A Universe of Dwarf Galaxies

CRAL-IPNL Conference

2010 June 14-18, Lyon, France

June 4, 2010

Program

Monday June 14 2010

8:30 Registration

9:15 Welcome

1. First stars

9:30 Eline Tolstoy, Kapteyn Astronomical Institute, University of Groningen
Evolution of Nearby Dwarf Galaxies

10:05 Else Starkenburg, Kapteyn Astronomical Institute
The search for extremely low-metallicity stars in dwarf galaxies using the NIR Ca II triplet

10:30 Evan Kirby, Caltech
The Elemental Abundance Distributions of Milky Way Satellite Galaxies

10:55 Coffee break

11:40 Martin Tafelmeyer, Ecole Polytechnique Federale de Lausanne
Chasing the most metal-poor stars in the Local Group dwarf Spheroidal galaxies

12:05 Giuliana Fiorentino, Kapteyn Institute
Variable stars in Dwarf Galaxies: key-tools to constrain distances and stellar content

12:30 Lunch

2. Star Formation history and Chemical enrichment

14:30 Sebastian Hidalgo, University of La Laguna & Instituto de Astrofisica de Canarias
The LCID project: star formation history of isolated, Local Group dwarf galaxies

14:55 Matteo Monelli, Instituto de Astrofisica de Canarias
The star formation histories of the Magellanic Clouds

15:20 David L Nidever, University of Virginia
Revealing the Stellar Periphery of the Small Magellanic Cloud

15:45 Denija Crnojevic, Astronomisches Rechen Institut
Dwarf galaxies beyond our doorstep: the Centaurus A group

16:10 Coffee break and Poster viewing

3. Blue Compact Dwarfs

17:10 Daniel Kunth, CNRS
The interplay between massive stars, WR stars and the HI-HII chemical enrichment in star-forming galaxies

17:45 Bethan James, Space Telescope Science Institute
Investigating the Chemical Homogeneity of Low-Metallicity Blue Compact Dwarf Galaxies Using Integral Field Spectroscopy

18:10 Alexei Moiseev, Special Astrophysical Observatory
What controls the gas random motions in dwarf galaxies?

18:35 Michael Rauch
High Redshift Dwarf Galaxies from Lyman alpha Emission and Absorption

19:10 Welcome cocktail

Tuesday June 15 2010

4. ISM and star formation

9:00 Evan Skillman
Gas and Star Formation in Dwarf Galaxies

9:35 Jayaram Chengalur, NCRA/TIFR
FIGGS: The Faint Irregular Galaxy GMRT Survey

10:00 Suzanne Madden, SAp, CEA, Saclay
The Dust and Gas properties of Low Metallicity Dwarf Galaxies as Viewed by the Herschel Space Observatory

10:25 Coffee break and poster viewing

5. Dwarf ellipticals

11:30 Thorsten Lisker
Early-type dwarf galaxies: origin, characteristics, cosmological relevance

12:05 Mina Koleva, IAC/CRAL
Population gradients in diffuse elliptical galaxies

12:30 Lunch

14:30 Elisa Toloba, UCM (Universidad Complutense de Madrid)
The origin of dwarf early-type galaxies in the Virgo cluster

14:55 Samantha Jane Penny, University of Nottingham
The effect of local environment on cluster dwarf galaxies

6. Globular clusters, UCDs cEs

15:20 Duncan Forbes, Swinburne University
The Dwarf galaxy–Ultra Compact Dwarf–Globular Cluster connection

15:45 Michael Hilker, ESO
A census of ultra-compact dwarf galaxies in nearby galaxy clusters

16:10 Kristin Chiboucas, Gemini Observatory
UCDs in the Coma Cluster

16:35 Coffee break

17:20 Alister William Graham, Swinburne University
Central massive objects in dwarf galaxies

17:45 M.E. Sharina, Special Astrophysical Observatory RAS
Observational properties of globular clusters in dwarf galaxies

18:10 Thomas H. Puzia, Herzberg Institute of Astrophyics
Chemodynamics of Compact Stellar Systems in NGC 5128

18:35 Myung Gyoon Lee, Seoul National University
Wandering Globular Clusters: the First Dwarf Galaxies in the Universe?

Wednesday June 16 2010

7. Distribution and luminosity function of dwarfs

9:00 Brent Tully, University of Hawaii
The Galaxy Luminosity Function in Groups

9:35 Dmitry Makarov, Special Astrophysical Observatory of RAS
Groups of dwarf galaxies in the Local Supercluster

10:00 Arna M Karick, Liverpool John Moores University
The HST/ACS Coma Cluster Treasury Survey: The nature of dwarf galaxies deep in the heart of Coma

10:25 Russell Smith, University of Durham
Ages and element abundances on the faint red sequence

10:50 Coffee break

8. Satellites, streams, ultra-faint galaxies

11:30 Eva K. Grebel, University of Heidelberg
Satellites in the Local Group and other nearby groups

12:05 Jason Kalirai, STScI
The SPLASH Survey: Comparing Internal Kinematics, Abundances, and Dynamical Masses of Milky Way and M31 dSphs

12:30 Lunch

14:30 Alan Walker McConnachie, Herzberg Institute of Astrophysics
The comparative anatomy of dwarf galaxies: a tool for understanding galaxy evolution

14:55 Nicolas Martin, Max Planck Institute for Astronomy
The complexity of faint Local Group dwarf galaxies

15:20 David Sand, Harvard University
The structure and star formation history of the new Milky Way satellite

15:45 David Martinez-Delgado, Max-Planck-Institute fur Astronomy
Stellar tidal streams in spiral galaxies of the Local Volume

16:10 Coffee break and Poster viewing

17:10 Gurtina Besla, Harvard-Smithsonian CfA
The Formation of the Magellanic Stream

17:35 Adam Ruzicka, Institut f. Astronomie, Univ. Wien
Local kinematics in the solar neighborhood and the formation of the Magellanic Stream

18:00 Pierre-Alain Duc, Laboratoire AIM, CEA Paris Saclay
Ultra faint dwarf galaxies in the Next General Virgo cluster Survey

Thursday June 17 2010

9. Models of formation and evolution

9:00 Lucio Mayer, University of Zurich
The formation and morphological evolution of dwarf galaxies in a hierarchical Universe

9:35 Gerhard Hensler, Institute of Astronomy, University of Vienna
The morphological origin of dwarf galaxies

10:10 Yves Revaz, EPFL
Dwarf Spheroidal Galaxies : from observations to models and vice versa

10:35 Coffee break

11:20 Joss Bland-Hawthorn, University of Sydney/University of Oxford
The smallest galaxies in the Local Group

11:45 Sven De Rijcke, Ghent University
The anisotropy of cluster dwarf galaxy populations

12:10 Isabel Franco-Rico, Astronomisches Rechen Institut
A stellar population picture of galaxy harassment

12:35 Lunch

14:00 Free afternoon

20:00 Conference diner

Friday June 18 2010

10. Cosmology and Dark matter

9:00 Matthew Walker, Institute of Astronomy
Dark Matter in Dwarf Spheroidal Galaxies

9:35 Stefan Gottloeber, Astrophysical Institute Potsdam
The CLUES-project: Constrained Local UniversE Simulations

10:00 Jorge Penarrubia, Institute of Astronomy, University of Cambridge
The impact of dark matter cusps and cores on the dSph population

10:25 Coffee break

11:10 Gary Mamon, IAP, France
Predicting which dwarfs are young and which are old

11:35 Sam Geen, Oxford Astrophysics
The role of feedback in Milky Way satellite galaxy formation using high resolution simulations

12:00 Qi Guo
From dwarf Spheroidals to cDs: simulating the full galaxy population in a LCDM cosmology

12:25 Lunch

11. Dwarf galaxy studies in the future

14:00 Julianne Dalcanton
Looking Forward to the Future of Dwarf Galaxy Studies

14:35 Beth Willman, Haverford College
Searches for resolved ultra-faint galaxies in the next decade

15:00 Giuseppina Battaglia, ESO Garching
Spectroscopy of resolved stellar populations in dwarf galaxies with the European Extremely Large Telescope

15:25 Philippe Prugniel, CRAL-Observatoire de Lyon
MUSE: Observation of dwarf galaxies

12. Summary

16:20 S. White

Abstracts of the presentations

1 First Stars

1.1 Evolution of Nearby Dwarf Galaxies

Authors: Tolstoy, E. **Invited talk**

Abstract: Within the Local Universe galaxies can be studied in great detail star by star. The Color-Magnitude Diagram synthesis analysis method is well established as the most accurate way to determine the detailed star formation history of galaxies going back to the earliest times. This approach has benefited enormously from the exceptional data sets that wide field CCD imagers on the ground and the Hubble Space Telescope can provide. Spectroscopic studies using large ground based telescopes have allowed the determination of abundances and kinematics for significant samples of stars in nearby dwarf galaxies. These studies have shown directly how properties can vary spatially and temporally, which gives important constraints to theories of galaxy formation and evolution.

