Kinematics and stellar populations of dwarf ellipticals in the Fornax cluster.

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Center for Space Research, North-West University

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Project Outline

Aim

To do a detailed study of the population of dEs in the Fornax cluster with special emphasis on the kinematics and stellar populations. This aim is achieved through the following:

- Long-slit spectral analysis on dEs > compared with MAGPOP and SMAKCED on dwarf galaxies in the Virgo cluster and the Field (Toloba et al. 2009,2011)
- Line-of-sight velocities and velocity dispersions as function of radius > the amount of rotational support as a function of radius inside the galaxy.
- Kinematics modeled with anisotropic Jeans models (Cappellari 2008) > measure dynamical masses > results will be compared with morphological and structural properties (nucleation, diskiness/boxiness, ellipticity)
- Stellar populations characterised as a function of radius within each galaxy using spectral fitting code ULySS > star formation history and rotating + non-rotating dEs formation histories.
- Results of the kinematic and stellar population analysis will be compared with simulations of harassment and tidal stirring and will thus provide insight in the origin of dEs

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Dwarf elliptical galaxies

Properties of dEs

- dEs > small, low luminosity galaxies > $M_B \geq -18$ mag.
- Most numerous galaxy > found in groups and clusters of galaxies
- Low surface brightness > time consuming spectroscopy + small data sets
- Structurally very different form luminous ellipticals > different formation histories
- Low metallicities compared to solar metallicity

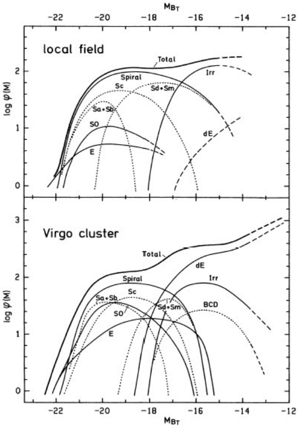

Figure : LF from Binggeli 1988

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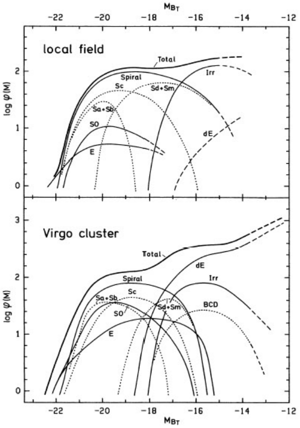

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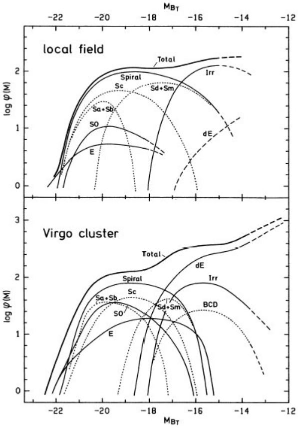

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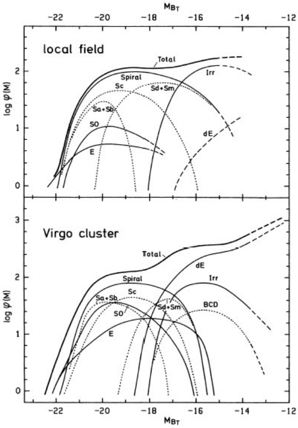

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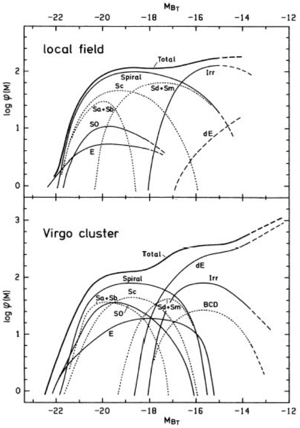

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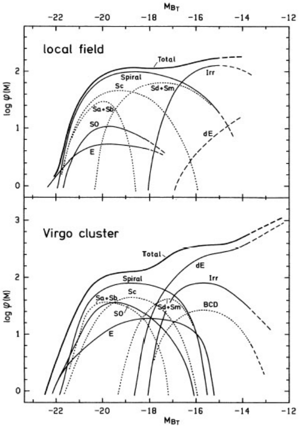

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Sample selection

Fornax cluster

- Southern cluster with the second largest collection of early-type galaxies ≤ 20 Mpc.
- Galaxy density higher than Virgo cluster and more concentrated than Virgo
- ACSFCS survey (Jordan et al. 2007) > target selection
- Early type dwarfs, FCC targets (Ferguson, 1989) > morphological classification (dE), $13.3 \geq b_t \leq 15.6$, ellipticity » 20 targets

Table : Properties of Virgo and Fornax clusters (Jordan et al 2007).

