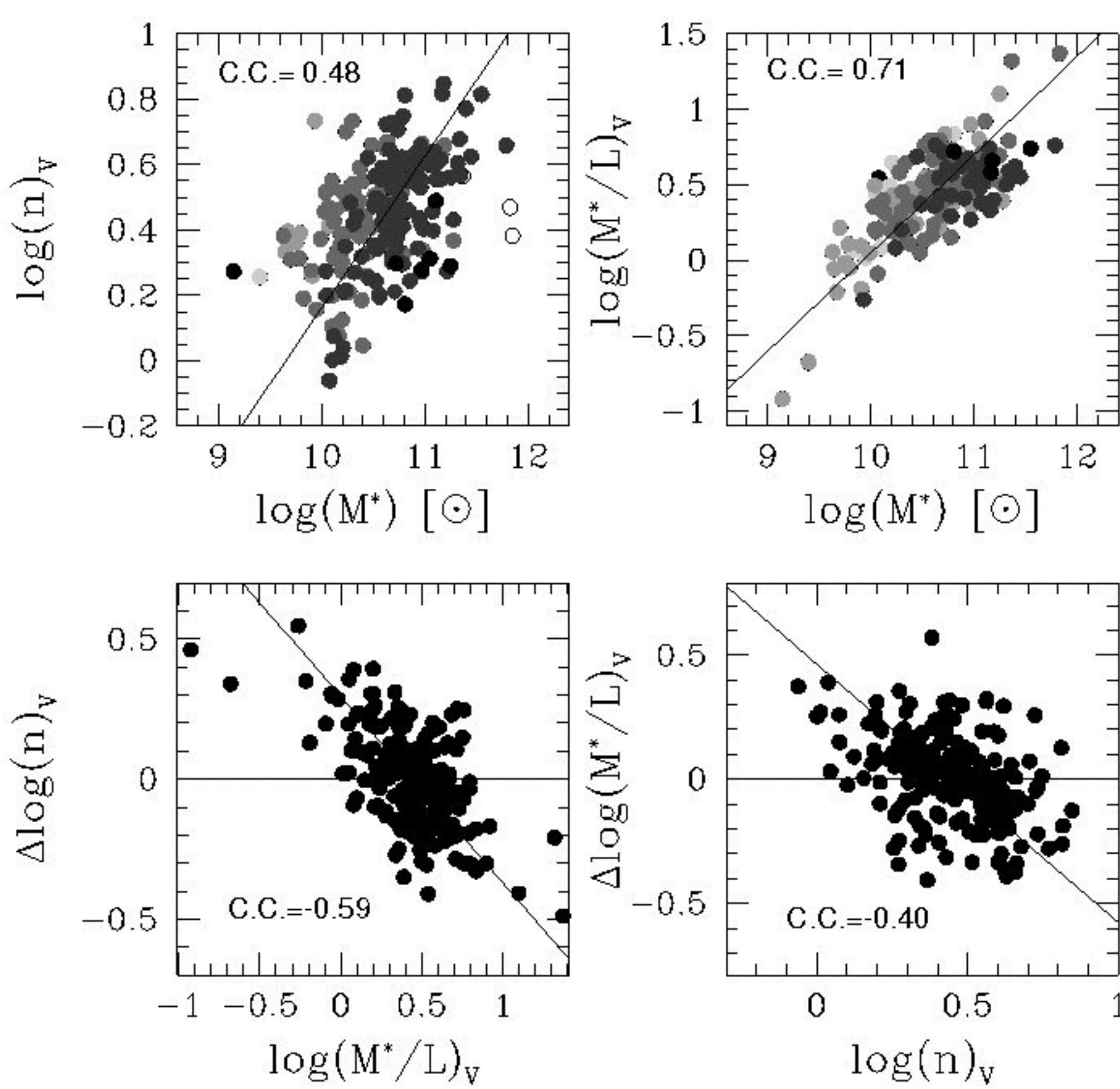
$$\log(M/L) - \log(n) - \log(M)$$

### THE TILT OF THE FP



The ETGs WINGS data in the figure show that the FP TILT is well visible both in the K and V bands. The TILT is stronger for the V band. Here the slopes of the fits give the angles of the FP with respect to the virial plane.