1.2 The search for extremely low-metallicity stars in dwarf galaxies using the NIR Ca II triplet

Authors: Else Starkenburg and the DART collaboration **Oral contribution**

Abstract: The NIR Ca II triplet has proven to be an important tool for quantitative spectroscopy, providing a better understanding of metallicities of dwarf galaxy stars and thereby an opportunity to constrain their chemical evolution processes. An interesting puzzle in this field is the significant lack of extremely metal-poor stars (below [Fe/H]=-3) found in classical dwarf galaxies around the Milky Way (e.g., Helmi et al., 2006). The question arises whether these stars are really absent, or if the Ca II triplet metallicities used to study these systems are inaccurate in the low metallicity regime. Here we present results of synthetic spectral analysis for the Ca II triplet for low-metallicity red giant stars, combined with observational data. Our results start to deviate strongly from the widely-used and linear empirical calibrations below [Fe/H]=-2. We provide a new calibration for Ca II triplet studies which is valid down until [Fe/H]=-4 and apply this new calibration to current data sets. We suggest that the classical dwarf galaxies are not so devoid of extremely low-metallicity stars as was previously thought and discuss preliminary results and possibilities for follow-up observations of these extremely low-metallicity candidates.

1.3 The Elemental Abundance Distributions of Milky Way Satellite Galaxies

Authors: Evan Kirby **Oral contribution**

Abstract: The proximity of the satellite galaxies of the Milky Way (MW) renders them the best targets for studying the stellar populations of small galaxies. The chemical compositions of their stars reveals information about the history of gas flows and star formation intensity. This talk presents a Keck/DEIMOS spectroscopic survey of the Fe, Mg, Si, Ca, and Ti abundances of about 3000 stars in eight MW dwarf satellites. The metallicity and alpha-to-iron ratio distributions obey the following trends with the total luminosity of the galaxy: (1) The more luminous galaxies are more metal-rich, indicating that they retained gas more efficiently than the less luminous galaxies. (2) The shapes of the metallicity distributions of the more luminous galaxies require gas infall during their star formation lifetimes. (3) At [Fe/H] $<$ -1.5, [alpha/Fe] falls monotonically with increasing [Fe/H] in all MW satellites. In the more luminous satellites, [alpha/Fe] becomes constant at [Fe/H] $>$ -1.5. (4) The average [Mg/Fe] and [Si/Fe] in the satellites is roughly the same as the MW halo, but [Ca/Fe] and [Ti/Fe] in the satellites lie below the MW average at nearly all metallicities. One interpretation of these trends is that the star formation timescale in all MW satellites is long enough that Type Ia supernovae contribute to the chemical compositions of stars at all times, but in the more luminous/massive satellites, the burstiness of the star formation rate achieves an equilibrium between the contributions of Types Ia and II supernovae.

1.4 Chasing the most metal-poor stars in the Local Group dwarf Spheroidal galaxies

Authors: Martin Tafelmeyer, Pascale Jablonka **Oral contribution**

Abstract: I will report on the recent discovery and analysis of extremely metal-poor stars (EMPS) in classical dwarf spheroidal galaxies (dSph). These results are part of a pilot programme of follow-up of metal-poor stars in Fornax, Carina, Sextans, and Sculptor dSphs, for which the metallicity estimates derived from the calcium triplet indicate [Fe/H] < -2.5. The spectroscopic observations were conducted with UVES at ESO at high resolution. All our sample stars are [Fe/H] $\lesssim -3$ and three stars are below -3.5. One star with [Fe/H]=-3.96 is the most metal-poor star ever observed in an external galaxy, but more fundamentally, it considerably revises the metallicity floor of dSphs, setting it at comparable level with the Milky-Way. I will review the chemical patterns of the EMPS and compare them with that in the halo of the Milky Way and in the Ultra Faint dwarfs. These comparisons provide critical evidences on how galaxies form. I shall put a particularly emphasis on the dispersion in carbon abundance and on the nucleosynthetic origin of the r-process elements which appear very dependent on the mass of the systems.

1.5 Variable stars in Dwarf Galaxies: key-tools to constrain distances and stellar content

Authors: G. Fiorentino et al. **Oral contribution**

Abstract: I will overview the important role of Cepheid and RR Lyrae variable stars and what they can teach us about Dwarf Galaxies. I will present recent results for three morphologically different cases: IZw18 (BCD), M32 (dE) and Leo A (dI). Despite ever improving star formation histories of Local Group dwarf galaxies uncertainties remain, in particular in the identification and characterization of the oldest stellar populations. This is because the old stellar populations can be hard to interpret, or even detect, due to their inherent faintness and scarcity, and often a strong overlying young population makes the crowding due to much brighter stars difficult to overcome. Despite crowding and faintness variable stars can be relatively easy to pick out in the crowded images and their light curves accurately determined. The detection and the identification of certain classes of variable stars help our understanding of the star formation history at ages which are difficult to retrieve from Colour-Magnitude diagram analysis alone. I will present my recent results for RR Lyr searches (in M32 and Leo A) carried out with HST and Gemini-North/GMOS, where these variables represent the only way to constrain the nature, and even presence of a stellar population >10 Gyrs old. I will also show HST results for IZw18 which allowed the first accurate distance determination from Cepheids, enabling a more secure detection of the Tip of the Red Giant Branch, and confirmed the existence of a population >2Gyrs old.

1.6 LPVs as indicators for distance and SFH in NGC 147 and NGC 185

Authors: D. Lorenz, T. Lebzelter, W. Nowotny, F. Kerschbaum, J. Telting, H. Olofsson, H.E. Schwarz
Poster

Abstract: We examined the pulsational behaviour of AGB variables of the two Local Group members NGC 147 and NGC 185. A photometric monitoring in the I-band has been done with the Nordic Optical Telescope at La Palma over ∼2.5 yrs resulting in ∼35 datapoints for the period analysis. We found 360 long period variables (LPVs) in NGC 185 and 153 LPVs in NGC 147. Additional K-band magnitudes could be derived for 279 (NGC 185) and 153 (NGC 147) LPVs, respectively. For a large fraction of these stars we also have indications for the chemistries (C- or O-rich) from narrow band photometry (Nowotny et al. 2003). The resulting K-logP diagrams for both objects show a well populated sequence of fundamental mode pulsators (sequence C). In NGC 185 we furthermore see a number of LPVs pulsating in an overtone mode (sequence C'). Interestingly, such stars are missing in NGC 147. We speculate that this lack of shorter periods in NGC 147 could orginate from a difference in the star formation history (SFH) of the two galaxies, with NGC 147 containing a smaller amount of intermediate-age C and M stars. We also present new distance estimates of NGC 147 and NGC 185 according to the best fit for sequence C stars in the K-logP diagram.

