ABSTRACT BOOK

On the Origin (and Evolution) of Baryonic Galaxy Halos

13 - 17 March 2017

I) ORAL PRESENTATIONS

DAY 1 (13 March 2017):

1.- NAME: Roberto Abraham

TITLE: Invited Talk on the low surface brightness universe revealed by Dragonfly

ABSTRACT: I will present some early results from the Dragonfly Telephoto Array, a robotic imaging system built by Toronto, Yale and Harvard and optimized for the detection of extended low surface brightness structures. In this talk, Dragonfly data will be used to shed some light on the low surface brightness universe in three separate ways: (1) Dragonfly has revealed the existence of an abundant population of large low surface brightness spheroids ("ultra-diffuse galaxies") in the Coma cluster. In this talk I will describe how observations from Dragonfly, Keck, Gemini and HST constrain the nature of these enigmatic objects, with a focus on the idea that ultra-diffuse galaxies might be nearly "pure" dark matter halos. (2) The stellar halos of nearby galaxies probed by Dragonfly show enormous scatter in their baryonic mass fractions. Some galaxies have strongly structured halos resembling that of M31, while some have no detectable stellar halos at all. The stellar halo mass fractions vary by over a factor of 100. I will argue that this rich variety in stellar halo properties paints a picture of galaxy assembly that is highly non-uniform for massive spiral galaxies. (3) Dragonfly has been used to probe the outermost structures of disks at extreme radii (around 20 scale lengths). I will describe the properties of the outermost parts of galactic stellar disks, and speculate on what these properties might reveal about the physics of galaxy assembly.

2.- NAME: Allison Merritt

TITLE: The Dragonfly Nearby Galaxies Survey: A Census of the Stellar Halos of Nearby Luminous Galaxies

ABSTRACT: The Dragonfly Telephoto Array, comprised of 48 individual Canon telephoto lenses operating together as a single telescope, is an innovative approach to low surface brightness imaging and the study of galactic stellar halos in particular. Sub-nanometer coatings on each optical element reduce scattered light from nearby bright stars and compact galaxy centers — typically a key obstacle for integrated light observations — by an order of magnitude, and Dragonfly's large field of view (2 x 2.6 degrees for a single frame) provides a large-scale view of stellar halos free from substructure biases. Using extremely deep (>30 mag/arcsec^2) optical imaging in g and r bands from the Dragonfly Nearby Galaxies Survey (DNGS), we have characterized the stellar halos of a sample of 20 nearby luminous galaxies. I will present measurements of the stellar halo mass fractions of these galaxies as a function of stellar mass, morphology, and environment, and discuss the scatter in halo fractions in the context of the galaxies' individual accretion histories.

3.- NAME: María Cebrián

TITLE: Unveiling galaxy halos beyond 31mag/arcsec^2

ABSTRACT: Detection of optical surface brightness structures with magnitudes fainter than 30 mag/arcsec^2 has remained elusive in current photometric deep surveys. We will show, for the first time outside the Local Group, surface brightness profiles down to 33 mag/arcsec^2 of two galaxies similar to our Milky Way (NGC 493) and M31 (UGC00180) and study the interesting low surface brightness features surrounding these galaxies. By combining an exquisite treatment of the sky subtraction and PSF effects, we reach similar depth as that obtained using star counts techniques in the Local Group. This work opens new frontiers not only in the study of galaxy halos but also in the theories of galaxy formation. We will present our on-going effort with GTC and other telescopes to explore other galaxies at similar depth as NGC 493 and UGC00180. With this data, we will be able to disentangle whether M31 and the Milky Way are the rule or the exception.

4.- NAME: Pierre-Alain Duc

TITLE: Probing the halos of massive galaxies with deep imaging

ABSTRACT: The on-going deep imaging programs, such as those carried out with the CFHT - NGVS and MATLAS - allows us to study the outer stellar populations in a large number of galaxies belonging to well-defined samples. The properties of the stellar halos and fine structures within them are compared to predictions from numerical cosmological simulations, providing key information on the past mass assembly of galaxies. I will address what what we have learned from these deep imaging surveys on the past and future evolution of massive early and late type galaxies, depending on their environment.

5.- NAME: Elisa Toloba

TITLE: Photometry and Spectroscopy of Resolved Stars in Streams and Satellites of Galaxy Halos Beyond the Local Group

ABSTRACT: Dwarf galaxies play a critical role in our understanding of galaxy formation in the context of the Λ Cold Dark Matter (ΛCDM) paradigm of structure formation. For instance, quantitative verification of the ΛCDM model has struggled in the dwarf-galaxy regime (e.g. the “missing satellites problem”, the “too big to fail problem”, and apparent planes of satellites), although the most recent numerical simulations make significant progress on several of these issues by including a wide range of baryonic physics. Additionally, the low mass and large numbers of faint dwarf galaxies make them good targets to learn about environmental processes (e.g. tidal and ram pressure stripping), which also makes them vital contributors to the build-up of massive halos. The challenges to the ΛCDM model on small scales in particular have been largely based on studies in the Local Group, even though a large dispersion in the numbers and properties of dwarf satellites and other halo substructures are expected. We present the PISCeS survey, a Panoramic Imaging Survey of CenA (NGC5128) and the Sculptor (NGC253) galaxies. In our deep Magellan/Megacam photometry of these halos we have discovered a plethora of substructure including dwarf galaxies, dwarf satellites of dwarf galaxies, dwarfs in the process of being disrupted, and streams. We are now doing a spectroscopic follow-up of these systems and also those found in the halo of M81 using Keck/DEIMOS to measure their radial velocities, velocity gradients, and stellar metallicities. The faintness of the stars targeted (tip of red giant branch at ~24mag), due to their location at ~4Mpc, makes this spectroscopy very challenging. We have developed a new spectroscopic technique based on coadding surface brightness fluctuations and have successfully applied it to the stellar stream discovered in the halo of the dwarf star forming galaxy NGC4449, and to some dwarf spheroidals in NGC253 and M81.

6.- NAME: Jeff Carlin

TITLE: The Magellanic Analog Dwarf Companions and Stellar Halos Survey: Near-Field Cosmology with Resolved Stellar Populations Around Local Volume LMC Stellar-Mass Galaxies

ABSTRACT: We discuss the first results of our observational program to comprehensively map nearly the entire virial volumes of roughly LMC stellar mass galaxies at distances of ~2-4 Mpc. The MADCASH (Magellanic Analog Dwarf Companions And Stellar Halos) survey will deliver the first census of the dwarf satellite populations and stellar halo properties within LMC-like environments in the Local Volume. These will inform our understanding of the recent DES discoveries of dwarf satellites tentatively affiliated with the LMC/SMC system. We will detail our discovery of the faintest known dwarf galaxy satellite of an LMC stellar-mass host beyond the Local Group, based on deep Subaru+HyperSuprimeCam imaging reaching ~2 magnitudes below its TRGB. We will summarize the survey results and status to date, highlighting some challenges encountered and lessons learned as we process the data for this program through a prototype LSST pipeline. Our program will examine whether LMC stellar mass dwarfs have extended stellar halos, allowing us to assess the relative contributions of in-situ stars vs. merger debris to their stellar populations and halo density profiles. We outline the constraints on galaxy formation models that will be provided by our observations of low-mass galaxy halos and their satellites.

7.- NAME: Alexa Villaume

TITLE: A Deeper Look at Ultra-Compact Dwarf Galaxies

ABSTRACT: There is strong evidence that at least some ultra-compact dwarf galaxies (UCDs) are the stripped remnants of once much larger galaxies. As such, UCDs can potentially provide insight into the build-up of stellar halos. However, UCDs are also easily classifiable as star clusters. This ambiguity is due both to the superficial similarity of many observables e.g. size and luminosity and because of the difficulty in detecting any "smoking gun" characteristics that indicate a given UCD is a stripped galaxy e.g. the presence of a supermassive black hole. We propose using detailed stellar population characteristics of UCDs as a way to distinguish between their possible formation histories and place UCDs in the broader context of galaxy formation. Here we present a new suite of stellar population synthesis models as a means to do this. We compare detailed abundance patterns, among other stellar population characteristics, of UCDs to those of globular clusters and early-type galaxies and discuss how these properties can delineate a star-cluster origin from a galaxy origin.

8.- NAME: Dong-Woo Kim

TITLE: Hot gaseous halos

ABSTRACT: The hot gas in early type galaxies (ETGs) plays a crucial role in understanding their formation and evolution. As the hot gas is often extended to the outskirts beyond the optical size, the large scale structural features identified by Chandra (including jets, cavities, cold fronts, filaments and tails) point to key evolutionary mechanisms, e.g., AGN feedback, merging history, accretion/stripping and star formation and its quenching. In our new project, the Chandra Galaxy Atlas, we systematically analyze the archival Chandra data of ~100 ETGs to study the hot ISM. Using uniformly derived data products with spatially resolved spectral information, we will present gas morphology, scaling relations and X-ray based mass profiles and address their implications.

9.- NAME: Akos Bogdan

TITLE: Hot X-ray Halos around Spiral Galaxies: A Unique Probe of Galaxy Formation Models

ABSTRACT: The presence of hot gaseous halos in the dark matter halos of massive spiral galaxies is a fundamental prediction of all structure formation models. Yet these halos remained unexplored for several decades, thereby posing a serious challenge to observers and theorists. Recently, a major breakthrough has been made, and several X-ray halos have been detected around massive spiral galaxies. Our group did not only play a leading role in these discoveries, but we also confronted the observed properties of these halos with the results of the Illustris simulation. This comparison pointed out that the properties of these halos are extremely sensitive to the incorporated physics in the simulations, and hence observations of X-ray halos provide a powerful method to constrain the physical processes (e.g. stellar and AGN feedback and metal enrichment) that play an essential role in forming galaxies from the early Universe to the present epoch. I will overview the key observational results, discuss the comparison between observations and simulations, and highlight the future prospects of further exploring hot halos around spiral galaxies.

10.- NAME: Michele Cluver

TITLE: Halo gas in compact groups of galaxies

ABSTRACT: We have proposed and evolutionary sequence where the halos of individual galaxies in Hickson Compact Groups (HCGs) seem to be dissolving through extreme interactions into an intragroup component, revealed as an intrincated network of HI tails and bridges as traced by VLA observations, ending in a phase in which almost no HI is detected. Based on exquisite GBT observations, we detected a diffuse HI component — increasing with evolutionary phase, but with uncertain distribution — that has escaped detection by interferometers to date. The extreme HI deficiency in HCGs, first reported nearly 30 years ago, is yet not well understood. In order to understand these process, we study a potential correlation between the mass removed from the galaxies in HI tails and the degree of HI deficiency. This had not been achieved so far since: a) the number of groups analysed so far by means of resolved HI maps was not enough for this aim, and b) separation of the HI in the intragroup

medium from that associated with the galaxies is not trivial. Untill the Square Kilometre Array (in particular SKA1-MID) starts observations, preparatory work through SKA pathfinders and the use of advanced visualization techniques is essential for the separation of HI structures (high surface brightness vs intragroup). In this talk we present the latest results derived from inspecting in much detail the HI-VLA cubes of more than 20 HCGs with the "X3D" visualization tool, that we have developed. Separation of galaxy vs intragroup HI structures based on 3D (spatial and kinematical) information has been performed, allowing us to compare, for the first time and for such large sample, the rate of HI (VLA) in the intragroup medium, with the total HI deficiency obtained from single dish GBT data. Our preliminary results suggest that the transition to HI deficiency seems to occur via a phase of intensive tidal stripping in which galaxies seem to have been devoid of cold gas. We also revisit previous results suggesting that MoHEGs (Molecular Hydrogen Emitting Galaxies) are transition objects from the SF blue cloud to the quiescent red cloud, whose enhanced H2 emission might be energized by shocks caused by collisions within the cold intragroup medium.