Property	Virgo	Fornax
Richness class	1	0
r_c (Mpc)	≈ 0.6	≈ 0.25
Mass	$(4-7)\times10^{14}$	$(7\pm2)\times10^{13}$
Distance	16.5	19.3
N	1170	235
σ_v (km s^{-1})	760	347 ± 26

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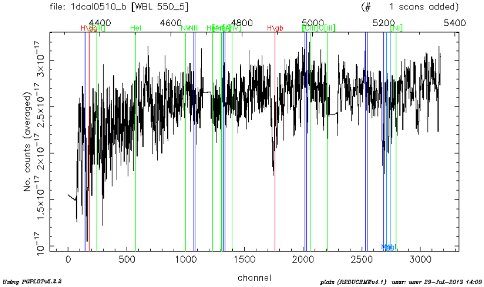
Data reduction

Observations and data reduction

- Observations > SALT, RSS spectrograph > 7300s per target
- Basic data reduction and calibration of the spectra > IRAF
- Spectral reduction > CR rejection + flat fielding + spectral line ID



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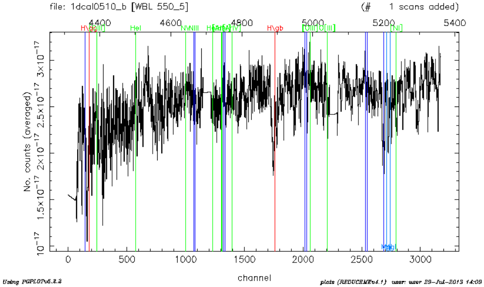

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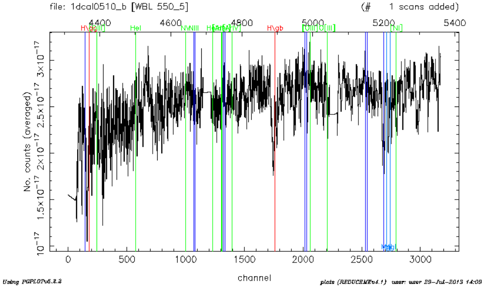

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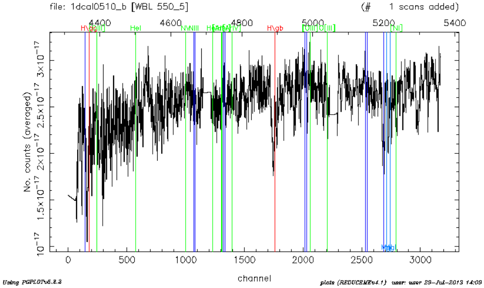

Data analysis

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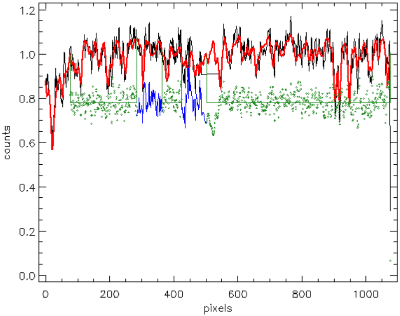
- pPXF (Penalized Pixel Fitting (Cappellari (2002)) > evaluate stellar kinematics by fitting line-of-sight velocity distribution and determines kinematics of gas by measuring emission line fluxes and widths
- GANDALF (Gas AND Absorption Line Fitting) > simultaneously fits stellar population and Gaussian emission line templates to the galaxy spectrum to separate stellar continuum and absorption lines from the ionised gas emission



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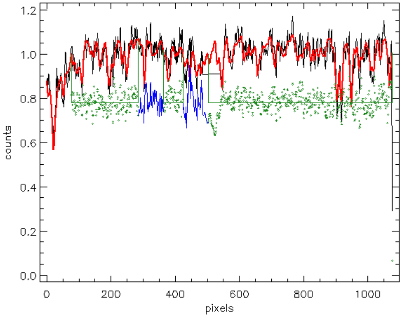

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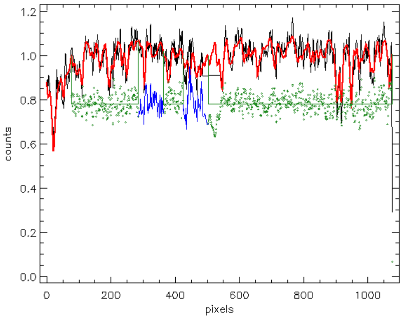
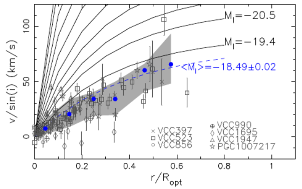


Rotational support in dEs

Rotational support

- ***Rotational curves***: Obtained from the ratio of rotational velocity to distance from centre of galaxy > V_{max} derived from rotation curve (Polyex model (Giovanelli & Haynes 2002))
- ***Velocity dispersion (σ)***: Dispersion of velocities about the mean velocity inside the galaxy > estimated from measuring all radial velocities
- ***Anisotropy parameter (v_{max}/σ)****: Galaxies are rotational supported for $(v_{max}/\sigma)^* > 0.8$ and pressure supported for $(v_{max}/\sigma)^* < 0.8$. Rotational supported systems > cluster outskirts or field

$V_{PE}(r) = V_0\left(1 - e^{-\frac{r}{r_{PE}}}\right)\left(1 + \frac{\alpha r}{r_{PE}}\right)$ as a function of V_0, r_{PE}, α



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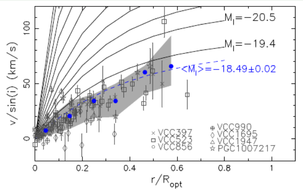

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$(v_{max}/\sigma)^* = \frac{v_{max}/\sigma}{\sqrt{\epsilon/(1-\epsilon)}}$ with $\sqrt{\epsilon/(1-\epsilon)}$ the isotropic oblate model

(Toloba et al. 2009)

Summary

- Longslit spectra from SALT will be used to study dEs in Fornax cluster.
- Stellar population data and kinematics of 20 dEs will be obtained and compared to dEs in other clusters (Virgo).
- Fornax contains slow rotating dEs > Why? > Look at the cluster environment.
- Answer fundamental questions about dE formation and star formation histories in dEs > metallicity gradients in dEs