CALAR ALTO "TETRA-ARMED SUPER-IFU SPECTROGRAPH" SURVEY

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- **Science Advisory Groups:**

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CATARSIS

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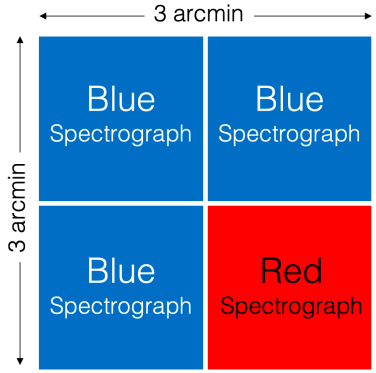
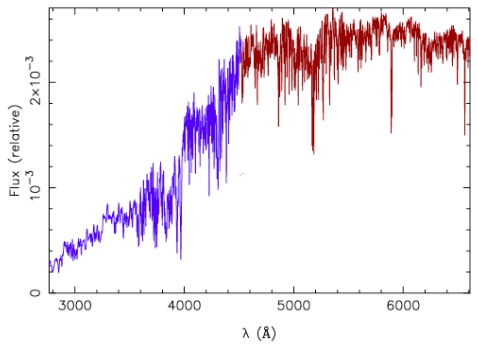
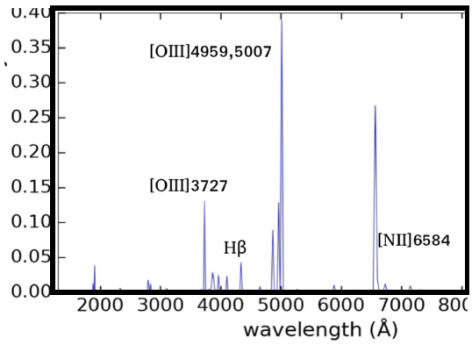
- **CATARSIS is a survey project** for the 3.5m telescope at the **Calar Alto Observatory** using a new instrument, **TARSIS**. With a field of view of ~3'x3', TARSIS (Tetra ARmed Super-Ifu Spectrograph) will cover a wavelength range of **320-760** nm with **R=1000-2000.** We will obtain deep spectroscopy of galaxy clusters and filaments at z~0.15 up to m_{AB} =22.
- The survey aims at **understanding the formation and evolution of galaxies in the cosmic web**, studying both, the growth of large-scale structure and the galaxies in it. CATARSIS will measure (1) cluster mass profiles and accretion rates, and the alignments of galaxies with filaments, testing predictions for structure formation in different cosmologies; (2) detailed star formation histories using the NUV range, which allow to distinguish recent and small burst, from residual star formation or quenching in different timescales; (3) chemical abundance ratios in both, gas and stars, including the comparison, for the first time, of Mg and N in both components.
- I will also describe how the deep exposures and wavelength range to be explored, that allows **observation of Lyα at redshifts between 1.6<z<3.2**, will allow us to study the nature of DLA, HeII and Lyα emitters and the intergalactic medium at the peak of cosmic star formation. Although these projects are normally carried out in large aperture telescopes, the reduce cosmic dimming at these redshifts and the efficiency of TARSIS make this project highly competitive.

In November 2019, the Calar Alto observatory issued a call for new legacy science projects.

• The CAHA Executive Board recommended on July 3rd 2020 CATARSIS, a new survey requiring a new instrument, TARSIS (**see A. Gil de Paz's talk**), to move ahead to the next phase, a competitive Conceptual Design. TARSIS is an IFU with 3x3 arcmin FOV