11.- NAME: Freeke van de Voort

TITLE: How galactic outflows change the hot haloes around galaxies

ABSTRACT: The thermal Sunyaev-Zel'dovich (SZ) effect and soft X-ray emission are routinely observed around massive galaxies and in galaxy groups and clusters. I will show results for these observational diagnostics of galaxy haloes for a suite of cosmological zoom-in simulations from the FIRE project and argue that stellar feedback has a large effect on the hot halo gas observables. Low-mass haloes are not just scaled-down versions of massive haloes, but more strongly affected by galactic winds driven by star formation. They therefore retain a much lower fraction of their baryons, which results in a strong suppression of the SZ signal compared to massive haloes. Our simulations therefore predict a scaling with halo mass that is steeper than self-similar. For halo masses similar to that of the Milky Way or lower, the X-ray luminosity is time-variable and correlated primarily with the star formation rate (SFR). For these objects, the diffuse X-ray emission is powered mostly by galactic winds and the gas dominating the X-ray emission is flowing out with radial velocities close to the halo's circular velocity. I will show that group-sized haloes, on the other hand, have X-ray luminosities that are much less variable and do not correlate with their SFRs, because the emission originates from the quasi-hydrostatic, virialized halo gas.

12.- NAME: Arif Babul

TITLE: The Origin and Evolution of Diffuse Coronae in Milky Way-sized Galaxies

ABSTRACT: We use “zoom-in” simulations of realistic Milky Way-galaxy analogs to study the origin of the the diffuse coronae in such systems and contrast the properties of this coronae against observations. We find that initially the diffuse corona is produced not by shocked gas accreting onto the galactic halos, but by galactic outflows powered by stellar feedback. In due course, the frequent bursts of galactic winds disrupt the cold gas filaments feeding the galaxies and only thereafter, does the accreting gas become the dominant source of the coronal gas. Following the simulated galaxies to z=0, we find the corona consists of a central hot bubble extending out to 140 kpc, surrounded by warm-hot (T={10}5-{10}6 K) gas that extends to the virial radius. The mass density and the X-ray luminosity of corona is consistent with the Milky Way O VII absorption and O VIII emission measurements by Miller and Bregman. Our z=0 simulated galaxies are baryon- deficient by ~30% relative to the universal value due to efficient expulsion of gas by supernova- powered winds at early time.

13.- NAME: Glenn Kacprzak

TITLE: Cold-mode Accretion: The cause of the fundamental mass metallicity relation at z=2

ABSTRACT: Using data from the MOSFIRE/Keck ZFIRE galaxy evolution survey, we will show that the stellar mass and gas-phase metallicity relation as z=2 is dependent on galaxy star formation rate. We will further show that this fundamental mass-metallicity relation (and its intrinsic scatter) is likely driven by the cold-mode gas accretion. The data are in complete agreement with cosmological simulations. These results demonstrate the direct relationship between cosmological accretion and the fundamental properties of galaxies.

14.- NAME: Eduardo Balbinot

TITLE: The visibility of cold streams

ABSTRACT: Cold streams have a long history of being a probe for the MW halo mass distribution, however time has shown that proper modelling and fitting of streams is a challenging task. In order to assess the usefulness of this method at larger galactrocetric distances I simulated streams for 2/3 of the MW globular cluster sample using a spray-particle method. This method was extended to progenitor-less streams by forward modelling the current cluster sample using a fast NBODY code, providing an expectation on the number of cold streams in the MW halo. After accounting for observational limits of existing photometric surveys we find that only a handful of streams are observable beyond 20 kpc, questioning the usefulness of this proxy to probe the MW potential. However, these streams may still be useful to probe the number of pure dark matter subhalos and/or triaxiality.

DAY 2 (14 March 2017):

15.- NAME: Jean Brodie

TITLE: Invited Talk on the SLUGGS Survey: Deconstructing the assembly histories of galaxies and their halos

ABSTRACT: Wide field observations of galaxies are critically important for testing galaxy formation scenarios, because many signatures of galaxy assembly processes are only revealed at large radius. I will report recent results from the SLUGGS (SAGES Legacy Unifying Globular clusters and GalaxieS) survey of 25+ nearby early type galaxies with a wide range of masses, morphologies and environments. The survey extends to ~3 effective radii for galaxy starlight, and ~10 effective radii for globular clusters (GCs). 2-D kinematic and stellar populations distributions are being compared to cosmological simulations, allowing details of galaxy assembly to emerge, along with clues about GC origins. Total masses and dark matter (DM) density profiles are being derived out to large radii where DM dominates. Dynamical models also constrain orbital distributions for comparison with LambdaCDM cosmological predictions.

16.- NAME: Duncan Forbes

TITLE: Assembly Pathways and the Growth of Massive Early-type Galaxies.

ABSTRACT: The kinematics and stellar populations of local galaxies contain key diagnostics of their evolutionary history. By combining the latest cosmological hydro simulations with the observations of the SLUGGS survey, we are able to reconstruct the formation and evolutionary pathways of individual galaxies. In particular, I present results from the SLUGGS survey which extends 2D spectroscopy maps of stellar kinematics and metallicities from ~1Re to ~3Re. In a two- phase galaxy formation model it is crucial to probe beyond the central (in-situ) region to the outer (accretive) region. Each SLUGGS galaxy is assigned to an assembly class, and hence pathway, from the simulations of Naab et al. We find that the majority of our sample have grown in mass via the accretion of gas-rich minor mergers (with major mergers playing a much smaller role). The fraction of accreted stars correlates with the mean stellar age and the metallicity gradient in the outer regions. I also briefly mention how globular clusters can probe galaxy halos to 10 effective radii and place additional constraints on halo growth.

17.- NAME: Marilena Spavone

TITLE: Photometric study of giant ellipticals and their stellar halos

ABSTRACT: Observations of diffuse starlight in the outskirts of galaxies are thought to be a fundamental source of constraints on the cosmological context of galaxy assembly in the ?CDM model. Such observations are not trivial because of the extreme faintness of such regions. In this work, we investigate the photometric properties of six massive early type galaxies (ETGs) in the VEGAS sample (NGC 1399, NGC 3923, NGC 4365, NGC 4472, NGC 5044, and NGC 5846) out to extremely low surface brightness levels, with the goal of characterizing the global structure of their light profiles for comparison to state-of-the-art galaxy formation models. We carry out deep and detailed photometric

mapping of our ETG sample taking advantage of deep imaging with VST/OmegaCAM in the g and i bands. By fitting the light profiles, we detect signatures of a transition between “relaxed” and “unrelaxed” accreted components and can constrain the balance between in situ and accreted stars. The very good agreement of our results with predictions from theoretical simulations demonstrates that the full VEGAS sample of ~ 100 ETGs will allow us to use the distribution of diffuse light as a robust statistical probe of the hierarchical assembly of massive galaxies.

18.- NAME: Pieter van Dokkum

TITLE: Mergence of the halos of massive galaxies

ABSTRACT: Massive galaxies show dramatic evolution in their outer surface brightness profiles: they are compact at z>2 but very extended with large effective radii and high Sersic indices at z=0. The talk will discuss recent results on both the compact z>2 galaxies and their z=0 descendants: we are getting to a point where most of the measurements are there, and the challenge is to make sense of them. Mergers remain the best candidate to explain the remarkable evolution of the halos of massive galaxies, but there is evidence that we are still missing some key physical process.

19.- NAME: Anthony Gonzalez

TITLE: Halos on the Largest Scales: Properties of Intracluster Stellar Populations

ABSTRACT: Intracluster stars typically comprise 10-50% of the total stellar mass on galaxy cluster and group scales, and encode information about both the cluster assembly history and past dynamical interactions of member galaxies. The properties of this cluster halo population however remain poorly constrained due to the low surface brightness nature of the ICL. I will present results from two ongoing investigations designed to elucidate the origin and formation history of this stellar population. The first is an HST/WFC3 program to constrain the dominant ICL formation mechanism and progenitor population for a statistical sample of clusters and groups. The second is a recently initiated spectroscopic program that enables mapping of metallicity gradients in the ICL out to ~50 kpc.

20.- NAME: Enrichetta Iodice

TITLE: A deep look at the outskirts of bright galaxies in the Fornax cluster with VST

ABSTRACT: The Fornax Deep Survey (FDS) with the ESO VLT Survey Telescope is a new deep, multi-imaging survey of the Fornax cluster. FDS aims to cover 26 square degrees around the cluster core up to its virial radius. One the priority science goals of FDS is to study the faint outer regions of the massive galaxies in the cluster. The large mosaic obtained with the 1 square degree field-of-view pointings of OmegaCam at VST, plus the high angular resolution of 0.21 arcsec per pixel and the large integration time allow us to study, on the cluster scale, the galaxy structure from the brightest inner regions to the faint outskirts, where the stellar envelope merges into the intracluster light. The deep observations can be directly compared with the predictions from the up-to-date theories for the stellar halo formation and the relation with the galaxy environment. The FDS team plans to release the full results for all the early-type galaxies inside the virial radius of the cluster soon in the next year. For now, the first results obtained for the two giant galaxies NGC1399, the cD at the center of the cluster, and NGC1316 (FornaxA, in the SW subgroup) are exciting and very promising. We found that the core of the Fornax cluster is characterised by a very extended and diffuse envelope surrounding the luminous galaxy NGC1399: we map the surface brightness out to about 192 kpc from the galaxy center and down to mu_g ~ 31 mag/arcsec^2 in the g band. The deep photometry allows us to detect a faint stellar bridge in the intracluster region on the west side of NGC1399 and towards NGC1387. By analyzing the integrated colors of this feature, we argue that it could be due to the ongoing interaction between the two galaxies, where the outer envelope of NGC1387 on its east side is stripped away. Results were published this year on the ApJ. A new deep mosaic of the south-west group of the Fornax cluster was obtained with VST, in the g and r bands, which covers an area of about 4 x 2 square degrees around the brightest cluster member NGC1316 (also known as FornaxA). The large integration time and the vast covered area allow us to map the surface brightness out to ~200 kpc from the galaxy center and down to mu_g ~ 30 mag/arcsec^2. The deep VST images allows us to study with a great detail the numerous substructures that characterised this fascinating galaxy, both in the center and in the region of the stellar envelope, and reveal new faint loops and tails

in the galaxy envelope. The paper describing the VST data of NGC1316 is going to be submitted soon. In the proposed talk, I would like to show the first results of FDS mentioned above. Moreover, moving on the cluster scale, thanks to the uniform and large coverage of the Fornax cluster and its subgroup given by the FDS with VST, I would also discuss about differences and similarities between the two giants galaxies in the Fornax cluster and their environments.

21.- NAME: Bryan Miller

TITLE: The Extended Baryonic Halo of NGC 3923

ABSTRACT: In the LambdaCMD paradigm of galaxy formation galaxy halos and their globular clusters systems build up over time by the accretion of small satellites. We can learn about this process in detail by observing systems with ongoing accretion events and comparing the data with simulations. Elliptical shell galaxies are systems that are thought to be due to ongoing or recent minor mergers. We present preliminary results of an investigation of the baryonic halo — light profile, globular clusters, and shells/streams — of the shell galaxy NGC 3923 from deep DECam g and i-band imaging. We will present the 2D and radial distributions of the globular cluster candidates out to a projected radius of about 130 kpc, or 26 Re, making this one of the most extended cluster systems studied. We will also present a new catalog of the shell system. Previous studies have identified between 27 and 42 shells, making NGC 3923 the system with the largest number of shells. Finally, we will use the shells to estimate the enclosed mass out to a projected radius of 130 kpc.

22.- NAME: Sabine Bellstedt

TITLE: SLUGGS Survey - The stellar kinematics of lenticular galaxies and their relation to the total mass profiles.