1.7 First stars and dwarf galaxies

Authors: Stefania Salvadori **Poster**

Abstract: Dwarf spheroidal galaxies (dSphs) have been historically considered one of the best systems to search for the fossil records of the first stellar generations. During the past two years this hypothesis has gained new popularity thanks to the observations of extremely metal-poor stars (EMPs, [Fe/H] < -3) in both classical and ultra-faint (UFs) dSphs. The latter, in particular, are very promising objects, since the number of EMP stars in these systems represent the 25% of their total stellar mass. Which is the origin of these stars? Which is the impact of truly second generation stars among the [Fe/H] < -3 stellar relics in UFs and classical dSphs? We investigate the origin and abundance pattern of extremely metal-poor stars in a general cosmological context, simultaneously accounting for different dSphs and MW properties, including their observed Metallicity Distribution Function (MDF).

2 Star Formation History and Chemical Enrichment

2.1 The ACS LCID project: the star formation history of isolated Local Group dwarf galaxies

Authors: Sebastian L. Hidalgo and LCID group. **Oral contribution**

Abstract: I will present the final results of the ACS 'Local Cosmology from Isolated dwarfs (LCID)' project, which has used over 100 orbits of HST time to obtain color-magnitude diagrams reaching the oldest main sequence turnoffs (V∼28) in six isolated Local Group galaxies (two dIrr, IC1613 and Leo A, two transition dIrr/dSph, LGS3 and Phoenix, and the only two isolated dSph in the Local Group, Cetus and Tucana). Complete star formation histories have been derived through comparison with synthetic color-magnitude diagrams. Isolated dwarf galaxies are important probes of the conditions of the early Universe, since their early star formation history and subsequent evolution are predicted to have been influenced by global phenomena such as cosmic reionization. I will discuss the detailed star formation and chemical enrichment histories that we have derived for the LCID galaxies, with particular emphasis on the similarities and differences of the six galaxies in the sample, in relation with their morphological type, population gradients and on whether their characteristic features can be interpreted as signatures of both global and local phenomena.

2.2 The star formation history of the Magellanic Clouds

Authors: M. Monelli **Oral contribution**

Abstract: The star formation history of the Magellanic Clouds, including the old and intermediate-age star formation events, can be studied reliably and in detail through color-magnitude diagrams reaching the oldest main sequence turnoffs. In addition, the metallicities and chemical bundances of individual stars can be obtained through spectroscopy. We are sampling the stellar populations of the Magellanic Clouds by imaging and spectroscopy of a large number of wide fields at different galactocentric distances. I will discuss our current results on the star formation histories of these galaxies, and discuss the impact of this information on general studies of galaxy formation and evolution.

2.3 Revealing the Stellar Periphery of the Small Magellanic Cloud

Authors: David Nidever, Steven Majewski **Oral contribution**

Abstract: The Magellanic Clouds are a local laboratory for understanding the evolution and properties of dwarf Irregular galaxies. To reveal the extended structure and interaction history of the Magellanic Clouds we have undertaken a large-scale photometric and spectroscopic study of their stellar periphery (The MAgellanic Periphery Survey, MAPS). We present our first results for the Small Magellanic Cloud (SMC); Washington M, T2 + DDO51 photometry reveal metal-poor red giant branch stars in the SMC that extend out to large radii (8.8 kpc), are distributed nearly azimuthally symmetrically (ellipticity=0.1), and are well-fitted by an exponential profile. There is evidence at ∼8 radial scalelengths for a "break" population indicative of a tidal tail or halo. These results suggest that the SMC's major stellar component is either a large, inclined exponential disk or has a large spheroidal structure. The outer stellar distribution contrasts with that of the inner stellar distribution (sometimes referred to as

the SMC "bar") that is more elliptical (0.3) and offset from the outer distribution by 0.5 kpc, although they share a similar radial exponential scale length. This suggests that the SMC has an off-center bar as is seen in the LMC. Our enhanced understanding of the stellar structure and populations of the SMC will help shed light on the evolution of dwarf galaxies that are interacting with their larger neighbors.

2.4 Dwarf galaxies beyond our doorstep: the Centaurus A group

Authors: Denija Crnojevic **Oral contribution**

Abstract: The study of dwarf galaxies in groups is a powerful tool to investigate galaxy evolution, chemical enrichment and environmental effects on these objects. Here we present results obtained for dwarf galaxies in the Centaurus A complex, a nearby (∼4 Mpc), dense group which contains two giant galaxies and about 30 dwarf companions of different morphologies and stellar contents. We use archival optical (HST/ACS) and near-infrared (VLT/ISAAC) data to derive physical properties and evolutionary histories from the resolved stellar populations of these dwarf galaxies. In particular, for early-type dwarfs we are able to construct metallicity distribution functions, to find population gradients and to quantify intermediate-age star formation episodes. For late-type dwarfs, we compute recent (∼1 Gyr) star formation histories and study their stellar distribution. We then compare the results with properties of the dwarfs in our Milky Way and in other groups. Our work will ultimately lead to a better understanding of the evolution of dwarf galaxies.

2.5 CaT Spectroscopy of RGB Stars in the Isolated Dwarf Irregular WLM

Authors: R. Leaman, K. Venn, A. Brooks, A. Cole, M. Irwin, A. McConnachie **Poster**

Abstract: The chemical abundances and radial velocities for ∼210 stars in WLM, ∼130 new stars from DEIMOS spectroscopy (Sept 2009) and 80 stars from Leaman et al. (2009) are presented. This sample shows that the isolated dwarfs have chemically, dynamically, and spatially distinct stellar populations similar to the nearby dwarf spheroidals. The kinematics of the stars are also decoupled from the HI gas, which shows a higher rotational velocity profile, suggesting the gas is from recent infall. The metallicity distributions are derived from both the Ca II triplet feature and from spectral synthesis measurements of the weaker Fe I and other atomic lines. A least squares minimization technique has been developed to examine these spectra and the fitting errors for [Fe/H] and [alpha/Fe].

2.6 Earliest epoch of star formation in Sculptor dwarf galaxies

Authors: M. Rejkuba, G. Da Costa, H. Jerjen, E. Grebel **Poster**

Abstract: We report the discovery of blue horizontal branch stars and numerous RR Lyrae variables in two Sculptor group dwarf galaxies. These stars are the first direct observational evidence of the presence of ancient stellar populations beyond the Local Group. The lower density of Sculptor group with respect to our Local Group probes a different environment. Our discovery suggests that gas can condense and form stars in low mass halos at the earliest epochs even in relatively low-density dwarfs, providing new constraints to star formation and galaxy formation models at early cosmological epochs.

2.7 NGC 6822: SFH of its intermediate-age population

Authors: Serge Demers & Paolo Battinelli **Poster**

Abstract: We have monitored, during four years, a 32'×32' area of the Local Group dwarf NGC 6822. Observations lead to the discovery of 30 Miras and 24 semi-regular variables. The period distribution of the Miras shows that 96% of them are younger than 3 Gyr. This result is basically consistent with the hypothesis that the intermediate-age population of NGC 6822 was born following the "polar ring" formation.

2.8 Star formation history of KDG61 and KDG64 from spectroscopy and colour-magnitude diagrams

Authors: L. Makarova, M. Koleva, D. Makarov, P. Prugniel **Poster**

Abstract: A study of two dE/dSph members of the nearby M81 group of galaxies, KDG61 and UGC5442

= KDG64, has been made. Direct Hubble Space Telescope (HST) Advanced Camera for Surveys (ACS) images and integrated-light spectra of 6 m telescope of Special Astrophysical Observatory of Russian Academy of Sciences have been used for quantitative star formation history analysis. The spectroscopic and colour-magnitude diagrams analysis gives consistent results. These galaxies appear to be dominated by an old population (12-14 Gyr) of low metallicity ([Fe/H]∼-1.5). Stars of ages about 1 to 4 Gyr have been detected in both galaxies. The later population shows marginal metal enrichment. We do not detect any significant radial gradients in age or metallicity in these galaxies. Our radial velocity measurement suggests that the HII knot on the line-of-sight of KDG61 is not gravitationally attached to the galaxy.