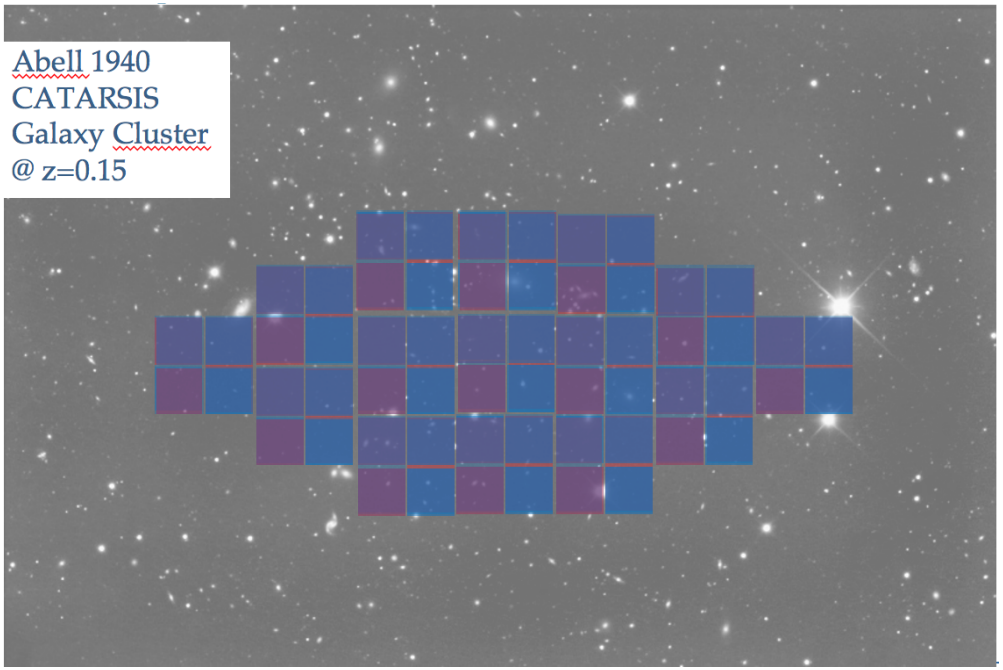


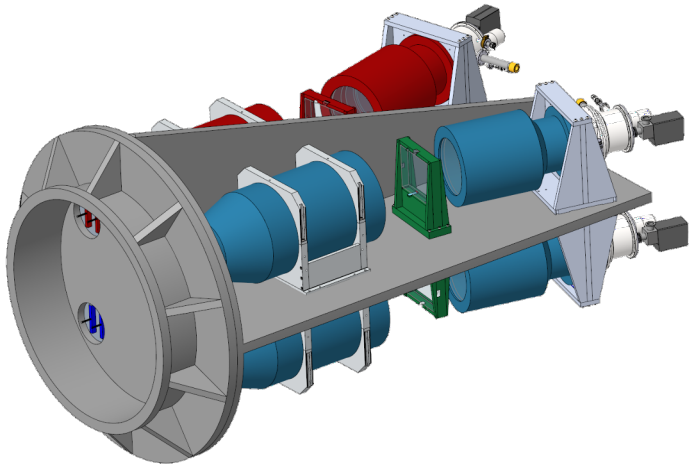




CATARSIS will perform a **spectroscopic survey of 20 clusters and filaments at z~0.15** with m_{AB} < 22 mag over a 1 deg^2 with a spectral resolution R ~1000-2000 in the wavelength range 320-760 nm [278 –661 nm at z=0.15].

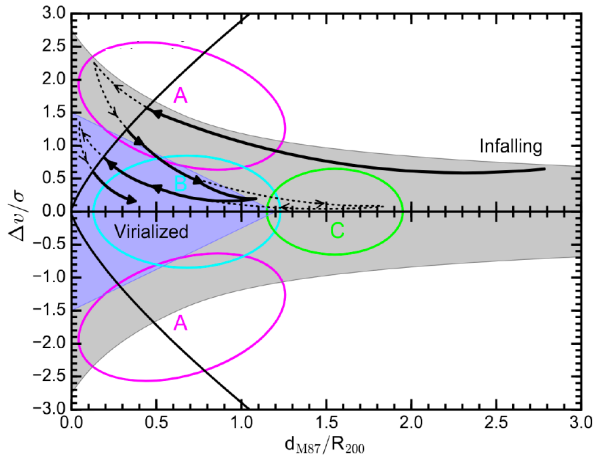
OBSERVING STRATEGY/METHODOLOGY





3x Exposure time
1x Exposure time

} Whole common FoV



Dynamical analysis with hundreds of galaxies:

a) to identify substructures within the cluster
b) to calculate the infall rate of galaxies into the clusters
c) to calculate the mass profile of clusters (epoch of formation)

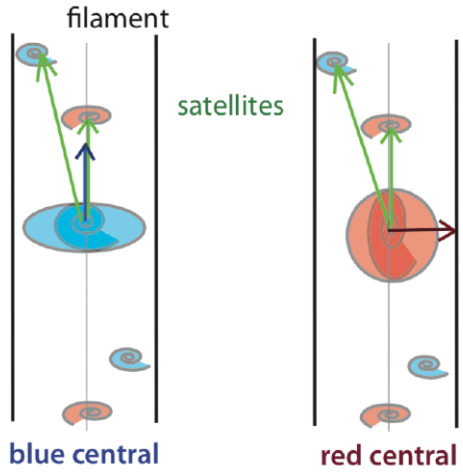
Alignments of galaxies

Predictions from ΛCDM:

• spins of low-mass, blue, oblate galaxies are preferentially aligned with the slowest collapsing direction of the large-scale tidal field

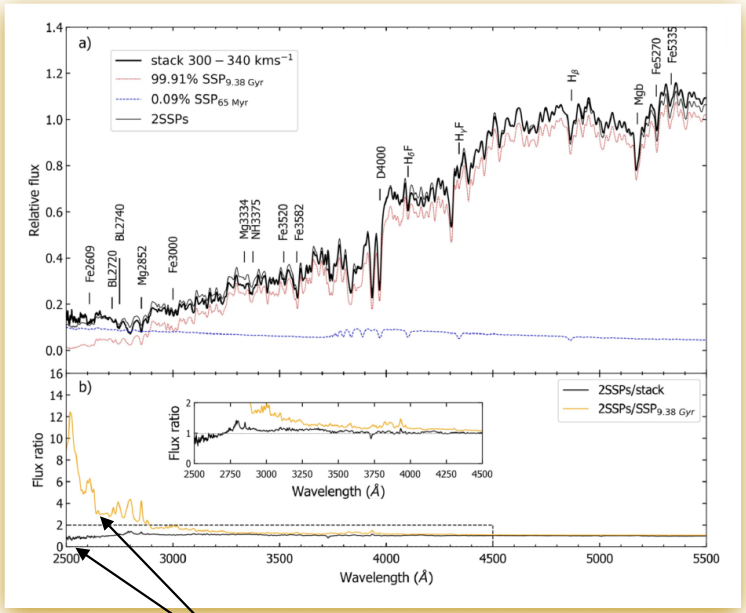
• massive, red, prolate galaxy spins tend to be perpendicular to this direction.

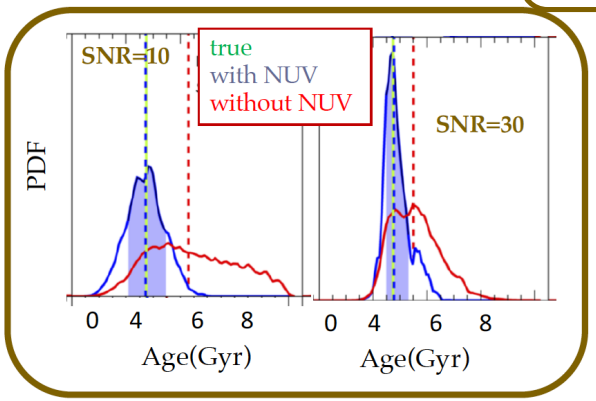
Difficult with image (which side is closer to us?) but we'll be able to do it for a large sample of galaxies (also important because aligment can mimic shear in weak gravitational lenses analysis)



The inclusion of the **NUV** improve dramatically the determination of SFH and mean ages (differences at λ < 300 nm

differences in the determination of the age including or not the NUV





Costantin+ 2019

diference when adding a 0.09% mass fraction 60Myr component to a 9.38 Gyr population

+ chemical abundances

nebular MgII λλ2797, 2803 [Mg/Ne])
Direct comparison of N and Mg in stars and nebulae! (very important for metallicity scales and chemical evolution. models)

stellar NH3360, NH3375, Mg3334, Mg5177, C4668...
Extra constrains to the SFH (and the yields)

WHAT ARE WE OFFERING OVER PREVIOUS ENVIRONMENTAL STUDIES?

i. A dynamical analysis of clusters, determination of substructure, and conditions of the ICM to better characterize "environment" with no pre-selection of targets
ii. A characterization of the epoch of formation of clusters via the mass profiles
iii. A characterization of the accretion rates to match the rate of galaxy transformations.
iv. A much improved analysis of star formation history (due to the inclusion of the NUV)
v. Several complementary analysis to derive SFH (C/Fe, N/Fe, N/O, Mg/Ne, etc...)
vi. New diagnostics lines that will allow to do new, pioneering science (comparison of abundances in stars and gas, Mg dust depletion, Mg nebular abundance, ...)

In summary, an integral study of galaxy and structure formation...

But that's not all... the gold shield of CATARSIS can buy you more..

CATARSIS will provide spectroscopy for all the objets in the field below our limiting magnitude. With 8h exposure we'll reach fluxes of **Lyα of ~ 1x10^{18} erg cm^{-2} s^{-1} at z=1.6**, allowing to tackle a variety of studies (escape fraction of Lyα, nature of DLA, HeII emitters, Ly α blows, etc etc) (**see J. Oñorbe´s talk**)