ABSTRACT: Although lenticular and elliptical galaxies are both historically classified as ‘early-type galaxies', lenticular galaxies have been observed to be distinct from both elliptical and spiral galaxies with respect to their structure and kinematics, and the mechanisms which lead to the formation of these distinct galaxies are not well understood. I present a detailed analysis of 2D kinematic data to ~2-3 effective radii for a number of low- to intermediate-mass lenticular galaxies from the SLUGGS Survey. Utilising not only kinematic maps but also angular momentum profiles and measurements of the higher LOSVD moments, we uncover features of the underlying behaviour of the stellar halo, and identify how this behaviour compares to that of elliptical galaxies. Additionally, I apply the Jeans Anisotropic MGE modelling technique to identify the total mass density slope as a proxy for the total mass distribution within these galaxies. I link the information of the total mass density slopes with the kinematic data to provide clues as to the formation histories of these lenticular galaxies.

23.- NAME: Chris Hayward

TITLE: How stellar feedback drives outflows

ABSTRACT: The gas content of galaxy halos is determined by a combination of inflows and outflows. The physics of gas inflow (gravity and cooling) is well understood, but the physics of how stellar feedback drives outflows is still unclear. I will present a simple analytic model for how momentum deposition from stellar feedback simultaneously self-regulates star formation and drives outflows. Importantly, the model predicts that outflows are suppressed in massive galaxies at $z \lesssim 1$, consistent with the results of the state-of-the-art FIRE cosmological zoom-in simulations.

24.- NAME: Annalisa Pillepich

TITLE: Invited talk on Illustris simulations of galaxy halos

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25.- NAME: Neal Katz

TITLE: A New Galactic Wind Model to Better Understand the Implications of QSO Absorption lines

ABSTRACT: QSO absorption line studies of the CGM using HST COS are the best direct way to study the accretion and galactic wind processes that are thought to dominate galaxy formation. Detailed numerical simulations are critical to interpret and understand these observations. Unfortunately, interactions at wind/ halo gas interfaces in the CGM occur on scales that are much below the resolution of any current or near future galaxy formation simulation. To mitigate this impasse, we propose to implement a new wind algorithm that explicitly models the "subgrid physics" in the wind-halo gas interaction analytically within a simulation, using the simulation to provide the physical characteristics that will inform the interaction. Unavoidably, this introduces a few free parameters but we can restrict them by matching observed galaxy properties. We conduct simulations to tune the new wind model to match the galaxy stellar and HI mass function and then compare with COS observations, to better understand their implications for galaxy formation. Previous simulations using a more standard wind model approaches reproduced many observed properties of galaxies and metal-line absorption, but our new wind implementation will allow us to tie empirical successes, and failures, more securely to the underlying wind physics, both the ejection (mass-loading factors and ejection speeds) and the interaction between the wind and gaseous halo, and allow us to identify absorption line features with specific physical processes.

26.- NAME: Ana-Roxana Pop

TITLE: On the formation and incidence of shell galaxies in the Illustris Simulation

ABSTRACT: Shells are low surface brightness tidal debris that form interleaved caustics on both sides of the galaxy center, with larger opening angles than in tidal streams. In this talk, I will give an account of the incidence and formation processes of shell galaxies in the Illustris simulation, a cosmological gravity+hydrodynamics simulation including a broad range of astrophysical processes for self-consistent galaxy formation and evolution. We select galaxies above a total mass of 5e12 Msun and visually identify shell structures at redshift zero using stellar mass surface density maps. We compile stellar history catalogs for all the stars in our selected shell galaxies, tracing the position, velocity, potential energy, and the galaxy to which each star is gravitationally bound at key moments in its lifetime (e.g., formation, accretion, stripping). In this way, we identify the individual stars and the progenitor galaxies responsible for forming the shells, and characterize each merger event through its mass ratio, trajectory, accretion and stripping times (as well as other kinematical and morphological properties of the infalling satellites). Out of the 273 galaxies in our sample, 15% exhibit shells. These are more frequent at the high mass end of the z=0 mass distribution of Illustris galaxies above 5e12 Msun. Our study indicates that shell galaxies observed at redshift zero form preferentially through high mass ratio merger events, with progenitors accreted on relatively radial orbits between 4 and 6 Gyrs ago. We also identify progenitors that lie in this preferred region of the parameter space but fail to produce shells due to the intrinsic complexity of a full cosmological simulation (e.g. because of multiple major mergers happening in quick succession). To conclude, I will discuss the possibility that other intrinsic properties of the progenitors (e.g., morphology and compactness) can influence shell formation, and I will show how the incidence of shell galaxies evolves with redshift.

27.- NAME: Benjamin Cook

TITLE: The Information Content of Stellar Halos: Accretion Histories and Stellar Population Gradients in Quiescent Illustris Galaxies

ABSTRACT: Long dynamical timescales in the outskirts of galaxies are thought to preserve the information content of their accretion histories, in the form of stellar population gradients. We present a detailed analysis of the stellar halo properties of a statistically representative sample of quiescent galaxies from the Illustris simulation, and show that stellar population gradients at large radii can indeed be used to infer galactic accretion histories. We measure metallicity, age, and surface-brightness profiles in the halos of Illustris galaxies ranging from 10^10 to 10^12 solar masses. We find that the ex-situ mass fraction – the fraction of stars that were accreted from smaller bodies – at large radius is correlated with the gradients of both metallicity and surface- brightness beyond 2 effective radii. There is a tight relation between the two gradients, suggesting that the information content of hierarchical accretion is predominantly the same between the two. The residuals from this mean

relation are correlated with the mass-weighted merger ratio, which implies that major and minor mergers leave slightly different signatures in the stellar populations of stellar halos.

28.- NAME: Michael Merrifield

TITLE: Dissecting Components in IFU Data

ABSTRACT: While everyone is now familiar with tools to decompose images into multiple components such as disks, bulges and halos, the equivalent techniques for spectral data cubes are still in their infancy. This is unfortunate, as integral field unit spectral surveys are now producing a mass of data in this format, which we are ill-prepared to process. We have therefore been developing several tools to separate out components using this full spectral data. The results of such analyses will prove invaluable in determining not only whether such decompositions have an astrophysical significance, but, where they do, also in determining the relationship between the various elements of a galaxy. Results for S0 galaxies are already showing that their disk components are systematically older than their spheroids, indicating that the latter are probably enhanced by a burst of chaotic star formation during the quenching process.

29.- NAME: Karl Glazebrook

TITLE: Angular momentum and galaxy outskirts

ABSTRACT: Angular momentum of galaxy halos is critical to our understanding of how galaxy disks form. A major recent triumph of disk simulations has in fact been getting the angular momentum budget and transport correct, resulting in disks large enough to agree with observations. Angular momentum though has been hard to measure observationally as most of it residing in the dim outskirts of galaxies > 2 effective radii. Recent results have finally been able to measure this component and have shown that angular momentum is a fundamental driver of (i) spiral disk size- mass-morphology scaling relations (ii) disk morphological evolution from z=2 to the present and (iii) the size and mass of large neutral hydrogen reservoirs outside the optically bright disks.

DAY 3 (15 March 2017):

30.- NAME: Carlos Frenk

TITLE: Invited Talk on cosmological hydrodynamical simulations of galaxy formation

ABSTRACT: I will present results from high resolution LCDM hydrodynamical simulations (part of the EAGLE project) on the assembly and structure of the baryonic components of halos. I will focus on the properties of the metal-poor halo, including the satellites (which hold the clue to the nature of the dark matter).

31.- NAME: Rhea-Silvia Remus

TITLE: A Universal Density Profile for the Outer Stellar Halos of Galaxies: Formation and Evolution

ABSTRACT: The outer stellar halo of a galaxy contains vital information about its specific formation history. To unveil some of the information encoded in those faint outer halo regions, I study the stellar outskirts of galaxies selected from a fully hydrodynamical high resolution cosmological simulation, called Magneticum. This simulation includes multiple sub-grid physics such as AGN and stellar feedback, metal cooling, stellar winds and an advanced model for star formation processes. I will show that the outer stellar halos of all galaxies, independent of their actual morphology, can be well described by an Einasto profile, where the three free parameters are closely correlated depending on the total mass of the galaxy. Furthermore, I will demonstrate that the curvature of the individual Einasto profiles is a good tracer of the merger history of the corresponding galaxy, and I will discuss how this is related to the radial distribution of accreted and in-situ formed stars. Finally, I will present a method to extract this information from the observations, providing means for a better comparison between simulations and observations.

32.- NAME: Klaus Dolag

TITLE: Distribution and Evolution of Metals in the Magneticum simulations

ABSTRACT: Metals are ideal tracers of the baryonic cycle within halos. Their composition is a fossil record connecting the evolution of the various stellar components of halos to the interaction with the environment by in- and outflows. The Magneticum simulations allows to study halos across a whide range of mass and environments, from massive galaxy cluster down to normal galaxies. It includes a detailed treatment of the chemo-energetic feedback from the stellar component and its evolution as well as feedback from the evolution of super massive black holes. Following the detailed evolution of various metal species and their relative composition due to continuous enrichment of the IGM and ICM by SNIa, SNII and AGB winds of the evolving stellar population reveals the complex interplay of local, star formation processes, mixing, global baryonic flows, continuous galaxcic evolution and environmental processes. I will report on our progress of understanding the importance of these different processes and its relation to the stellar component, especially in the outskirts of halos across a wide range of halo masses.

33.- NAME: Nicola C. Amorisco

TITLE: GC/stellar accreted haloes: different progenitors, different properties

ABSTRACT: Baryonic populations in the accreted halo are contributed hierarchically by destroyed satellite galaxies, a highly stochastic process which results in a significant halo-to-halo scatter. I will highlight how, apart from scatter, systematic differences in the properties of the accreted halo result from considering different tracer populations. Chiefly, stars and GCs are contributed by each progenitor in very different proportions per unit of accreted dark matter mass: recent studies suggest that the number of a galaxy's GCs is proportional to its virial mass. It follows that the importance of accretion events with low satellite-to-host virial-mass ratios (m/M) is much higher for the accreted GC population (~23.5% of the total for m/M<1/50 in a 10^13 Msun host galaxy) than what happens for the accreted stars (which are weighted by the much steeper stellar-to-halo mass relation, ~1.7%). I will use a suite of idealised minor merger simulations and a particle- tagging technique to explore how this systematic difference affects the properties of stellar and GC halo populations, with a particular eye to their kinematics. Progenitors with lower virial mass ratio are able to more efficiently retain their angular momentum and contribute material with a stronger rotational support, with lower values of the kurtosis. This could justify the apparent contradiction between the expectation that accreted populations have radially biased orbits (driven by the study of stellar haloes), and the recent observation of several GC systems whose kinematics suggests otherwise.

34.- NAME: Adriano Agnello

TITLE: Dissecting the halos of galaxies, over the last 7 billion years

ABSTRACT: I will present progress on two parallel projects, in collaboration between UCLA and ESO, to assess the baryonic structure and substructure in the halos of early-type galaxies using: Globular Clusters (GCs) and Planetary Nebulae for nearby massive ellipticals; and strong gravitational lensing for galaxies at z~1. Starting from a recap on the case of multiple GC populations in M87, I will then illustrate the chemo-dynamics of halo tracers in two well-studied systems, NGC5128 (Cen-A) and NGC1399, from a compilation of literature and new data, concentrating on different sources of systematics. The composition and inferred orbits of multiple GC halo components enables the characterization of the endpoints of massive galaxy formation. On the far end, when quasars are strongly lensed by galaxies, the baryonic density distribution in the lens can produce observable flux-ratio `anomalies' in the multiple quasar images. I will show how distinctive signatures are produced by dark or baryonic substructure and smooth structure (isophote shape variations, extended/faint disks), and their role in current observatinal samples. By bridging these two regimes, we can dissect the halos of massive galaxies as of ~7bn year ago, and reconstruct how they assembled down to the present day.