### THE CONNECTION BETWEEN M\*, N AND M\*/L

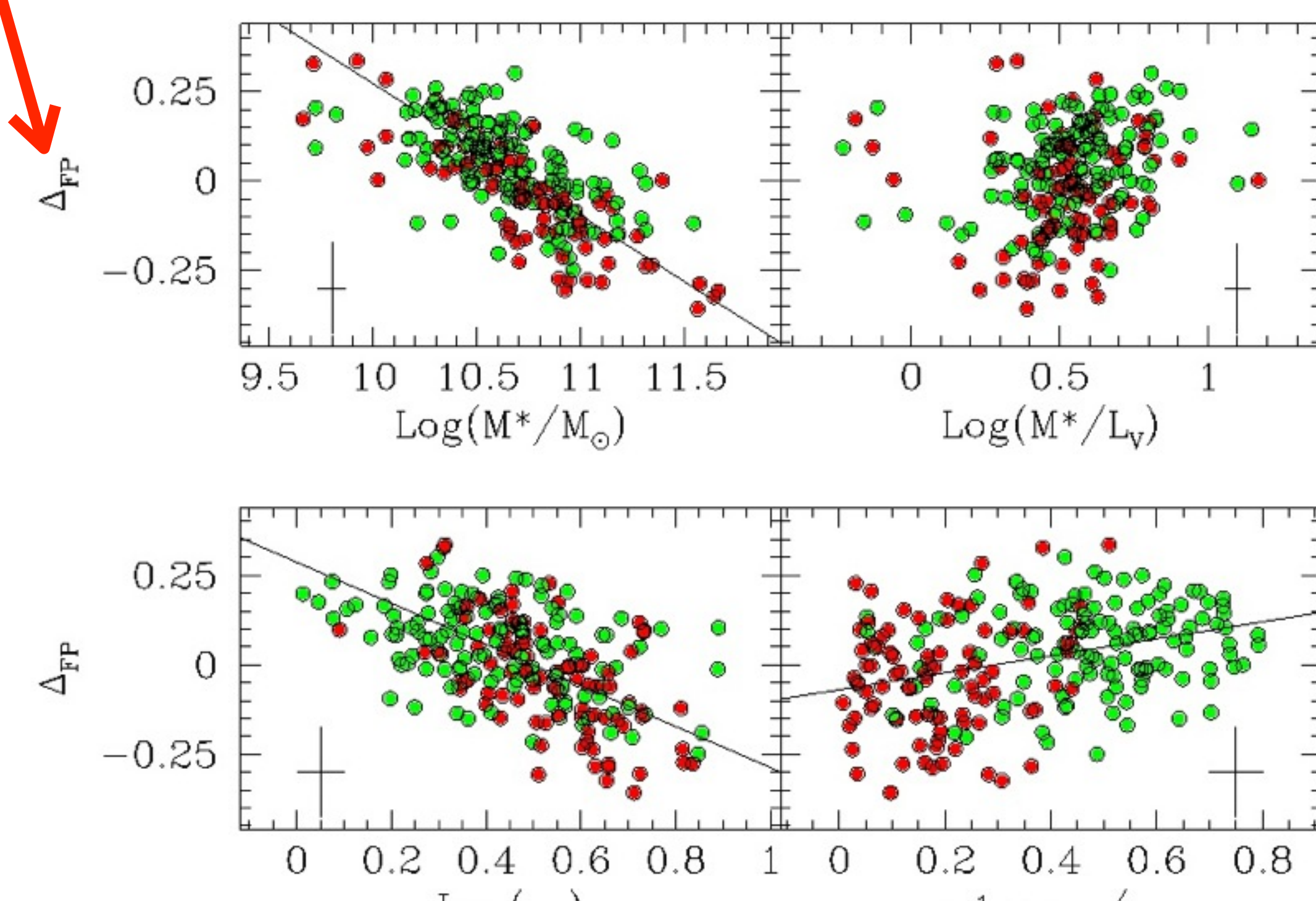


This plot shows that the above predicted relation between M, n and M/L is indeed observed using the WINGS data for the ETGs. Here we used M\* instead of M and K\*\_V instead of K\_V.

The lower panels show that the residuals of the M\*-n relation depend on M\*/L and in turn the residuals of the M\*-M\*/L relation depends on n. This is a clear indication that these variables share a plane in a 3D space.