2.9 The Star Formation History of Isolated Dwarf UGC4879

Authors: B. A. Jacobs, R. B. Tully, L. Rizzi, I. D. Karachentsev **Poster**
Abstract: Recent observations of UGC4879 with the Advanced Camera for Surveys on the Hubble Space Telescope confirm that it is a nearby isolated dwarf galaxy. We measure a distance of 1.36±0.02 Mpc using the Tip of the Red Giant Branch method. This distance puts UGC4879 beyond the radius of first turnaround of the Local Group and ∼700 kpc from its nearest neighbor Leo A. This isolation makes this galaxy an ideal laboratory for studying pristine star formation uncomplicated by environmental factors. We present the star formation history of UGC4879 derived from simulated color-magnitude diagrams.

2.10 Disentangling the stellar populations of Fornax dwarf spheroidal

Authors: Cesetti et al. **Poster**
Abstract: We have studied the star-formation history of Fornax dwarf spheroidal galaxy using HST/WFPC2 imaging of 7 galaxy fields. Our observations reach the oldest main-sequence turn-offs, revealing distinct stars formation episodes and allowing us to address the evolution of this prototype dwarf spheroidal galaxy known to have experienced an extended history of star formation. From our HST data, spatial gradients in the stellar content of Fornax emerge with greater clarity. The outermost fields show only stars with ages between 7-12 Gyr, while the intermediate region hosts a stellar population between 4-10 Gyr, and stars younger of 2 Gyr are found in the innermost fields. A clearly visible gap in the subgiant branch points to bimodality in the main star formation episode. Our observations also indicate that the inner clump detected by Coleman et al. (2004) is characterized by the presence of young stars with age about 1.8 Gyr.

2.11 New Catalog and Ultraviolet Properties of Dwarf Galaxies in Virgo Cluster

Authors: Suk Kim, Soo-Chang Rey, Eon-Chang Sung, Wonhyeong Yi, Thorsten Lisker **Poster**
Abstract: We present a new catalog of dwarf galaxies in Virgo cluster using SDSS DR7 data. Basically, the morphology of galaxy is classified based on the image and spectral feature of SDSS data. We secure 994 dwarf galaxies as members of the Virgo cluster, from which 492 galaxies are new objects not included in Virgo Cluster Catalog (VCC) of Binggeli et al. (1985). Comparing with VCC, we confirm that the scheme of our morphological classification is reliable. By matching with GALEX GR5 data, we present ultraviolet (UV) properties for various dwarf galaxies in Virgo cluster. Many fraction of dwarf lenticulars (dS0s) and peculiar dwarf ellipticals (dEs) with blue center show distinct locus from that of ordinary dEs in UV-optical two color diagram. These galaxies have bluer UV colors than ordinary dEs, which indicates recent or on-going star formation activities. We also discuss a hint of environmental effects to the UV properties of Virgo dwarf galaxies. Our results of UV properties suggest that there are different star formation histories among different subclasses of early-type dwarf galaxies in Virgo cluster related with their morphology and environment.

2.12 The Star Formation Histories of Red-sequence Dwarf Galaxies

Authors: M. J. Hudson, R. J. Smith, S. P. Allanson, J. R. Lucey **Poster**
Abstract: I will discuss the star formation histories, stellar and total mass content of dwarf red-sequence galaxies. From new ultradeep spectroscopic studies, we determine the ages and metallicities of galaxies along the red-sequence, and, using these, derive the stellar masses as a function of velocity dispersion and

luminosity. By comparison with dynamical studies, we show that red galaxies with velocity dispersions of ∼70 km/s are predominantly stellar and have a low dark matter content. Moreover, we show that the tilt of the Fundamental Plane is due primarily to variations in the stellar ages along the red sequence, and not to a variation in the dark matter.

2.13 The Sagittarius Age-Metallicity Relation

Authors: S. Zaggia, L. Girardi, P. Bonifacio, L. Monaco et al. **Poster**
Abstract: We present the core age-metallicty relation of the SGR dwarf galaxy.

2.14 High resolution spectroscopy of Red Giant Branch stars in the Carina Dwarf spheroidal galaxy

Authors: B. Lemasle and the DART collaboration **Poster**
Abstract: Carina is a small and faint classical dwarf spheroidal galaxy in the halo of the Milky Way. It has a most unusual highly episodic star formation history (Hurley-Keller et al. 1998). A long quiescent period separates 2 distinct star formation episodes (∼13 Gyr and ∼7-11 Gyr old), and there is also evidence of a younger population (< 1 Gyr). Despite all this activity the red giant branch of Carina is very narrow. To understand the chemical evolution of Carina and how it corresponds to the star formation history, it is necessary to make a spectroscopic survey of a large sample of red giant branch stars. Using VLT/FLAMES in HR mode we significantly increase the current sample of about twenty stars with high resolution VLT/UVES spectroscopy (Shetrone et al. 2003; Koch et al. 2008). We increase three-fold the number of stars with accurate abundances of iron, but also numerous alpha-elements and some heavy elements.

2.15 Star Formation History of the Fornax Dwarf Spheroidal Galaxy

Authors: Pino, Andrés del; Aparicio, Antonio; Gallart, Carme; Hidalgo, Sebastian. **Poster**
Abstract: We present color-magnitude diagrams reaching the oldest main sequence turnoffs for three fields in the Fornax dwarf spheroidal galaxy, obtained with FORS1 at the VLT. One of them is situated at the center of the galaxy while the other two are located at a distance of 10' from the center. We determine their full star formation history, extending to the first star formation events, using IAC-star and IAC-pop codes and the MinnIAC suite. The nature of the stellar population gradients in Fornax, out to the observed galactocentric radius, is discussed.

2.16 An accurate timescale for Star Formation and chemical enrichment of the Sculptor dSph

Authors: Thomas de Boer **Poster**
Abstract: The Sculptor dwarf Spheroidal is a Milky Way satellite with a dominant old (> 10 Gyr) population. Even in the short time that it formed stars it built up a certain degree of complexity with at least two distinct stellar populations formed over 2-3 Gyr, with different spatial distributions, kinematics and metallicities. Sculptor has been the target of large spectroscopic surveys with VLT/FLAMES both to determine high resolution abundances of a range of chemical elements in the centre of the galaxy and low resolution Ca II triplet metallicities and kinematics over the whole galaxy. I will present new sensitive BVI imaging data from CTIO/MOSAIC covering the entire galaxy and a detailed study of the stellar population of Sculptor, including the main sequence turnoff properties and make the link to the chemical evolution history coming from the spectroscopic studies. This will provide an accurate timescale for the star formation and chemical enrichment timescales in this relatively simple system that formed most of its stars at redshift, z∼5.

2.17 Photometric and spectroscopic investigation of the Carina dSph galaxy

Authors: Michele Fabrizio **Poster**
Abstract: We present deep, accurate and homogeneous multiband optical (U,B,V,I) photometry of the Carina dwarf spheroidal galaxy. We collected more than 4,000 individual CCD images with wide field