35.- NAME: Shea Garrison-Kimmel

TITLE: Not so lumpy after all: The inevitable depletion of dark matter subhalos by Milky Way-size galaxies

ABSTRACT: An apparently inescapable conclusion of the LCDM paradigm is that there should be large numbers of small, dark subhalos orbiting within the halo of the Milky Way. Current attempts to detect these systems have relied primarily upon careful observations of stellar streams, which may be disrupted by dark substructures passing nearby. Due to the mass resolution required to resolve these tiny subhalos in simulations, however, predictions for the subhalo mass function have primarily been derived from dark matter-only simulations, which neglect potentially important baryonic physics. I first show that the inclusion of hydrodynamics, including the FIRE prescriptions for star formation and feedback, results in roughly a 50% reduction in the number of subhalos within 100 kpc and a 90% reduction within 10 - 20 kpc, where searches via stellar streams are most sensitive. By inserting an analytic potential that is designed to match the galaxies that form naturally in the FIRE simulations into the dark matter-only runs, I then demonstrate that at least 75% of the substructure depletion can be unambiguously attributed solely to the gravitational effects of the central galaxy. The agreement between these "embedded disk" simulations and the fully hydrodynamical FIRE simulations further suggests that this technique therefore presents a path towards accurately modeling substructure depletion in collisionless simulations, thereby enabling statistical samples of ultra-high resolution, dark matter-only simulations with realistic subhalo populations.

36.- NAME: Claude-Andre Faucher-Giguere

TITLE: The Cosmic Baryon Cycle and Galaxy Halos in the FIRE Cosmological Simulations.

ABSTRACT: The FIRE ("Feedback In Realistic Environments") simulations resolve the interstellar medium of individual galaxies and explicitly model stellar feedback from radiation, stellar winds, and supernovae while self-consistently capturing the cosmological environment. We have shown that the FIRE simulations simultaneously reproduce a broad range of observed galaxy properties, including stellar masses, star formation histories, the Kennicutt-Schmidt law, mass-metallicity relations, and the neutral hydrogen content of galaxy halos. I will review key results from the FIRE simulations with a focus on their predictions for the cosmic baryon cycle: the properties of gaseous galaxy halos in hydrogen and metals at both z~0 and z=2-4, and a particle tracking analysis revealing the origin and fate of galactic baryons (including inflows, outflows, wind recycling, and in situ vs. ex situ star formation).

37.- NAME: Chervin Laporte

TITLE: The assembly and evolution of Brightest Cluster Galaxies as traced by their star light and globular clusters

ABSTRACT: I will present new results from the Phoenix project, a suite of high-resolution cosmological zoom-in N-body simulations of galaxy clusters from the Virgo Consortium in which I study the assembly of the Brightest Cluster Galaxies (BCGs) and their (red and blue) globular clusters. This work extends the models of Laporte et al. (2013) to include the evolution of GCs to study the origin of the high specific frequencies observed in BCGs. At z=2 dark matter halos are populated with stellar components (and associated globular clusters) following the scaling relations of z=2 galaxies and their subsequent evolution is followed to the present-day. This leads to a significant build up of the outer envelope of BCGs through accretion and stripping of galaxies consistent with the observed surface brightness profiles of real objects strongly suggesting a dissipationless merger scenario involving little star formation. I will show that the increase in specific frequency of GCs in BCG is orchestrated predominantly from the heavily stripped material of massive progenitor galaxies with surviving cores at the present-day that contribute significantly to the BCG stellar halo. The contribution of GCs from accreted dwarf galaxies does little to the increase in specific frequency of GCs within the inner 100 kpc of BCGs, however it becomes significant/dominant at larger radii. This is because the distribution of blue GCs from accreted dwarfs provide an almost constant number density background of GCs which overtakes that of GCs coming from more massive galaxies, offering a viable solution to the flattening of the GC number density profile of Coma observed in Peng et al. (2011) at large radii beyond 200 kpc. Many of these GCs contributed from dwarfs remain bound to their host, thus if a significant proportion of GCs at large radii (100> kpc) are found to be associated with faint dwarfs (e.g. through photometry given the recent discovery of UDGs or a large

spectroscopic surveys of GCs in clusters) this will be a smoking gun for the scenario presented here.

38.- NAME: Kathryn Johnston

TITLE: Invited Talk on Halo Substructure in Galaxy Halos

ABSTRACT: This talk will discuss work on two ongoing investigations on two novel aspects of halo substructure: the formation of halo substructure from stars born in galactic disks; and the dispersal of substructure due to dynamical chaos.

DAY 4 (16 March 2017):

39.- NAME: Roelof de Jong

TITLE: Invited talk on the GHOST survey

ABSTRACT: Invited talk on the GHOST survey

40.- NAME: Michelle Collins

TITLE: Using the nearby ultra diffuse galaxy, Andromeda XIX, to probe galaxy evolution at the lowest surface brightnesses

ABSTRACT: Over the past few years, a class of extremely low surface brightness galaxies have been detected in galaxy clusters. These ultra-diffuse galaxies (UDGs) have presented the community with quite a puzzle. Are they the low-surface brightness tail of typical dwarf galaxies? Are they failed LMCs, or even failed Milky Ways, that managed to build up their galactic halos without building a central disk or bulge? The first kinematics from long-slit spectroscopy and globular cluster tracers in these systems suggest they are dark matter dominated, but consensus as to their true nature has not been reached. In this talk, I will present findings from our in-depth study of a more extreme, local UDG; the enigmatic Andromeda XIX dwarf spheroidal. Our spectroscopic survey of 100 stars within this system and its environs allow us to shed light on the nature of UDGs, and comment on the likely formation scenarios of its more distant, less extreme, counterparts.

41.- NAME: Eric Bell

TITLE: Diverse stellar halos in nearby Milky Way mass galaxies, and what those halos tell us about the formation of galactic bulges

ABSTRACT: We have examined the resolved stellar populations at large galactocentric distances along the minor axes (from 10 kpc up to 50-75 kpc), with limited major axis coverage, of six nearby highly-inclined Milky Way-mass disc galaxies using HST data from the GHOSTS survey. We select red giant branch stars to derive stellar halo density profiles. The projected minor axis density profiles can be approximated by power laws with projected slopes of between -2 and -3.5, implying a diversity of stellar halo masses of 1-4e9 M_sun, or 2-8% of the total galaxy stellar masses. The typical intrinsic scatter around a smooth power law fit is ~0.06 dex owing to substructure. By comparing the minor and major axis profiles, we infer projected axis ratios at ~25 kpc between 0.4-0.75. The GHOSTS stellar haloes are diverse, lying between the extremes charted out by the (rather atypical) haloes of the Milky Way and M31. We find a strong correlation between the stellar halo metallicities and the stellar halo masses. We compare our results with cosmological models of stellar halo formation, finding good agreement between our observations and accretion-only models where the stellar haloes are formed by the disruption of dwarf satellites. In particular, the strong observed correlation between stellar halo metallicity and mass is naturally reproduced by virtue of the fact that the most massive satellites that deliver the bulk of the stellar halo's mass also dominate the measured stellar halo metallicity. We can use these stellar halo properties as a tool to measure galactic merger history, as mergers with larger satellites produce more massive, higher metallicity stellar halos. We focus in particular on examining the role of merging (major or minor mergers) in driving the formation of galactic bulges. We find an order of magnitude range in bulge to total ratio and bulge mass, and two orders of magnitude in black hole mass, at a given stellar halo mass (or, equivalently,

merger history). Galaxies with low mass bulges show a relatively wide range of quiet merger histories, implying formation mechanisms that do not require intense merging activity. The five galaxies with massive `classical' bulges and central black holes also show a wide range of merger histories. Three galaxies with massive bulges have massive stellar halos consistent with a star-rich minor or major merger bulge origin. Surprisingly, two galaxies with massive bulges have lower mass stellar halos implying a quiet accretion history — merging appears to have had no role in making these massive `classical' bulges. These galaxies may be ideal laboratories to study massive bulge formation through pathways such as early gas-rich accretion, violent disk instabilities or misaligned infall of gas throughout cosmic time.

42.- NAME: Ericson López

TITLE: Inferring magnetic fields in halos of external galaxies

ABSTRACT: From observations of a sample of nearby galaxies (e.g. NGC 2146, NGC 2403, NGC 2841, NGC 2903), magnetic field strengths are inferred in their halos. Most of the studied sources are spiral galaxies and are located within a ~14 Mpc radius. We use CO(2-1) emission maps to derive several physical parameters of the halos such as density, mass and temperature, among others, which are used in turn to estimate the magnetic field strengths. The inferred magnetic fields are compared with those found in the central regions of the galaxies. Mechanisms responsible for the generation of magnetic fields in the halos are also discussed.

43.- NAME: Evan Skillman

TITLE: Do Dwarf Galaxies Have Halos?

ABSTRACT: Hubble Space Telescope observations of resolved stars in nearby galaxies have allowed us to trace the star formation histories and chemical evolution in a significant number of Local Group dwarf galaxies of various morphological types. These galaxies universally shown both age gradients and chemical abundance gradients. I will discuss the evidence for and against the formation of halos in dwarf galaxies as a specific dynamical process or at a specific epoch.

44.- NAME: Soeren Larsen

TITLE: Globular Clusters and the Halos of Dwarf Galaxies

ABSTRACT: Over the past years, key constraints on globular cluster disruption have emerged from studies of clusters in dwarf galaxies. This has important implications for scenarios that invoke heavy cluster mass loss to account for the large fractions of enriched "second-generation" stars in GCs, as well as for globular cluster disruption and its contribution to the field star populations in halos in general. However, our knowledge of multiple populations within individual clusters inevitably remains less complete in external galaxies than in the Milky Way, a problem that becomes more acute in more distant galaxies where individual stars can no longer be studied in detail. I will discuss our efforts towards detailed chemical abundance analysis from integrated-light observations of globular clusters in Local Group dwarf galaxies and beyond, with particular emphasis on the prospects for detecting the signatures of multiple populations. This type of measurement may ultimately make it possible to search for multiple populations in young “super star clusters” such as those encountered in large numbers in starburst galaxies.

45.- NAME: David Sand

TITLE: Finding Unresolved Dwarfs, both Hosted and in the Field

ABSTRACT: Over the last decade, wide-field surveys have revolutionized our view of the Local Group, with dozens of new streams and satellite galaxies now amenable to study. However, to verify that our understanding of galaxy formation is correct, we must measure the faint satellite and stellar stream content of a variety of galaxies, across morphologies and environments. This has not been accomplished yet. Here I'll talk about several programs to move Near Field Cosmology beyond the Local Group, with a focus on finding unresolved, diffuse dwarf galaxies in wide field surveys. First I will discuss a search for dwarf galaxy counterparts to the recently discovered ultra compact high

velocity HI clouds in order to find isolated, star-forming dwarfs in the Local Volume. Following this, I will present a search for faint and diffuse dwarfs in wide-field public imaging surveys, such as the CFHTLS and DES. As a showcase for our technique, I will present results from a search for dwarfs around M101 using CHFTLS data where we have uncovered 15 new dwarf galaxy candidates (with incoming HST data), and have uncovered dwarfs
~2 mag fainter than previous work.

46.- NAME: Jairo Armijos

TITLE: Constraining galactic halo mass

ABSTRACT: We estimate the halo mass of a sample of galaxies using observations taken with the HERSCHEL space telescope. NGC 2146, NGC 2403, NGC 2841, NGC 2903 and other galaxies are included in our work. Most of the studied sources are spiral galaxies and are located within ~14 Mpc. Measurements of fluxes are used in the estimates of the galactic halo mass. For the studied galaxies, the mass of the halo and those of their central regions are compared, as well as with the expected values due to the consideration of the dark matter and with those obtained by following other approaches.

47.- NAME: Kristine Spekkens

TITLE: Dwarf galaxy gas as a baryonic halo probe: current constraints and future prospects

ABSTRACT: By virtue of its sensitivity to ram pressure and near-ubiquity in the field, atomic gas in dwarf galaxies is a key probe of the baryonic halos of nearby massive parents. Meaningful searches for gas reservoirs in the faintest optically detected satellites of Local Volume galaxies are within the reach of current radio telescopes, while blind surveys with SKA precursor facilities set to begin in 2017 will revolutionize the field. I will discuss how the atomic gas content of a galaxy's satellite population constrains its hot corona using deep observations of the Local Group and the nearby dwarf spiral NGC 3109 as specific examples. I will then report on how the distribution of diffuse gas as a function of halo mass throughout the Local Volume will be constrained with upcoming widefield SKA precursor surveys.