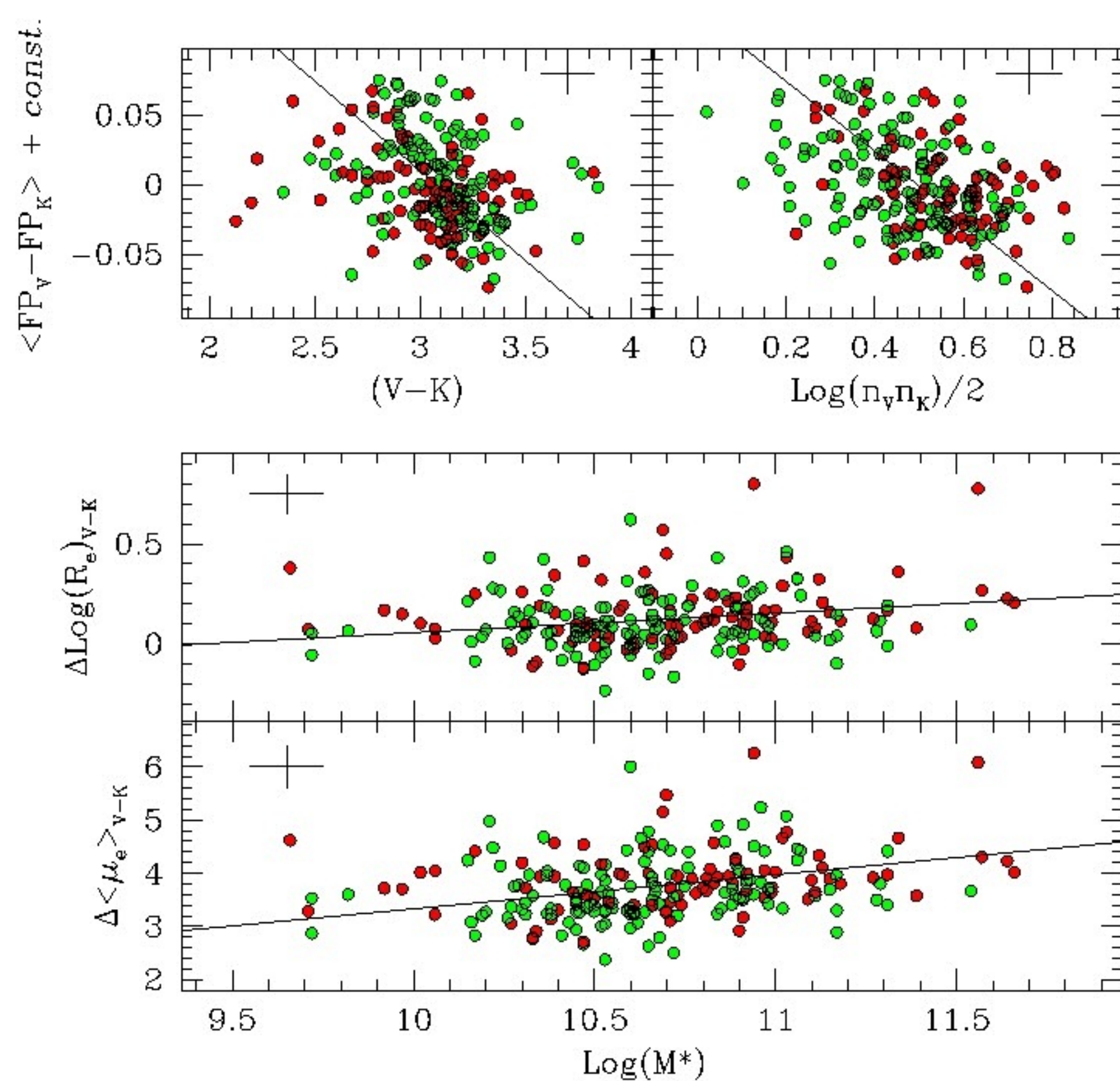
There is therefore a connection between shape and stellar population in ETGs at the origin of the FP problem.