imagers available at the 4 m CTIO Blanco telescope and at the 2.2 m MPG/ESO telescope and they cover the entire body of the galaxy. Special attention was given to the photometric calibration and the precision for B,V,I-band is on average better than 0.01 mag. We performed a detailed comparison in the V,B-V and in the V, B-I Color-Magnitude Diagram (CMD) betweeen candidate Carina stars with three old, metal-poor Galactic Globular Clusters (GGCs, M53, M55, M79). We found that only the more metal-poor GCs (M55, [Fe/H]=-1.85; M53, [Fe/H]=-2.02 dex) provide a good match of the old Carina stars. We performed a similar comparison in the V,V-I CMD using three intermediate-age clusters (IACs) of the Small Magellanic Cloud (Kron 3, NGC 339, Lindsay 38). We found that the color extent of the SGB of the two more metal-rich IACs (Kron 3, [Fe/H]=-1.08; NGC339, [Fe/H]=-1.36 dex) is smaller than the range in color covered by Carina intermediate-age stars. Moreover, the slope of the RGB of these two IACs is shallower than the slope of the Carina RGB. However, the ridge line of the more metal-poor IAC (Lindsay 38, [Fe/H]=-1.59 dex) agrees quite well with the Carina intermediate-age stars. Current findings indicate that the Carina old stellar population is metal-poor and with limited spread in metallicity (0.2-0.3 dex). The Carina intermediate-age stellar population can hardly be more metal-rich than Lindsay 38 and its spread in metallicity also appears modest. The above results are at odds with recent spectroscopic investigations suggesting that Carina stars cover a broad range in metallicity (-2.5<[Fe/H]<-0.5 dex). We also present a new method to estimate the metallicity of complex stellar systems using the difference in color between the red clump and the middle of the RR Lyrae strip. We found for Carina a metallicity of [Fe/H]=-1.70 $\pm$ 0.19. This estimate agrees quite well with spectroscopic measurements. We also present the preliminary spectroscopic results concerning the radial velocity distribution of Carina stars. In order to provide accurate measurements of radial velocities for intermediate (red clump, m_v=20.25 mag) and old (horizontal branch, m_v=20.75 mag) subpopulations, we collected a sizable sample of low-resolution spectra (359) with FORS2@VLT. These data were complemeted with intermediate and high-resolution spectra collected with Giraffe@VLT. We ended up with a sample of 1500 radial velocities covering the entire galaxy. The overall accuracy is on average better than 2 km/s and for the first time we can investigate the radial velocity distributions using robust tracers for the old and of the intermediate-age subpopulations.

2.18 Transtion type dwarfs

Authors: Mina Koleva, Philippe Prugniel, Antoine Bouchard, Sven De Rijcke **Poster**

Abstract: From the mid 80s, it was proposed (Sandage & Binggeli 1984) that the late and early types of dwarf galaxies, may have evolutionary connection. Resolved population studies suggest (Skillman et al., 2007), that a shut down of the star formation in an irregular galaxy will turn it onto an elliptical dwarf only after half a Gyr of passive evolution. This theory is supported by the discovery of galaxies which have the smooth isophote appearance of early type galaxies, but still contain sufficient amount of gas which can feed future star formation. We focus on this latter population of transition type galaxies. We compare the SFHs from dwarf elliptical galaxies (Koleva et al 2009) with the sample of transition type dwarfs from SDSS. We conclude that except of the last few Gyrs the both classes have similar SFHs.

2.19 Getting the star formation history from spectra: What can we trust?

Authors: M. Koleva, A. Vazdekis, I. de la Rosa, P. Sanchez-Blazquez, J. Cenarro **Poster**

Abstract: To determine the star formation history of galaxies we can use fossil record methods. Beside the color-magnitude diagrams analyzes which are well tested and widely accepted, the studies for integrated spectra are still young.

In order to assess their capabilities and limitations, we compare the results of three publicly available star formation recovery programs (StarLight, STECKMAP and ULySS).

3 Blue Compact Dwarfs

3.1 The interplay between massive stars, WR stars and the HI-HII chemical enrichment in star-forming galaxies

Authors: Kunth Daniel, Lebouteiller Vianney **Invited talk**

Abstract: Massive stars strongly influence the ISM in star-forming galaxies. First they produce metals, then they disperse them. I will review the evidences that point towards a complete mixing of heavy elements but will discuss the observational results showing a discrepancy between the metallicity as measured in the HII gas and the one measured from absorption lines that originates from the HI gas that surrounds the HII regions in a given object. How reliable are these measurements? We will address few important questions: are there pockets of metal enriched gas around massive stars? Are WR stars giving clues to this problem? Are WR galaxies more metal rich that others? Why? We will call for possible ways to pin down this problem in the future.

3.2 Investigating the Chemical Homogeneity of Low-Metallicity Blue Compact Dwarf Galaxies Using Integral Field Spectroscopy

Authors: B. James, Y. Tsamis, M. Barlow, M. Westmoquette, J. Walsh, A. Aloisi **Oral contribution**

Abstract: The study of the chemical and physical evolution of Blue Compact Dwarf (BCDs) galaxies is fundamental in our understanding of galaxy formation in the early Universe. Being nearby, BCDs serve as excellent laboratories to study chemical enrichment processes in often unblemished enrionments, in comparison to their high-redshift counterparts. It has been claimed in the past that in low-metallicity BCDs (12+log(O/H)<8.3), the N/O value is independent of metallicity (O/H ratio), implying the need to invoke a primary production of nitrogen in intermediate-mass stars, in addition to the secondary nitrogen produced from the CNO cycle in high-mass stars. In order to better understand this controversial issue, more extensive spatial information than that offered by traditional longslit spectroscopic methods, is required. We undertook an integral field spectroscopic study of the nebular gas within a sample of BCDs previously thought to have anomalously high N/O values. Here we present the results of this study for 3 BCDs: two with anomalous N/O values (Mrk996 and UM420) and one with more normal N/O values (UM462). We describe in detail how we derived the physical conditions (Te, Ne) as a function of position within the galaxy, and as a consequence, how this revealed both revised metallicities and normal N/O ratios. Abundances for other elements will also be discussed. In the case of Mrk996, which displays both narrow and broad component emission lines, we associated an increased N/O ratio with the broad component in the nebular gas clearly correlated with WR emission features. This is the first clear evidence of nitrogen self-enrichment of an HII region from WR stars. All the above mentioned results suggest that the nitrogen enrichment seen in the low-metallicity gas of these BCDs is not due to primary nitrogen production, as suggested by current theories. This investigation is also a direct proof that performing spatially resolved spectroscopy, and conducting a separate analysis of broad and narrow emission line components, are vital in deriving the 'true' chemical abundances of BCD galaxies.

3.3 What controls the gas random motions in dwarf galaxies?

Authors: A. Moiseev, A. Tikhonov, A. Klypin **Oral contribution**

Abstract: We present the analysis of the internal gas kinematics in the sample of 48 dwarf and blue compact galaxies. 3D spectroscopic observations have been made with a scanning Fabry-Perot interferometer of the SAO RAS 6-m telescope. Maps of the ionized gas velocity dispersion were constructed and compared with the H-alpha emission line brightness distribution. The 'intensity versus velocity dispersion' diagrams are used to detect regions of turbulent gas motions caused by star formation processes. The correlation between mean velocity dispersion and other integral properties (B-band and H-alpha luminosity, SFR, etc.) is considered. We discuss the origin of high (several tens of km/s) ionized gas velocity dispersion observed in dwarf galaxies. Do the gas random motions connect directly with a galaxy gravitational potential or feedback processes (SN bursts and massive stars winds) are more important? Pro- and contra-arguments are considered.

3.4 High Redshift Dwarf Galaxies from Lyman alpha Emission and Absorption

Authors: Michael Rauch **Oral contribution**

Abstract: Recent deep, spectroscopic searches for Lyman alpha emission have uncovered a large number density of faint emitters at redshifts ∼3. Their low star-formation rates, steep luminosity function, number densities and cross-section on the sky suggest a considerable overlap with the host galaxies of damped Lyman alpha absorbers, long suspected to be an observational signature of high redshift dwarf galaxies. The abundance of Lyman alpha emitters and the kinematics of damped Lyman alpha systems can be reconciled if both classes of objects inhabit the same, mostly low mass, dark matter halos.

We will describe relevant observations and report on recent modeling aimed at reconciling the various manifestations of high z dwarf galaxies.

3.5 On the truthful metallicty distribution of blue compact dwarf galaxies

Authors: Enrique Pérez-Montrero, Rubén García-Benito, Guillermo F. Hägele, Ángeles I.Díaz **Poster**

Abstract: Blue compact dwarf galaxies take up the low end of the distribution of metallicity as derived using collisional emission lines in ionized gaseous nebulae. In fact, the most metal poor objects in the Local Universe belong to this category. Nevertheless, the abundance discrepancy factor (ADF) found in some local HII regions whose metallicity have been derived by means of recombination lines and the offset claimed by some authors in relation to the predictions of some photoionization models question the real chemical status of these objects. In this contribution, I will show how tailor-made models of a subsample of HII galaxies with a good determination of the thermal inner structure can be used to shed some light on this issue, helping also to clarify the star formation history and the properties of their ionizing stellar clusters in these objects.