48.- NAME: Aaron Romanowsky

TITLE: Invited Talk on discrete chemodynamical tracers and X-rays in galaxy halos

ABSTRACT: I will discuss the use of discrete chemodynamical tracers — planetary nebulae, globular clusters, and other satellites — for tracing the assembly histories and mass distributions of galaxy halos. These include both equilibrium dynamical models and the dynamics of transient substructures. I will also discuss the relation between X-ray gas properties and dynamical mass.

49.- NAME: Michael Hilker

TITLE: The assembly of stellar halos around nearby central cluster galaxies

ABSTRACT: Central cluster galaxies are surrounded by extended stellar halos and host systems of thousands of globular clusters (GCs) out to several tens of effective radii. Halo stars and GCs are ideal probes to trace the assembly history of the diffuse and extended stellar halos residing in the cores of galaxy clusters. Colors and spectral line indices can be used to identify and characterize sub-populations of metal-poor and metal-rich stellar populations as well as the contribution of young stars and GCs. Together with kinematic information one can reconstruct the assembly history of different halo components. I will present new results on the kinematics and stellar population properties of the stellar light and GCs around the nearby Fornax, Hydra I and Centaurus clusters. In Fornax, our analysis is based on VST/OmegaCAM, VISTA/VIRCAM and DECam and photometry as well as VIMOS and FORS2 spectroscopy of a large sample of GCs around NGC 1399. In Hydra I and Centaurus, we collected U- to K-band photometry to constrain the ages and metallicities of GCs around the central galaxies. FORS2 and MUSE spectra were used to analyse the kinematics and stellar populations of the stellar halo component around NGC 3311, the central Hydra I cluster galaxy. In all three clusters, we see several evidences for an ongoing assembly of the stellar halos around the

central galaxies.

50.- NAME: Joef Pfeffer

TITLE: An end-to-end understanding of the origin of globular clusters: from their high-redshift origin to present-day galaxy haloes

ABSTRACT: Globular clusters presently reside in the silent waters of galaxy haloes, but they formed under the extreme conditions seen in high-redshift galaxies. I will discuss the current evidence that the high-pressure formation environment of globular clusters shaped a wide range of their present-day properties. These insights are combined in the first end-to-end model for globular cluster formation, which connects our current understanding of (1) star and cluster formation in the high-pressure interstellar medium of high-redshift galaxies, (2) cluster disruption by tidal shocks in the gas-rich host galaxy disc, (3) cluster migration into the galaxy halo, and (4) the final evaporation-dominated evolution of globular clusters until the present day. I will conclude by presenting the E-MOSAICS project, in which we carry out fully self-consistent, cosmological zoom-in hydrodynamics simulations of the co-formation and evolution of globular clusters and galaxies. These models represent the first step in finally fulfilling the decades-old promise of using globular clusters as tracers of the formation and evolution of galaxies and galaxy haloes.

51.- NAME: Lilia Bassino

TITLE: Disentangling the evolutionary history of galaxies through non-standard properties of their globular cluster systems

ABSTRACT: Hints on the evolutionary history of galaxies can be obtained from globular cluster (GC) systems whose properties depart from those considered as "standard" ones. For instance, GC color distributions that show three sub-populations instead of just two (i.e. regular old metal-poor and metal-rich GCs). On the one hand, the sub-population of "intermediate" color may be younger clusters that originated during a recent merger like in NGC 4753 (Caso et al. 2015), where the presence of two type Ia SNe reinforces such scenario. On the other hand, it can be interpreted as the signature of a quite old starburst like in NGC 7507 (Caso et al. 2013), where no signs of a merger are identifiable. We have recently performed a new analysis of NGC 3610 and its GC system, based on GMOS/GEMINI data, which is the first wide-field study of this system (Bassino et al. 2016). This galaxy is considered as a prototype of an intermediate-age merger remnant. We detect an extended disk in the galaxy outskirts, where a rich fine structure (shells, plumes, etc.) is also present at a very low surface-brightness level. The cluster population that seems to be associated to this outer component has "intermediate" colors. Thus, the outer disk as well as the fine structure and the atypical clusters, may have originated in the disk-disk merger that produced the remnant.

52.- NAME: William Harris

TITLE: Beyond Bimodaility: Globular Cluster Systems in the Biggest Galaxies

ABSTRACT: Brightest Cluster Galaxies (BCGs) hold tens of thousands of globular clusters. New photometry in (g-I) with the HST cameras shows that the metallicity distribution function of the GCs can still be formally deconstructed with the standard 'bimodal Gaussian' paradigm, but the internal dispersions of the blue and red modes becomes so large and overlapped that the total MDF is more of a broad continuum. Our results show strong differences in the spatial distributions of the GCs versus metallicity: the metal-rich clusters closely mimic the halo light distribution while the metal-poor ones follow a much shallower, near-isothermal form. These metallicity extremes formed at very different stages in the hierarchical merging process and with very different efficiencies.

53.- NAME: Jeremy Bailin

TITLE: The Link Between Globular Cluster Systems and Clumpy Star Formation

ABSTRACT: Globular cluster (GC) systems are a major component of the baryonic halos of massive galaxies, and GC metallicities, presumed to trace the metallicities of their primordial gas clouds, are often used as indicators of galactic history. However, a number of recent observations suggest that

elemental abundances are heavily influenced by self-enrichment within the cluster. I present a new model of GC formation in which cluster star formation occurs in clumps, as observed in present star formation regions, and the consequences for the elemental abundances in individual GCs, and in GC systems more broadly.

54.- NAME: Ana Chies Santos

TITLE: From the Milky Way to the distant Universe: Star Clusters in JPAS and JPLUS

ABSTRACT: Globular clusters (GCs) are important discrete tracers of galaxy assembly as they are survivors of epochs of violent star formation events. In the Milky Way, until very recently GCs were considered as prototype simple stellar populations. However, several observational studies, indicate the presence of multiple stellar populations that manifest themselves as splits in sequences in colour magnitude diagrams or have different abundances. In this talk I will present the efforts that are being carried out to shed light on GC evolution both in the Milky Way and in more distant galaxies within the brazilian-spanish collaborations JPLUS and JPAS. With12-59 broad/narrow-band filters, and very large fields-of-view, these surveys will produced unprecedented homogenous datasets that will map a significant sample of Milky Way GCs out to a very large radius and produce important and homogenous extragalactic GC systems catalogues.

55.- NAME: Michael Hudson

TITLE: The dark matter halo-star-globular cluster connections

ABSTRACT: Weak gravitational lensing measurements have given us the clearest way to map the connection between the stellar content of galaxies and their dark matter halos. I will review recent results from CFHTLenS and other surveys on the co-evolution of dark matter halos and the stellar component of galaxies as a function of cosmic time. I will also present recent results linking galaxy sizes to their host halo properties. I will conclude by presenting recent, updated evidence for a strong physical link between globular cluster systems and their host dark matter halos.

DAY 5 (17 March 2017):

56.- NAME: Marina Rejkuba

TITLE: Invited Talk on Resolved stellar halos of nearby galaxies

ABSTRACT: Observations of low surface brightness extended stellar envelopes around galaxies have been difficult due to their large extent and faint magnitudes, and therefore until recently limited mostly to the Milky Way and our nearest neighbor, the M31. Thanks to deep pencil beam observations with the HST as well as wide field cameras on large ground based telescopes, we can detect halos in early and late-type galaxies out to distance of ~10 Mpc. The halo physical properties, such as stellar density profiles, metallicity gradients, amount of substructure and shape of stellar halos are relics of their host galaxy formation and assembly history. With increasing samples, the questions such as the ubiquity of stellar halos, their shapes, and extent can start to be addressed. This field is fast evolving and I will summarize some of the results from imaging studies of galaxies beyond the Local Group.

57.- NAME: Raja GuhaThakurta

TITLE: The Stellar Halos of the Milky Way, Andromeda and other galaxies in the Local Volume

ABSTRACT: I will present some recent results from the following surveys: – HALO7D: This survey of distant (D ~ 20–100 kpc) Milky Way halo main sequence turnoff stars relies on HST-based proper motions and radial velocities and chemical abundances from ultra-deep (8–32 hour) Keck DEIMOS spectroscopy. – SPLASH: This survey relies on Keck DEIMOS spectroscopy and a variety of wide-field ground-based images to study individual red giant stars in the halo of M31 out to a projected radius of ~200 kpc. Recent measurements include the surface brightness profile, metallicity profile, and velocity dispersion profile. – PISCeS: This survey uses Magellan/MegaCam to carry out a wide-field

imaging and star counts study of the outer halos of galaxies in the Local Volume (e.g., NGC 253 in the Sculptor group, Centaurus A). It is complemented by a new coadded SBF spectroscopy technique using the Keck telescope and DEIMOS spectrograph.

58.- NAME: Karoline Gilbert

TITLE: Kinematics and Chemical Abundances Throughout the Stellar Halo of Andromeda

ABSTRACT: Large surveys of the resolved stellar populations of Andromeda have revolutionized our view of this galaxy over the past decade. The combination of large-scale, contiguous photometric surveys and pointed spectroscopic surveys has been particularly powerful for discovering substructure and disentangling Andromeda's structural components. The SPLASH survey consists of imaging and spectroscopy of stars in lines of sight from 2 kpc to more than 200 kpc from Andromeda's center. I will present recent analyses of the kinematics of Andromeda's stellar halo, including evidence of a population of heated disk stars in Andromeda's inner halo and a measurement of the velocity dispersion of the halo as a function of radius. I will also present new measurements of the iron and alpha element abundances of stars in Andromeda's halo. Finally, I will discuss the potential of large spectroscopic stellar surveys for disentangling the formation history of stellar halos throughout the nearby universe.

59.- NAME: Denija Crnojevic

TITLE: Resolving the extended stellar halos of nearby galaxies: the wide-field PISCeS survey

ABSTRACT: I will present results from the wide-field Panoramic Imaging Survey of Centaurus and Sculptor (PISCeS): we investigate the resolved stellar halos of two nearby galaxies (the spiral NGC253 and the elliptical Centaurus A, D~3.7 Mpc) out to a galactocentric radius of 150 kpc with Magellan/Megacam. The survey to date led to the discovery of 11 confirmed faint satellites and stunning streams/substructures in two environments substantially different from the Local Group, i.e. the loose Sculptor group of galaxies and the Centaurus A group dominated by an elliptical. The newly discovered satellites and substructures, with surface brightness limits as low as ~32 mag/arcsec^2, are then followed-up with HST imaging and Keck spectroscopy to investigate their stellar populations. These discoveries clearly testify the past and ongoing accretion processes shaping the halos of these nearby galaxies, and provide the first complete census of their satellite systems down to an unprecedented M_V<-8. This survey pushes the limits of near-field cosmology beyond the Local Group, and enables a comparison of external galaxies' resolved halos to the M31 wide-field PAndAS survey. The detailed characterization of the stellar content, shape and gradients in the extended halos of NGC253, Centaurus A and in their satellites represent crucial constraints to theoretical models of galaxy formation and evolution.

60.- NAME: Carl Grillmair

TITLE: Debris Streams in the Milky Way Halo

ABSTRACT: We review the current census of halo debris streams detected in the Sloan and Pan-STARRS surveys.

61.- NAME: Alyson Ford

TITLE: The Search for Extended HI Emission around Spiral Galaxies

ABSTRACT: Recent UV absorption line studies suggest that a large fraction of missing baryons are in the warm ionized and neutral phases, with about half of Milky Way-mass galaxies containing absorption systems with HI column densities of 10^18 cm-2 or greater. While previously difficult to detect, this faint HI emission can be probed using the Green Bank Telescope (GBT) due to the telescope's large collecting area and clean beam. Results from deep GBT observations of ten nearby optically luminous spirals, in which we detect faint HI emission in half of our targets (sensitive to 10^18 cm-2), will be presented. These include the extent of HI gas located 100 kpc from the centers of these galaxies, their significance regarding missing baryons, and current follow-up projects.