### SOLUTIONS OF THE FP TILT

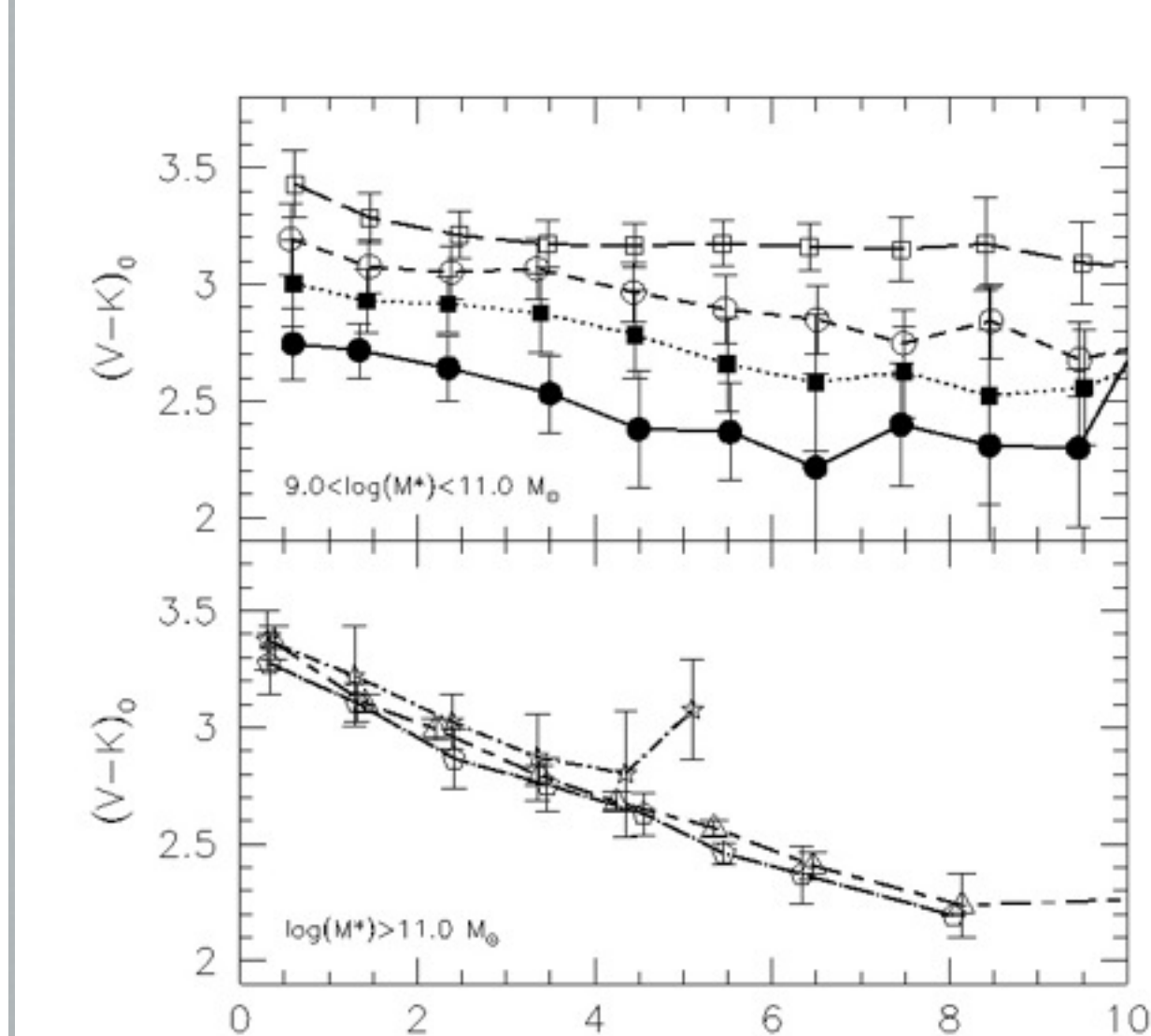


The TILT of the FP is plotted here against the stellar mass M\*, the mass-to-light ratio M\*/L, the Sersic index n and the ellipticity. The driver of the TILT is n, which parametrize the shape of the ETGSs.