3.6 The Local Environments of Blue Compact Dwarf Galaxies

Authors: Eon-Chang Sung (KASI), Jaemann Kyeong (KASI), and Joon Hyeop Lee (KASI) **Poster**

Abstract: We present an extensive observations in optical, near inrared, and HI radio for a homogeneous sample of 115 blue compact dwarf galaxies and a study of dynamical environments for a sample of several BCDGs from SDSS DR6. We found that although BCDGs have well-shaped outer envelopes and the similar inner structure, their physical natures including the evolutionary status and the origin of starburst triggers are very different galaxy by galaxy. We introduce a new classification scheme of blue compact dwarf galaxies (BCDGs) based on environmental criteria; BCDGs can be classified into four groups; the isolated, the post-merger, the detached interacting, and the merger -in-progress. And also, we will discuss structural properties and evolutionary connections between dwarf galaxies based on surface photometry of a sample of BCDGs.

3.7 Study of Blue Compact Dwarf Galaxies at z=0.2–0.6 using SDSS DR7

Authors: J. Chung, E.-C. Sung, S.-C. Rey, S. Kim, Y. Lee, J. Kyeong **Poster**

Abstract: We present the mass-metallicity (M-Z) relation of 420 blue compact dwarf galaxies (BCDs) at z=0.2-0.6 using the Sloan Digital Sky Survey (SDSS) DR7 spectroscopic data. We derive gas phase oxygen abundances based on the classical Te method and the empirical method. For high redshift (z>0.35) sample, we estimate the oxygen abundance using IRAF Nebular/ionic task. Stellar mass of galaxy is derived from spectral synthesis code STARLIGHT. We also derive star formation rates of sample galaxies using Halpha and [O II] line luminosities Comparing sample between z=0.2 and z=0.4, we found different M-Z relations depending on the redshift in which metallicity evolution of low mass galaxies is stronger than that of high mass galaxies. The specific star formation rate (SSFR) shows tight correlation with galaxy mass in the sense that low mass galaxies have substantially high SSFR. Our results seem to support downsizing galaxy formation scenario. We also discuss environmental effect to SSFR vs galaxy mass relation in the sense that, at a given mass, merging system shows systematically higher SSFR than isolated one.

3.8 Kinematically detected polar rings in blue compact dwarf galaxies

Authors: A. Moiseev **Poster**

Abstract: Polar ring galaxies are systems with nearly orthogonally rotated components. We have found ionized gas on the polar orbits in two BCD galaxies using the H-alpha velocity fields taken with Fabry-Perot interferometer of the SAO RAS 6-m telescope. Our analysis shows that all ionized gas in Mrk 33 is concentrated in a compact disk (3 kpc in diameter) which rotates in the polar plane relative to the main stellar body. The Mrk 370 galaxy has two kinematically distinct gas components: circumnuclear disk nested in the stellar disk and external emission knots belong to the polar ring. We discuss the links between current burst of star formation in BCD galaxies and polar-rings phenomenon which is closely connected with the processes of intergalactic interactions and merging.

3.9 Star formation and star formation histories of Blue compact dwarf galaxies

Authors: Ramya .S, Prabhu T. P., Sahu D. K. **Poster**

Abstract: Blue compact dwarf (BCD) galaxies are dwarf galaxies currently undergoing a strong burst of star formation. It has been well established that BCDs are not forming stars for the first time. They all possess an older underlying population of stars. An attempt has been made here to shed light on the ages of these older populations, using the Starburst99 model. We show for the first time that populations with at least three different distinct age groups are clearly detected with ages of ∼1 Gyr, ∼500 Myr and the current burst of <10 Myr)

We thus infer quiescent periods of several 100 Myr between major bursts of star formation. The broad band UBVRI and H-alpha narrow band observational data of ∼15 nearby BCDs used in this analysis are obtained from the Himalayan Chandra Telescope (HCT) of Indian Institute of Astrophysics. Also, the low resolution spectra of the bright star forming regions of these 15 galaxies are obtained. The spectra are typical of HII region like spectra with innumerable number of emission lines. The diagnostic diagrams are emloyed to obtain the accurate ages of these HII regions. The results obtained from the above analyses will be presented in the poster.

4 ISM and Star Formation

4.1 Gas and Star Formation in Dwarf Galaxies

Authors: Evan D. Skillman **Invited talk**

Abstract: Resolved observations of nearby galaxies help us to understand the relationship between gas and star formation in dwarf galaxies. The star formation histories recovered from their fossil records place constraints on how much gas dwarf galaxies could have acquired at early times. Are dwarf galaxies able to accrete a significant amount of gas at later times, or is the bulk of the gas in place once the dwarf galaxy establishes its gravitational identity? In the current epoch, we have a wealth of observations which allow us to study the process of star formation. Spatially resolved, recent star formation histories allow us to ask fundamental questions such as: What conditions are required for star formation? What is the impact of the star formation on the structure of the ISM? Does star formation heat the ISM and consequently suppress future star formation, or does it compress the ISM and lead to more star formation? Does understanding star formation at z=0 help us to understand star formation at higher redshifts?

4.2 FIGGS: The Faint Irregular Galaxy GMRT Survey

Authors: Jayaram N Chengalur **Oral contribution**

Abstract: I will present results from FIGGS (Faint Irregular Galaxy GMRT Survey) observations of nearby dwarf galaxies. FIGGS is the largest existing systematic HI survey of nearby dwarf galaxies. The HI data are supplemented by multi-wavelength (HST, ground based broad band and H-alpha images, GALEX UV images etc.) data. In the context of hierarchical galaxy formation models nearby dwarf galaxies could be considered to be the analogs of the primeval building blocks of more massive galaxies, and detailed observations of them could help provide inputs and constraints to galaxy formation models.

Further, dwarf galaxies also provide unique sites for understanding star formation in extreme environments, with unusually low metallicity and dust content, low pressure, low shear, and low escape velocity. I will present results for the morphology of the gas disks, kinematics and mass models for the galaxies, scaling relations (Tully-Fisher and Baryonic Tully-Fisher) and star formation recipes derived from our observations.

4.3 The Dust and Gas properties of Low Metallicity Dwarf Galaxies as Viewed by the Herschel Space Observatory

Authors: S. Madden, F. Galliano, M. Galametz, B. O'Halloran, D. Cormier & the Herschel PACS and SPIRE consortia **Oral contribution**

Abstract: The Herschel Dwarf Galaxy Survey investigates the dust and gas properties of local universe dwarf galaxies using the new FIR and submm imaging spectroscopic and photometric observations from the recently launched Herschel Space Observatory Most of the galaxies of the survey possess massive young star clusters and/or super star clusters, which represent unusual and relatively rare modes of star formation with stellar surface densities orders of magnitude in excess of normal HII regions and OB associations. The combination of the high angular resolution, high sensitivity and the 50 to 550 micron coverage of Herschel provides a unique opportunity to study the impact of the star formation activity on the properties of the metal-poor gas and dust. We have mapped the galaxies in up to 7 FIR fine-structure lines (63 and 145 mu OI, 158 mu CII, 122 and 205 mu NII, 88 mu OIII, 57 mu NIII) and we find dramatic variations in the line ratios throughout the galaxies, giving us, for the first time, probes of the low density ionised gas, the HII regions and photodissociation regions in dwarf galaxies. We find line ratios in the metal-poor ISM which are characteristically different than those in the metal-rich environments, highlighting the different filling factors of neutral versus ionised gas. The dust properties are also very different in the metal-poor environment compared to those of our Galaxy or the more metal-rich galaxies. We model the dust spectral-energy distributions which are well-constrained with the new Herschel as well as MIR Spitzer data and find, generally hotter dust temperatures throughout galaxies, as well as significant cold dust mass which has also been previously suggested to be present in dwarf galaxies from ground-based submillimeter obervations. The Herschel Dwarf Galaxy survey will give us statistical information on the nature of the dust and gas in low metallicity galaxies and provide constraints on the chemical evolution of galaxies.