62.- NAME: Emily Cunningham

TITLE: HALO7D: Disentangling the Milky Way Accretion History with Observations in 7 Dimensions

ABSTRACT: The Milky Way (MW) is shrouded in a faint metal-poor stellar halo. Its structure and kinematics provide a unique archaeological record of the MW's formation, past evolution, and accretion history. These data also help us constrain the dark matter mass out to large radii (50 to 100 kpc). However, studies of the MW stellar halo are hindered by observational constraints. Beyond D~10 kpc, our knowledge of the MW halo is limited to line of sight velocities and rare tracer populations (blue horizontal branch and red giant branch stars). We aim to address these limitations using highly accurate HST-measured proper motions and very deep (8-24 hour integrations) Keck DEIMOS spectroscopy of MW main sequence turn-off stars in the CANDELS fields. By combining these two datasets, we can obtain 6D phase-space information plus chemical abundances (7 "Dimensions") for our halo stars. This survey, which will be unique even in the era of Gaia, will vastly improve our understanding of the Milky Way structure, evolution and mass in a way that neither the HST proper motions nor Keck spectroscopy can do on their own.

63.- NAME: Jorge Penarrubia

TITLE: Re-constructing LMC pertubations to the Galactic potential with tidal streams

ABSTRACT: Although the Large Magellanic Cloud (LMC) is the brightest satellite galaxy of the Milky Way its mass remains largely unconstrained. A number of recent contributions suggest that the LMC may be falling into our Galaxy for the first time embedded in a massive dark matter halo. In this talk I will show the effects of the LMC infall on the orbits of cold stellar streams orbiting in the stellar halo of the Milky Way, and how this may affect the Galactic potential inferred from the dynamical modelling of these systems. In addition, I will introduce a non-parametric statistical technique that is able to re-construct the combined Milky Way-LMC potential without a priori assumptions about the time-evolution of the tidal stream orbits.

64.- NAME: Robyn Sanderson

TITLE: Better Galactic mass models through chemistry

ABSTRACT: With the upcoming release of the Gaia catalog and the many multiplexed spectroscopic surveys on the horizon, we are rapidly moving into a new data-driven era in the study of the Milky Way's stellar halo. When combined, these data sets will give us a many- dimensional view of stars in accreted structures in the halo that includes both dynamical information about their orbits and chemical information about their formation histories. Using simulated data from the state-of-the-art Latte simulations of Milky-Way-like galaxies, which include hydrodynamics, feedback, and chemical evolution in a cosmological setting, I demonstrate that while dynamical information alone can be used to constrain models of the Galactic mass distribution in the halo, including the extra dimensions provided by chemical abundances can improve these constraints as well as assist in untangling different accreted components.

65.- NAME: Kyle Oman

TITLE: What are the `building blocks` of the Milky Way and M31 stellar halos?

ABSTRACT: The APOSTLE simulations are a suite of high resolution cosmological hydrodynamical simulations of regions selected to resemble the Milky Way + Andromeda galaxy pair, and surrounding environment. I will present the properties of stellar halos of APOSTLE galaxies including age and metallicity gradients, the age-metallicity relation and the origins (accretion, in- situ formation, disc ejection) of the stellar populations present in the halos. I will also discuss which ensemble of accreted objects - the so-called `building blocks` of the stellar halo - are consistent with the observed haloes of the Milky Way and Andromeda, and whether close analogues of these building blocks survive as observationally accessible dwarf galaxies in the field.

66.- NAME: Dante Minniti

TITLE: A new dwarf spheroidal galaxy satellite

ABSTRACT: A concentration of field RRLyrae type ab stars discloses the presence of a new dwarf galaxy satellite of our the Milky Way. RR Lyrae stars are excellent distance indicators, and they allow us to measure the distance and to estimate the metallicity of the new galaxy. The presence of this dwarf galaxy is also confirmed by the near IR color magnitude diagrams. The color- magnitude diagram is consistent with that of a dwarf spheroidal galaxy. Even though some dwarf spheroidal galaxies have composite populations, all the well studied dwarf spheroidal satellites of the Milky Way contain old stars. The absence of gas also indicates a dwarf spheroidal type. The total galaxy luminosity is also estimated and compared with similar objects. The possible orbit and survival would also be discussed. This discovery has implications for the completeness of the satellite dwarf system, and the LSST strategy for completing the dwarf galaxy census will be discussed. Dwarf spheroidal galaxies appear to be the most dark matter dominated galaxies in the Universe, and this new dwarf spheroidal galaxy may have implications for the detection of dark matter using high energy telescopes.

67.- NAME: Sarah Pearson

TITLE: Holes in the Pal 5 Stream Caused by the Galactic Bar

ABSTRACT: Recent Pan-STARRS data show that the stellar stream emerging from the Milky Way globular cluster Palomar 5 (Pal 5) is asymmetric: the leading tail appears shorter than the trailing tail. However, all previous simulations of the dynamical evolution of Pal 5 predict leading and trailing tails of similar angular extents at Pal 5's present day position. In this talk, I will present recent results demonstrating that including the Milky Way's rotating Galactic bar in the dynamical modeling of Pal 5 can lead to tail asymmetries similar to those seen in the current observational footprint of the stream. In particular, as the bar sweeps by parts of the Pal 5 stream as each star reaches its orbital pericenter (~8 kpc from the Galactic center), some stream stars experience an asymmetric net torque, which can lead to the formation of large holes along Pal 5's tidal tails. The fact that the Galactic bar can cause holes to form in streams has important consequences for using holes in streams as indirect dark matter sub halo detections. We conclude that only streams orbiting far from the Galactic center or streams on retrograde orbits (with respect to the disk/bar) can be used to unambiguously constrain dark matter subhalo interactions. Additionally, reproducing the Pan-STARRS data for Pal 5 provides a promising method to constraining the pattern speed of the bar given Pal 5's orbit as the size and location of the holes depends strongly on the bar parameters. We predict that the Pal 5 leading arm debris should re-appear south of the Pan-STARRS data cutoff which can be investigated with future data.

68.- NAME: Nicolas Martin

TITLE: In-situ characterization of the stellar halo of M31 and direct comparison with the Aquarius stellar halos

ABSTRACT: I will present the properties of the stellar halo of the Andromeda galaxy as extracted from PAndAS, a deep photometric survey of the whole region within 150 kpc of this large spiral galaxy. Stemming from a forward modeling of the distribution of the spatial and color-magnitude information of the 10 million potential M31 stars in PAndAS, this study provides the most in-depth view of a stellar halo, down to surface brightnesses of ~36 mag/arcsec^2. In addition, I will present a direct and *quantitative* comparison of these observations with "observations" of the stellar halos of the Aquarius simulations, processed in exactly the same way. Although observations and simulations show broad agreement, there are significant differences between the two, which I will highlight during my talk.

69.- NAME: Dougal Mackey

TITLE: Tracing halo substructures in M31 and the Milky Way with globular clusters

ABSTRACT: Recent wide-field surveys of the M31 stellar halo (e.g., PAndAS) have revealed prolific substructure and a well-populated globular cluster system extending to very large galactocentric radii. There is strong evidence that many of the globular clusters are physically associated with the streams

and overdensities seen in the field (e.g., Mackey et al. 2010; Veljanoski et al. 2014). These objects thus provide a means of probing the properties and orbits of the now-defunct stream progenitors - quantities that are otherwise inaccessible due to the extreme faintness of the diffuse substructures. I will report on new results from an extensive program of Hubble Telescope observations designed to (i) quantify the global properties of accreted globular clusters in the M31 system, and (ii) trace the 3-dimensional loci of several narrow stellar streams in the M31 halo. In addition I will present several recent discoveries from a new DECam survey of the outer regions of remote Milky Way globular clusters, which is aimed at revealing the remnants of accreted dwarf galaxies in the poorly-explored outer Galactic halo. Our observations have uncovered tidal tails emanating from globular clusters residing up to ~100 kpc from the Galactic centre, as well as extended stellar envelopes surrounding several of the most massive clusters in the halo (e.g., Kuzma et al. 2016).

II) POSTER PRESENTATIONS

Posters (A0, portrait format) will be displayed every day.

71.- NAME: Karla Alamo-Martinez

TITLE: Specific frequencies of individual galaxies in Abell 1689

ABSTRACT: Abell 1689 is one of the most massive galaxy clusters with a very high galactic density in its core. We present the decomposition of the light for the 78 brightest cluster galaxies, and the individual globular cluster population for the brightest 30 galaxies. We estimate the specific frequencies, and together with the best Sersic parameters and galactocentric position we look for environmental dependencies. We discuss the aforementioned properties including kinematic information obtained from the literature for 27 galaxies. We also estimate the number of globular clusters that are not associated to individual galaxies (i.e., do not belong to a Sersic distribution) but that are bound to the galaxy cluster potential well.

73.- NAME: Juan Pablo Caso

TITLE: Revisiting The Globular Cluster Systems Of NGC 3258 And NGC3268

ABSTRACT: A new photometric study of the two giant ellipticals NGC 3258 and NGC 3268 in the Antlia cluster has been carried out, focusing on their globular cluster systems (GCS). Both galaxies present similar stellar and halo masses, besides large GCS, which might imply a rich accretion history based on the current scenarios for globular clusters (GCs) formation. For both galaxies, the color distribution for blue GCs seems to get bluer at larger radii, in agreement with the two-phases GCS formation scenario proposed by D. Forbes. Despite the apparent proximity between NGC 3258 and NGC 3268, the composition of their GCS indicates different formation histories. For a reduced sample of NGC 3258 GCs, we perform a multi-color study spanning from filters B to z', obtaining photometric metallicities for a large number of clusters. Under the assumption that they are old stellar populations, our results point to a real metallicity bimodality behind the color bimodality and a radial gradient, as metal-rich GCs tend to be more concentrated towards the galaxy than metal-poor ones.

74.- NAME: Kyungwon Chun

TITLE: Cosmological origin of satellite stellar systems around a dwarf galaxy

ABSTRACT: We aim to investigate cosmological origin of satellite stellar systems around an isolated dwarf galaxy in the Lambda-Cold Dark Matter model. For this, we modify a cosmological hydrodynamic code, GADGET-3, in a way that includes gas cooling down to T~10 K, gas heating by universal reionization, UV shielding for high density regions of nshield > 0.014 cm^{-3}, star formation in the dense regions (nH > 100 cm^{-3}), and also mass, energy, and metal feedback by supernova explosion. In order to get good statistics, we perform three different zoom simulations whose target galaxy mass is ~10^10 Msun. Each initial zoom simulation covers a cubic box of 1Mpc/h^3 with 17 million particles. Particle mass for dark matter (DM) and gas components is M_DM = 4.1×10^3 Msun and M_gas = 7.9×10^2 Msun, respectively, and thus each satellite system is resolved with more than hundreds – thousands of particles. We trace satellite systems that had formed in a mini dark matter halo outside of the host galaxy but later merged with the host galaxy. The

analysis of satellite systems indicates that their properties are mainly determined by the environment that they have passed through until fall into the host galaxy.

75.- NAME: Gwendolyn Eadie

TITLE: The Milky Way Galaxy: Inferring The Dark Matter from the Light.

ABSTRACT: The Galaxy's mass is dominated by its dark matter halo, but the value of this mass is poorly constrained. The underlying reason for this is that there are serious challenges associated with using the motions of tracers like globular clusters or halo stars to deduce the mass profile; the 3D velocity measurements are often incomplete and uncertain, and few of the tracers are at large distances from the Galactic center. I will explain a hierarchical Bayesian method we have developed to help deal with these challenges, discuss its advantages and how it will be used with Gaia data, and show our latest results for the mass of the Milky Way. Unlike all previous attempted derivations of the Milky Way mass profile, our method makes maximal use of all available velocity and proper-motion data (both complete and incomplete). With suitable simplifications, it can be used for any other galaxy.