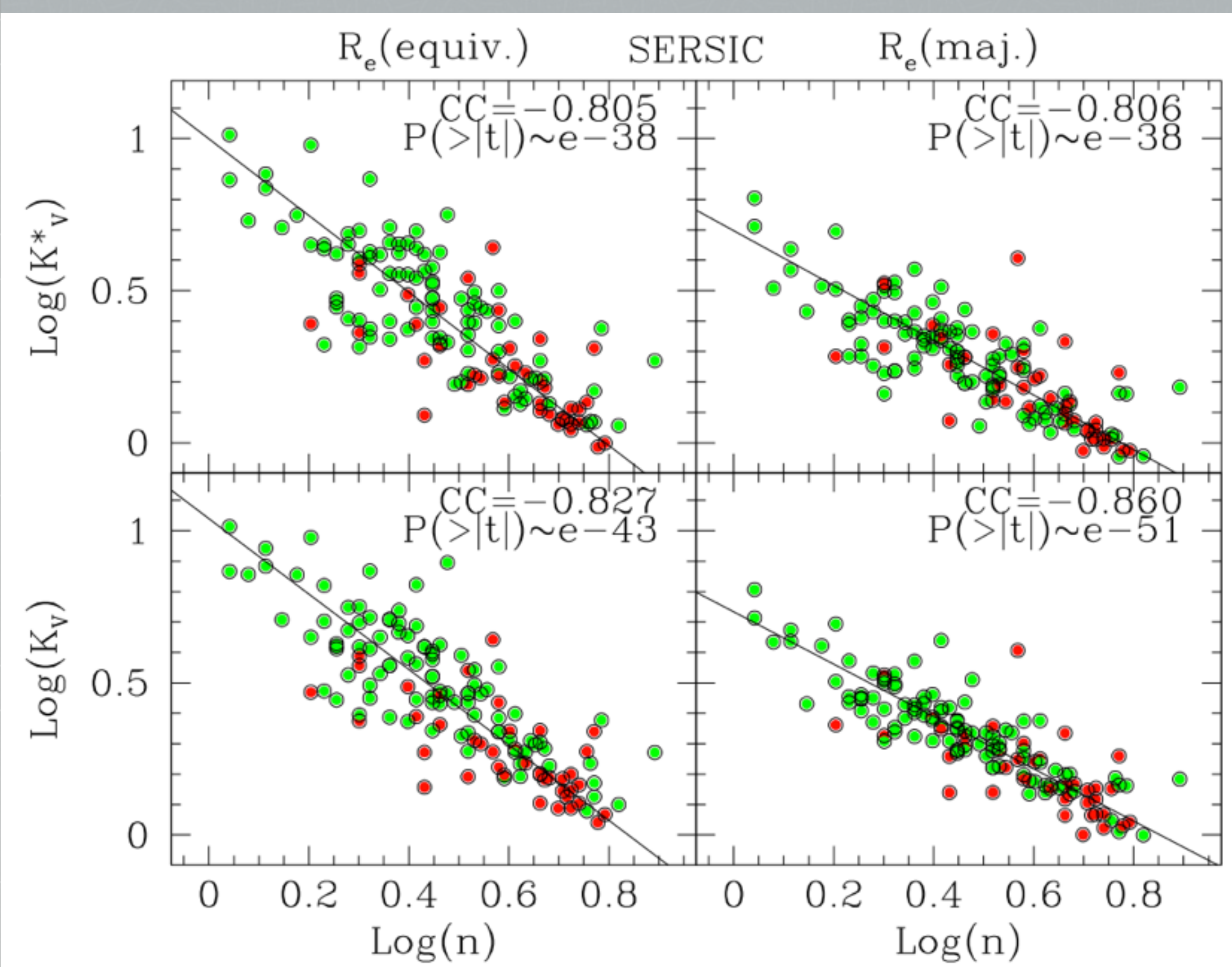
### THE ROLE OF STELLAR POPULATION



These plots show that the role of the stellar population in tilting the FP is limited to that of producing a differential tilt of the FP in the various wavebands. The tilt occurs because galaxies of higher masses have higher color gradients due to higher mean metallicities.



### THE ROLE OF NON-HOMOLOGY



The figure shows the correlation between K\*\_V and K\_V with the Sersic index n. Whatever the definition of R\_e and whatever the sample used (ATLAS, WINGS or SDSS) this correlation is always observed and demonstrate that the shape of the ETGs plays an important role.

## CONCLUSIONS

THE WINGS DATA SUGGEST THAT AT THE ORIGIN OF THE FP TILT THERE IS THE CONNECTION BETWEEN SHAPE AND STELLAR POPULATION IN EARLY-TYPE GALAXIES. THIS CONNECTION IS PREDICTED TO EXIST SIMPLY BY POSTULATING THE VALIDITY OF THE VIRIAL THEOREM AND BY THE OBSERVATION OF THE TILTED FP. THE DATA CONFIRM THAT A RELATION OF THIS KIND INDEED IS PRESENT AND THAT THE NON-HOMOLOGY OF ETGS IS THE MAIN DRIVER OF THE FP TILT.

FROM A THEORETICAL POINT OF VIEW THE EXISTENCE OF SUCH RELATION MIGHT BE UNDERSTOOD IN A SCENARIO OF ETGS FORMATION THROUGHOUT MULTIPLE DRY MERGING EVENTS.

THANKS TO EVERYONE FROM THE WINGS TEAM !!