4.4 Supernova Remnants and Planetary Nebulae in NGC 4214

Authors: Michael A. Dopita and the WFC3 SOC Team **Poster**

Abstract: We present narrow band, continuum subtracted H*alpha*, [SII], H*beta*, [OIII] and [OII] SOC team early-release data taken with the Wide Field Camera 3 on the Hubble Space Telescope in the nearby dwarf starburst galaxy NGC 4214. From these images, we identify seventeen new planetary nebula candidates, and seven supernova remnant candidates. We also identify a number of unusual high-excitation nebulae. We use the observed emission line planetary nebula luminosity function (PNLF) of the planetary nebulae to establish a new velocity-independent distance to NGC 4214 of 3.19*pm*0.36 Mpc.

4.5 Relation between gas and star formation in faint dwarfs

Authors: S. Roychowdhury, J. N Chengalur, S. S. Kaisin, A. Begum, I. D. Karachentsev **Poster**

Abstract: We use data from the FIGGS HI survey from the GMRT, and 6m BTA telescope H-alpha survey data, supplemented with archival GALEX FUV data to study correlations between gas and star formation in Local Volume dwarf irregular galaxies. Along with disk-averaged properties for each galaxy, pixel by pixel correlations between star formation rates and gas densities are also done. Empirical laws like the Schmidt-Kennicut law and star formation thresholds are investigated, as also the inter-relationship between H-alpha and FUV emission as star formation rate indicators, for each individual galaxy as well as collectively for the entire sample. I plan to present the results of these investigations.

4.6 Thin discs, thick dwarfs and the importance of feedback effects

Authors: R. Sánchez-Janssen, J. Méndez-Abreu, J.A.L. Aguerri **Poster**

Abstract: We investigate the role of stellar mass in shaping the intrinsic thickness of faint systems by determining the probability distribution of apparent axis ratios for two different samples that probe the faint end of the galaxy luminosity function (M_B < -8). We find that the (b/a) distribution has a characteristic 'U-shape' and identify a limiting mass M $\sim$ 2x10^9 Msun below which low-mass galaxies start to be systematically thicker. We argue that this is the result of the complex interplay between galaxy mass, specific angular momentum and stellar feedback effects: the increasing importance of turbulent motions in lower mass galaxies leads to the formation of thicker systems. We find a good agreement between our results and the latest numerical simulations of dwarf galaxy formation, and discuss several further implications of this finding.

4.7 Ionized gas and sources of its ionization in the Irr galaxy IC10

Authors: Egorov O.V., Arkhipova V. P., Lozinskaya T. A., Moiseev A. V. **Poster**

Abstract: IC10 is the nearest starburst irregular galaxy, which is remarkable for its number of WR stars per unit luminosity, the highest in the LG. About sixty star clusters have been found in this galaxy. We have observed IC10 with the 6-m telescope of the Special Astrophysical Observatory of the Russian Academy of Sciences. Five spectrograms were taken with SCORPIO focal reducer operating in the slit spectrograph mode. Six fields were taken with the integral-field Multi-Pupil Fiber Spectrograph (MPFS). We used the observational data to analyze the emission spectra from HII-regions ionized by star clusters and the WR stars. Our analysis allowed us to reduce the scatter of oxygen abundances of HII-regions. We used the new evolutionary models of emission-line spectra from HII regions computed by Martin-Manjon, Garcia-Vargas et al (2009) to determine the masses and ages of ionizing star clusters in the violent star formation region in the galaxy. We have estimated amount of stars needed to ionize the gas in the brightest HII-region HL 111 in IC10.

4.8 Dwarf galaxies in nearby groups of galaxies

Authors: J. Vennik and U. Hopp **Poster**

Abstract: Dwarf galaxies outnumber the bright galaxies in poor groups and clusters of galaxies. Yet, the properties of dwarf galaxy population outside the Local Volume and their dependence on different group environments are still poorly understood. The low-mass and low-density dwarfs are expected to show the most significant signs of environmental influences and provide ideal testbed for evolutionary scenarios of galaxies and their aggregates. We have selected new dwarf galaxy candidates in a sample of fairly isolated nearby groups of galaxies, based on photometric and morphological criteria. The main aim of our project is to investigate the impact of the group environment on the evolution of its dwarf members by means of measuring and comparing their structural and star-forming (SF) properties, conditioned by the local environment both in the dense core as well as in the sparse halo (or in-fall region) of the group. To this purpose we have combined our own CCD imaging data and spectral observations, obtained with the Hobby-Eberly telescope, with archival data from the SDSS. Here we report the photometric characteristics and SF properties of new dwarf galaxies in studied groups.

4.9 Investigating Metal Abundances of Gas Rich Dwarf Galaxies in the Local Volume with WiFeS

Authors: David C Nicholls, Michael A Dopita, Helmut Jerjen **Poster**

Abstract: Using an optically-unbiased selection process based on the recent blind HIPASS neutral hydrogen survey, we have identified over 300 spatially isolated, gas-rich dwarf galaxies in the southern hemisphere at distances between 350 and 1500km/s, with R-band luminosities and HI masses less than the Small Magellanic Cloud.

Many of these objects have not been studied to date. We are measuring nebular abundances in ionised hydrogen clouds associated with star formation regions, using the strong line and direct methods, from observations with the highly efficient WiFeS wide field IFS at the 2.3m ANU telescope at Siding Spring. One of the aims is to test the statistical robustness of the low end trend seen in the galaxy

mass-metallicity relation, eg from Lee et al. (2006). I will discuss the target sample, noting the apparent over-abundance of Blue Compact Dwarfs, and present first results from our WiFeS observing runs.

4.10 A Radio Perspective on Star Formation in II Zw 40

Authors: Amanda Kepley, Amy Reines, Kelsey Johnson, Adam Leroy **Poster**

Abstract: Star formation in the low mass and low metallicity environments of dwarf galaxies provides important clues about how star formation proceeded in the early universe. To measure the properties of youngest star forming regions – those closest to stellar birth conditions – one needs to use an extinction-free tracer of thermal emission, such as free-free continuum emission in the radio, to penetrate the dust surrounding these regions. We present high sensitivity and high resolution observations of the radio continuum emission in the low metallicity dwarf galaxy II Zw 40. We identify 7 radio continuum sources beyond the four already identified by Beck et al. 2002 and use the radio continuum emission to derive the number of ionizing photons, the extinction, and the star formation rate of each source. We also use HST ACS data to determine the ages of the optical clusters. From these measurements II Zw 40 appears undergoing a second, weaker, round of star formation in the central region. To determine the amount of fuel remaining for star formation in this galaxy, we have obtained single dish CO(1-0) data for II Zw 40. The CO(1-0) emission in this galaxy is relatively weak, suggesting that the the CO emission in this galaxy may have been suppressed by it's harsh environment and that its current star formation episode is nearly over.

4.11 A probe for dust content of the nearby low surface brightness dwarf irregular galaxy: IC1613

Authors: I-Chenn Chen **Poster**

Abstract: By using multi-wavelength data (optical: CFHT, near-IR: 2MASS & IR: Spitzer), we try to address a new method, the "degree of obscuration" (reddening) of the detected background sources, to determine dust content of the nearby low surface brightness dwarf galaxy, IC1613. We will show our up to date result in this poster.