76.- NAME: Allan Ernest

TITLE: Can baryonic halos form early in cosmic history?

ABSTRACT: Observational evidence points to the formation of super-massive black holes and galactic halos much earlier in cosmic history than expected (1). However, if photon scattering cross sections were less, it becomes possible for baryonic halos to form at earlier times, and relax tensions that exist with Lambda Cold Dark Matter (LCDM) theory. Furthermore, recent quantum calculations (2-5) have shown that photon-baryon interaction cross sections in deep gravity wells can indeed be significantly less than those theoretically calculated for traditional localized particles. If reduced baryon-photon interaction cross sections are combined with Carr's prediction (6) of the formation of black holes by direct collapse of over-density regions during phase transitions in the primordial universe, it becomes possible to formulate a scenario in which baryonic halos form very early in cosmic history. Carr's primordial black hole mass spectrum formulation, calculated for the last phase transition (t = 1 s), leads to an order-of-magnitude, supermassive primordial black hole (SMPBH) number density consistent with that of present day galaxy number densities, suggesting these as the origin of galactic centre black holes. Such early formed SMPBHs, combined with reduced baryon-photon oscillation, provide wells of sufficient depth to enable baryonic halos (and ultimately their descendent galaxies) to form much earlier in cosmic history, yet potentially maintain consistency with cosmic microwave background observations and primordial nucleosynthesis. In addition, this scenario enables an understanding of the black hole-bulge/black hole-dark halo relations, provides a unified model relating globular clusters, dwarf spheroidal galaxies and bulges, and enables prediction of the dark to visible matter ratio based on the physical parameters of a halo. The physics of reduced cross sections in deep gravity wells and the scenario of early halo formation will be presented and discussed. (1) Xue- Bing Wu et al, (2015). Nature, 518,512-515 doi: 10.1038/nature14241 (2) Ernest, A. D., 2006, in Proceedings of the EPS-13 Conference, Eds: A.M. Cruise, L. Ouwehand. ESA-SP 637 (3) Ernest A. D., 2009, J. Phys. A: Math. Theor. 42 115207, 115208 (4) Ernest A. D, 2012, in Advances in Quantum Theory, Ion I. Cotaescu, Ed. ISBN: 978-953-51-0087-4, InTech, Rijeka., 221-248 (5) Ernest A. D., and Collins, M.P., 2015, Proceedings of the International Astronomical Union, 11, pp 298-299. doi:10.1017/S1743921315006894 (6) Carr B. J., 1975. ApJ., 201, pp. 1-19. doi: 10.1086/153853

77.- NAME: Carlos Escudero

TITLE: One Piece at a Time

ABSTRACT: One of the biggest challenges that still persists in astronomy today is to understand how galaxies that we observe today were formed. In this regard, it has been recognized the importance of globular clusters (GC) as tracers of the first formation stages of early type galaxies, and also as a useful tool to obtain information on different epochs, regions and physical processes, that would otherwise be impossible. In this study we focus on the analysis of the GC systems associated with lenticular galaxies (S0) located in low density environments, such as groups and/or the field, with the aim to obtain information on the assembly and subsequent evolution of these objects. Through the use of excellent photometric data obtained with Gemini/GMOS, we compared the predictions of different models of galaxy formation with observational data, some of which have been studied for the first time, showing unique features.

78.- NAME: Ginevra Favole et al.

TITLE: Modeling the galaxy halo occupation distribution of Hα emitters in new- generation spectroscopic surveys

ABSTRACT: Among star-forming galaxies there is a particular population whose optical spectra exhibit strong nebular emission lines. These galaxies will be the preferred targets of new-generation spectroscopic surveys as Euclid, the Dark Energy Spectroscopic Instrument, the 4-metre Multi-Object Spectroscopic Telescope, and the Subaru Prime Focus Spectrograph. All these surveys will observe [OII] and Hα emission-line galaxies up to redshift z~2 to trace star formation and to measure the baryon acoustic oscillations as standard ruler for distances, in the attempt to unveil the nature of dark energy and probe the large scale structure of the Universe. Therefore, it is crucial to understand how to measure and precisely model the clustering properties of such galaxies and how they form, evolve and distribute within their dark matter halos. We address these issues using state-of-the-art data and large-volume high-resolution cosmological simulations to prepare the clustering prospects for the new generation of optical and near-IR experiments.

79.- NAME: Favio Faifer

TITLE: The Brazil-Argentina Gemini Group of globular Cluster systems (BAGGS): FLAMINGOS-2 and GMOS data for NGC1395

ABSTRACT: We present preliminary results of the analysis of Flamingos-2 and GMOS-S observations of the globular cluster (GC) system of the elliptical galaxy NGC1395. This is the first study of a long term Brazilian-Argentinian collaboration (BAGGS) for the study of GC systems in early type galaxies. We obtained deep and high quality NIR photometric data in two different photometric bands (J and Ks) which were combined with high quality optical photometry from previous GEMINI-GMOS runs. This allowed us to obtain different color indices less sensitive to the effect of HB stars, for several hundreds of GC candidates, and to test the presence of bimodality in different color-magnitude diagrams.

80.- NAME: Michael Fellhauer

TITLE: Tidal Tails and their overdensities as tracers for the halo potential

ABSTRACT: We are performing an extensive study of tidal tail formation in cored and cusped haloes. We analyse the length of tidal tails as well as the locations and sizes of overdensities, forming due to the epicyclic motion of escaped stars, and connect these quantities with the underlying DM halo potential. We will present the results obtained so far of this ongoing study. We compare with recent analytical work and show which description can be confirmed with our simulations.

83.- NAME: Doug Geisler

TITLE: Exploring the Formation and Evolution of the SMC: Field Stars vs. Star Clusters

ABSTRACT: We present results based on VLT Ca Triplet (CaT) medium resolution spectroscopy of some 200 red giant members of 29 SMC intermediate - old age clusters. We derive mean cluster velocities to a few km/s and mean metallicities to 0.05 dex. We also derive accurate velocities and metallicities for about 750 surrounding field giants. We investigate the metallicity distribution, age-metallicity relation and metallicity gradient in great detail for the SMC using this large and homogeneous database. We find a number of interesting results and some surprising differences between the clusters and fields. The clusters display a likely bimodal metallicity distribution while the field stars are unimodal. The clusters show no strong evidence of a metallicity gradient while the field stars show a strong negative gradient in the inner region of the galaxy that appears to reverse sign in the outer region. The difference between the cluster metallicity and the mean of the surrounding field stars is a strong function of the cluster metallicity. The age-metallicity relation of the clusters shows a significant intrinsic metallicity dispersion at all ages, and no satisfactory fit to any current chemical evolution model. We discuss these results and their implications for the formation and evolution of the SMC.

84.- NAME: Maren Hempel

TITLE: Tracing the halos of interacting galaxies by their Globular Cluster Systems

ABSTRACT: The Globular Clusters of individual galaxies can be traced to galactocentric distances far exceeding the one to which we can detect the diffuse galaxy light. This makes them ideal to study both the central region of the host galaxy as well as their halo, and to do so consistently using the same tool. Here we present the results of a wide-field study on the Globular Cluster Systems in the W' group of galaxies. The dominant galaxy of this group is NGC 4365, whose Globular Cluster System has been discussed widely in recent years, due to the detection of not only two, but at least 3 distinct GC populations, although their origin is still under debate. Based on combined optical and near-infrared observations we study the radial distribution of these GCs, in particular in comparison to NGC 4342, a low mass lenticular galaxy, currently falling into the center of W'. With the age of NGC 4342 known to be slightly younger than NGC 4365 this study will not only allow us to study the earliest stages of galaxy interactions, but also to test to which degree photometric data can distinguish different GC populations.

85.- NAME: Shogo Ishikawa

TITLE: Linking High-z Galaxies to Their Host Dark Matter Haloes via Precision Clustering Statistics

ABSTRACT: We present the results of the clustering analysis for high-z galaxies. We construct a large number of Lyman break galaxy (LBG) samples at z = 3, 4, and 5 using CFHTLS Deep Survey data and derive the physical properties of LBG with the SED fitting technique (Tanaka 2015) by combining NIR data from WIRCam Deep Survey. The two-point angular correlation functions (ACFs) are measured to estimate the dependence of clustering properties on redshift and galaxy stellar mass, and applied the halo occupation distribution (HOD) analysis to investigate the relationship between LBGs and their host dark matter haloes. The mean halo masses of our LBGs are log(Mh) = 11.7–12.6, which are consistent with previous studies. We also calculate the stellar- to-halo mass ratios (SHMRs) and compare them with the results of the numerical simulation (Berhoozi et al. 2013). Our results are agree with model predictions within the 1sigma confidence levels and show the decreasing trend of SHMRs toward the both massive and less massive ends from the pivot halo masses.

86.- NAME: Jisu Kang

TITLE: Tracing the Giant Stellar Halo Around the Sombrero Galaxy with Globular Cluster Systems

ABSTRACT: M104 (NGC 4594, the Sombrero) is a mysterious early-type galaxy, hosting a massive disk surrounded by a dominant spheroidal component. Recently, from the detailed structural analysis of Spitzer images of this galaxy, it was suggested that a bulge of M104 is much smaller than the value in the previous studies, and that there may exist an extra outer halo around M104. On the other hand, recent studies based on globular clusters and resolved stars in massive galaxies suggested that massive early-type galaxies have dual halos: a metal-rich inner halo and a metal-poor outer halo. From these two results, it is expected that M104 also has dual halos, and its outer halo is much larger than the previously known size. In this study, we present the results of our search for an extended halo in M104. Using wide and deep images of M104 obtained with the CFHT/MegaCam, we detect a large number of globular clusters in M104. The spatial distribution of the blue (metal-poor) globular clusters shows clearly the presence of an outer halo, extended out to 80 kpc. This is much larger than the size of the system known in the previous studies. We will discuss implications of these results in relation with the formation history of M104.

88.- NAME: Myung Gyoon Lee

TITLE: The Origin of the Baryonic Halo in the cD Galaxy M87 in Virgo

ABSTRACT: Nearby galaxy clusters are an ideal target to investigate the origin of the baryonic halos in massive galaxies. One of the most intriguing problems in the current study of the relation between galaxy halos and intracluster light in galaxy clusters is a metallicity discrepancy between halo lights and globular clusters in the outer galaxy halos as well as in the intracluster field. The globular cluster populations in the intracluster fields and outer galaxy halos are dominated by metal-poor ones. On the other hand, whether stellar populations in the outer galaxy halos are dominated by metal-rich stars or metal-poor stars is controversial. Most of the previous studies on the outskirts of massive galaxies in the local universe are

based on photometry or spectroscopy of integrated stellar light, which provides only limited information. Taking advantage of high resolution in the HST images, we present the metallicity distribution functions (MDFs) of the resolved stars at the large range of galactocentric distance from the center of M87, cD galaxy in Virgo. Resolved stars are fossils of early chemical evolution, revealing how their host galaxies formed and evolved. The MDFs of the resolved stars in the outer fields of M87 are clearly bimodal, showing the presence of two distinct components. The metal-rich component represents a dominant primary metal-rich halo, while the metal-poor component denotes a secondary metal- poor halo. Even in the intracluster field located at the Virgo core the metal-rich component is substantial, while the contribution of the metal-poor component becomes more significant. Thus the contribution of metal-rich halos in and around massive galaxies are significantly wider than expected, and the contribution of the metal-poor halos is recognized even close to the central region of massive galaxies. The MDFs of these stars in M87 are described remarkably well by the accreting gas model of chemical evolution with double components (a metal-rich one and a metal- poor one). These results support the dual halo mode scenario that the massive galaxies form first in the metal-rich halo mode, and they grow in the metal-poor halo mode, as described in Lee and Jang (2016, ApJ, 822, 70). We will discuss the implication of these results on the origin of the baryonic halos of massive galaxies.

89.- NAME: Duane Lee

TITLE: Playing Your CARDs Right: Determining the Accretion History of the Galaxy via Statistical Chemical Tagging

ABSTRACT: Here I present on the potential use of a statistical model analysis called the EM algorithm on stellar chemical abundance ratio distributions (CARDs) in the Halo to reliably recover its accretion history. I find that this method is particularly sensitive to older accretion events involving low-luminous dwarfs e.g. ultra-faint dwarfs which is precisely those events that are too ancient to be seen by phase-space studies of stars and too faint to be seen by high-z studies of the early Universe. Since our results only exploit two dimensions in chemical abundance space while near-future surveys promise to provide ~6-9+ important dimensions, we conclude that these new high-resolution spectroscopic surveys of the stellar halo will allow us to recover the luminosity function of accreted dwarf galaxies — and a detailed accretion history of the halo — across cosmic time.

90.- NAME: Nawon Lee

TITLE: Does M81 have a halo?

ABSTRACT: M81 (SA(s)ab) is regarded as a twin galaxy of the Milky Way Galaxy, and is a primary galaxy in the M81 Group, the nearest galaxy group. There are numerous studies on this galaxy. Recent spectroscopic studies suggested that the globular clusters in M81 follow strong rotation and show a mean metallicity higher than those in the Milky Way and M31. However, these studies covered only the main body of M81, so little is known about the halo in this galaxy. In this study we present a wide field (1.5d x 1.5d) study of the central region of the M81 Group, including M81. Globular clusters are an excellent tracer of halos in massive galaxies. We select globular cluster candidates in the CFHT/MegaCam images, and obtain their spectra using the MMT/Hectospec. We find about one hundred globular clusters confirmed by their radial velocities. Spatial distribution of these sources shows a concentration of globular clusters around M81 as well as M82. It shows also a small number of intragroup globular clusters. The globular clusters in the halo of M81 show little rotation, which is in strong contrast to the case of the disk globular clusters which show a strong rotation in the previous studies. The globular clusters in the halo of M81 are mostly metal-poor, while those in the main body of M81 are mostly metal-rich. This shows the existence of a massive halo that is metal-poor and pressure-supported in M81.

92.- NAME: Cameron Liang

TITLE: The Structural Properties and the Evolution of the Circumgalactic Medium

ABSTRACT: I will present insights on the Circumgalactic Medium from the analysis of a suite of high-resolution cosmological re-simulation of a Milky-Way size galaxy and show that the CGM properties are quite sensitive to the details of the star formation - feedback loop modeling (Liang, Kravtsov, Agertz 2016). Combining with recent HST (low-z) and ground-based (high-z) observations, I show that the CGM column density profiles of all commonly observed ions follow an exponential form. Furthermore, they are self-similar

and evolving extremely mildly over four decades of stellar mass and 11 billion years in cosmic time (Liang & Chen 2014; Liang, Kravtsov, Agetz 2016).

93.- NAME: Ericson López, Jairo Armijos, Mario Llerena, Franklin Aldás

TITLE: Physical conditions of the Galaxy Halo derived from the 21-cm HI emission

ABSTRACT: We use observations of the 21-cm HI emission to derive physical conditions in the Galaxy halo. The radial velocity, column density, and the spatial distribution of the HI emission are derived for the Galaxy halo. The atomic hydrogen mass in the halo is estimated from the HI line emission. We compare our results with those derived for the Galaxy disk using the same tracer and with values obtained using data at other wavelengths. We also review the possible mechanism responsible for the excitation of the atomic hydrogen in the Galaxy halo.

94.- NAME: Sebastian Marchi

TITLE: Scaling relations of Milky Way outer halo satellite objects

ABSTRACT: The study of properties of satellite stellar structures present in the Milky Way halo can yield important information about the formation and evolution of the Galaxy. These substructures are classified in two main groups: globular clusters (GCs) and dwarf spheroidal galaxies (dSphs). During the last decade, new surveys and analysis techniques have increased the number of known satellites, more than doubling its population. These new discoveries, among which are low- luminosity dSphs and extended GCs, have changed our previous understanding. If previously GCs were thought to be compact and, in general, less luminous in comparison to dSphs, now this gap is starting to close, casting doubts about the different origin for this two types of structures. Moreover, it is known that dSphs are dominated by a dark matter halo, while GCs show no evidence of it. In this context, it is reasonable to think that the presence of dark matter may leave an imprint on the photometric and structural properties of these structures. To better understand differences and similarities between GCs and dSphs, their origin and what their role in the formation and evolution of the Milky Way is, it is necessary to characterize and homogeneously compare their structural and photometric properties. To achieve this, observations that are simultaneously deep, wide and homogenous are mandatory. In this work, I perform such a study by exploring relations between several parameters (luminosity, ellipticity, Sersic index, half-light radius and surface brightness) for 58 stellar structures present in the outer halo of our galaxy (beyond 25 kpc from the galactic center). For this, I use a new photometric dataset constructed from a survey that fulfills the previously stated requirements.

95.- NAME: Claudia Mendes de Oliveira

TITLE: The stellar populations of the Hydra I cluster core

ABSTRACT: The complex kinematics and stellar populations of the Hydra cluster core suggests an active past with numerous merging events and ongoing accretion. MUSE spectra are used here to analyse the kinematics and stellar populations of the stellar halo component around the central Hydra I cluster galaxy, NGC 3311. The stars of NGC 3311 may be divided into two radial regimes, inside and outside one effective radius, which is similar to a dichotomy observed also in the velocity dispersion distribution of the galaxy. Our results provide evidence supporting recent theoretical models of massive elliptical galaxies formation as a two-phase process: the inner halo is old and has negative metallicity gradients and positive alpha-element gradients while the outer halo is also very old, but has a negative age gradient. The metal and element abundances of the outer halo have a large variance, indicating that stars from other galaxies in the cluster may have been accreted to the outer regions of NGC 3311. Detailed maps of the properties, substructures, and of the separation of in-situ and accreted stars will be shown in this poster.

96.- NAME: Sergio Ortolani, Santino Cassisi

TITLE: Interstellar reddening effects on the ages of population II stars

ABSTRACT: The age of the stellar halo component of the Galaxy is based mainly on the comparison of the main sequence turnoff of the globular cluster stars with the isochrones. The standard procedure includes a vertical shift, in order to take into account account the distance and extinction, and a horizontal one, to compensate the reddening. However the photometry is typically performed with broad band filters where the

shape of the stellar spectra introduces a shift of the effective wavelength response of the system, dependent on the temperature (or color index) of the star. The result is an increasing distortion (in fact a rotation and a progressive compression with the temperature) of the color-magnitude diagrams relatively to the standard unreddened isochrones, with increasing reddening. While the ratio of the absorption to the reddening is widely discussed in the literature, the importance of latter effect is often overlooked. In this contribution we present isochrone simulations and comparison with some data, showing the effect of temperature dependent absorption on the age determinations.

97.- NAME: Hong Soo Park

TITLE: Globular Cluster System of the Virgo Giant Elliptical Galaxy M86 in Infalling Cluster Environment

ABSTRACT: We will present a kinematic and chemincal study of the globular clusters (GCs) in the giant elliptical galaxy M86 in the Virgo cluster. We measured the radial velocities and metallicities of M86 GCs from spectra obtained using the multi-object spectroscopy mode of the Faint Object Camera and Spectrograph (FOCAS) at the Subaru Telescope. We will report the kinematics and chemical properties of the GCs in M86 are not consistent with those in other massive early-type galaxies (ETGs) as follows: (1) the mean radial velocity of the M86 GCs is different with the radial velocity of the M86 nucleus, (2) the M86 GC system has a rotation, but the M86 stellar system does not, and (3) the M86 GCs show a radial metallicity gradient. These kinematic decoupling between M86 stellar component and the GC system against other ETGs, including the metallicity variation and large effective radius of M86 galaxy, seems to be caused by an interaction between the stellar halo system and Virgo intracluster medium (ICL) in infalling cluster environment.

98.- NAME: Janet Preston

TITLE: Mapping the tidally disrupting Andromeda XXVII and its stellar stream

ABSTRACT: Andromeda XXVII is a dwarf spheroidal galaxy in the outskirts of the (M31) Andromeda galaxy. Dissolving in to the Northern arc of M31, Andromeda XXVII appears to be the remnant of a strong tidal disruption. In this presentation, I will discuss the results of our spectroscopic program, which has measured velocities for multiple stars within both the dwarf galaxy progenitor and its stream, using the Keck II DEIMOS telescope, as part of the PAndAS survey. The program determined velocity dispersions, scale radii and metallicities of both the dwarf and the stream, which enabled us to investigate the mass profile of the progenitor galaxy.

99.- NAME: Ricardo Salinas

TITLE: Dark matter and globular cluster systems of isolated elliptical galaxies

ABSTRACT: As tracers of star formation, galaxy assembly and mass distribution, globular clusters have provided important clues to our understanding of early-type galaxies. But its study has been mostly constrained to galaxy groups and clusters where early type galaxies dominate, leaving the properties of the globular cluster systems (GCSs) of isolated ellipticals as a mostly uncharted territory. We present observations of ~10 isolated elliptical galaxies. Photometry of their GCSs reveals clear color bimodality in most of the cases. All the studied GCSs are rather poor with a mean specific frequency Sn~1.5, independently of the parent galaxy luminosity. Considering also previous work, it is clear that bimodality and especially the presence of a significant, even dominant, population of blue clusters occurs at even the most isolated systems, casting doubts on a possible accreted origin of metal-poor clusters as suggested by some models. Additionally, I will present our ongoing efforts to measure their dark matter content based on stellar and globular cluster kinematics.

100.- NAME: Ivo Saviane

TITLE: Halo assembly and the mass-metallicity relation at 70% the age of the universe.

ABSTRACT: We report on the mass-metallicity relation of the AC 114 galaxy cluster at z=0.35. We compare the relation to that of local galaxies, finding clear signs of evolution. In addition we find a few objects that have lower abundances for their luminosity, and that appear to be accreting metal-poor dwarf galaxies from

the environment. These objects can be used to constraint the merger rate in galaxy clusters, and thus to assess the relevance of mergers for halo formation in such galaxy aggregates.

101.- NAME: Felix Schulze

TITLE: Connecting Outer Stellar Halo Kinematics to the Formation Histories of Early-Type Galaxies

ABSTRACT: Several recent studies, using integral-field spectroscopy, suggest that the formation history of galaxies, and especially their in- and outflow history, is encoded in the stellar kinematics. We use a sample of well resolved galaxies extracted from the hydrodynamical cosmological simulation Magneticum to investigate their stellar kinematics out to five half-mass radii. We present extended radial angular momentum profiles, and discuss the relation between their shapes and the formation histories of the individual galaxies. Furthermore, we present results on the correlation of the profile shapes with observable quantities such as sersic index, stellar mass and specific angular momentum. Finally, we apply our results to recent observations, providing insights into the formation histories of the observed galaxies.

105.- NAME: Ana Ennis, Lilia Bassino, Juan Pablo Caso

TITLE: The globular cluster system of the galaxy NGC 6876

ABSTRACT: We present preliminary results from a study of the globular cluster system (GCS) associated to NGC 6876, the central elliptical galaxy of the Pavo group. The results presented here are based on GMOS-Gemini data and cover the globular cluster colour distribution, spatial and radial projected distributions, as well as azimuthal distribution. Previous studies in X-rays, IR and HI of this thirteen members' group show interactions between NGC 6876 and the massive spiral galaxy NGC 6872, while this last one also shows deformations due to tidal forces. Our final aim, in the long term, is to investigate whether the interactions present in the Pavo group are also made evident by the properties of the GCS of NGC 6876, and to trace the evolution of massive galaxies in low density environments, as is the case of this galaxy.