4.12 The Difference Between Neutral- and Ionized-Gas Metal Abundances in Local Star-Forming Galaxies with COS

Authors: B. James, A. Aloisi, T. Heckman, H. McLaughlin, K. Sembach, M. Tosi **Poster**

Abstract: The metallicity of galaxies and its evolution with redshift is of paramount importance for understanding galaxy formation. Abundances in the interstellar medium (ISM) are typically determined using emission-line spectroscopy of HII regions. However, since HII regions are associated with recent SF they may not have abundances typical for the galaxy as a whole. This is true in particular for star-forming galaxies (SFGs), in which the bulk of the metals may be contained in the neutral gas. It is therefore important to directly probe the metal abundances in the neutral gas. This can be done using absorption lines in the Far UV. We have developed techniques to do this in SFGs, where the absorption is measured for sightlines toward bright SF regions within the galaxy itself. We have successfully applied this technique to a sample of galaxies observed with FUSE. The results have been very promising, suggesting in I Zw 18 that abundances in the neutral gas may be up to 0.5 dex lower than in the ionized gas. However, the interpretation of the FUSE data is complicated by the very large FUSE aperture (30 arcsec), the modest S/N, and the limited selection of species available in the FUSE bandpass. The advent of COS on HST now allows a significant advance in all of these areas. We will therefore obtain absorption line spectroscopy with G130M ($\sim$1150-1450 A) in the same sample for which we already have crude constraints from FUSE. The results will provide important new insights into the metallicities of galaxies, and into outstanding problems at high redshift such as the observed offset between the metallicities of Lyman Break Galaxies and Damped Lyman Alpha systems. Here we present the preliminary results of a few galaxies, including the renowned low-metallicity blue compact dwarf galaxies SBS0335-052 and SBS1415+437.

4.13 Rendez-vous of dwarfs

Authors: R. Uklein **Poster**

Abstract: We present spectral observations of multiple system of dwarf galaxies with Russian 6-m telescope. It is part of our project "Group of dwarf galaxies in the Local Supercluster". The group of galaxies under consideration looks like filament of 5 dwarfs. Two faint galaxies show peculiar structure. Long slit spectra reveal inner motions in the dwarf galaxy about 150 km/s. It suggests that the galaxy is on stage of ongoing interaction. Probably, we see the group in moment of its formation. Such groups are deserve a detailed study in HI line with high coordinate resolution.

4.14 Unveiling the nature of the "green pea" galaxies: oxygen and nitrogen chemical abundances

Authors: Ricardo O. Amorín, E. Pérez-Montero & J.M. Vílchez **Poster**

Abstract: We have investigated the oxygen and nitrogen chemical abundances in extremely compact star-forming galaxies with redshifts between 0.11-0.35, popularly referred to as "green peas". Direct and strong-line methods sensitive to the N/O ratio applied to their SDSS spectra reveals that these systems are genuine metal-poor galaxies, with mean oxygen abundance 20% solar. At a given metallicity these galaxies display systematically large N/O ratios compared to normal galaxies, which can explain the strong difference between our metallicities measurements and previous ones. While their N/O ratios follow the relation with stellar mass of local star-forming galaxies in the SDSS, we find that the mass–metallicity relation of the "green peas" is offset >0.3 dex to lower metallicities. We argue that recent interaction-induced inflow of gas, possibly coupled with a selective metal-rich gas loss, driven by supernova winds, may explain our findings and the known galaxy properties, namely high specific star formation rates, extreme compactness, and disturbed optical morphologies. The "green pea" galaxy properties seem to be not common in the nearby Universe, suggesting a short and extreme stage of their evolution. Therefore, these galaxies may allow us to study in great detail many processes, such as starburst activity and chemical enrichment, under physical conditions approaching those in galaxies at higher redshifts.

4.15 Panchromatic Observations of Extreme Star Formation in Dwarf Galaxies

Authors: Amy E. Reines & Kelsey E. Johnson **Poster**

Abstract: In the earlier universe, the cosmic star formation rate was high and the formation of massive star clusters in low-mass, low-metallicity galaxies was common. In the local universe, super star clusters are the most extreme clusters with properties expected for young globulars. Packed with massive stars, these clusters can have a major impact on the energetics and morphology of their host galaxies, especially dwarfs with shallow potential wells. By combining multi-wavelength observations from the radio to the ultraviolet, we aim to improve the current understanding of the birth and early evolution of super star clusters in local dwarf starbursts and thereby gain insight into the origin of globular clusters in the early universe.

4.16 HI in Local Group Dwarfs

Authors: Grcevich, Jana; Putman, Mary; Heitsch, Fabian: Peek, Josh; Saul, Destry **Poster**

Abstract: Most of the newly discovered ultra-faint dwarfs are found to have no detectable HI. Combining what is known about the HI content of these and other Local Group Dwarfs, we find that those dwarf galaxies within 270 kpc of the Milky Way tend not to have gas. I will explore ram pressure stripping as a possible means of gas loss in these dwarfs via hydrodynamic simulations of dwarf galaxies as they move through a hot halo medium similar to what might be encountered in orbit. Gas loss seen in these simulations are compared to the commonly used analytical stripping criterion and the gas loss timescale is determined for various cases. Finally, the possibility of finding additional ultra-faint dwarf galaxies through the detection of their HI will be discussed along with the progress of an automated search of the GALFA (Galactic Arecibo L-Band Feed Array) survey data for discrete clouds, some of which may be previously undiscovered dwarfs.

4.17 The spatial distribution of the HeII emission line in compact HII galaxies

Authors: Patricio Lagos, Casiana Muñoz-tuñón **Poster**

Abstract: In this work, based on new Integral Field Unit spectroscopic observations on Gemini South telescope, we study the spatial distribution of the HeII 4686 emission line and its relationship with the properties of the interestellar medium in a sample of compact HII galaxies. We explore the possible mechanisms responsible for the emission of these high-ionization emission lines: high-mass X-ray binaries, WR stars and radiative shocks moving through a dense interstellar medium.

4.18 Merging or Interacting? Determining the Nature of the Large-Scale Structure Around NGC 1569

Authors: Megan Jackson, Deidre Hunter and Felix J. Lockman **Poster**

Abstract: We present a preliminary large-scale, neutral Hydrogen emission map of structure around dwarf irregular galaxy NGC 1569. This galaxy is one of the nearest examples of a starburst system and therefore provides a detailed look at a process that is important in the early universe. NGC 1569 is a member of the IC 342 galaxy group and IC 342 is the nearest large spiral to NGC 1569. Our primary objective was to search for HI structure potentially connecting NGC 1569 with IC 342 as an explanation for the starburst and peculiar kinematics prevalent in NGC 1569. These data were taken earlier this year with the Robert C. Byrd Green Bank Telescope. We mapped a 9x2 degree region that includes NGC 1569 and IC 342 as well as two other dwarf galaxies, with a 2x1 degree appendage to the south of NGC 1569. We did not detect structure connecting NGC 1569 with IC 342 with our sensitivity limits, however, we did detect a large, half-degree, cold HI cloud sitting directly on top of NGC 1569 along with what appears to be two tidal tails extending out toward UGCA 92, a nearby dwarf galaxy. These tidal tails extend for about 1.5 degrees and may be the remnants of two systems that had merged and have now formed NGC 1569. Other explanations for this structure include possible RAM pressure stripping of the HI gas from members of the IC 342 group, or interaction between NGC 1569 and UGCA 92. We plan to investigate these scenarios by using hydrodynamic simulation methods. If an expert in these simulations is interested in collaborating, please let us know!

5 Dwarf ellipticals

5.1 Early-type dwarf galaxies: origin, characteristics, cosmological relevance

Authors: Thorsten Lisker **Invited talk**

Abstract: Early-type dwarf galaxies exhibit a puzzling variety of observable properties. Are they at all a single class of objects? Could some of them be "primordial" galaxies, while others were created by environmental processes? Which unsolved problems still need to be investigated to enable the use of early-type dwarfs as probes of the history of different environments and as tests for cosmological models of galaxy formation? The review will address these questions and summarize our current knowledge on early-type dwarf galaxies.

5.2 Population gradients in diffuse elliptical galaxies

Authors: Mina Koleva, Philippe Prugniel, W. W. Zeilinger, Sven De Rijcke **Oral contribution**

Abstract: Radial gradients of the stellar populations have been found in dE galaxies with mass around 10^9 $M_\odot$. The mean age is lower in the central region by typically 0.3 dex, corresponding to a star formation history which extended until a few hundreds Myr ago. In about 2/3 of the galaxies the metallicity decreases outwards. In the other 1/3 of the galaxies the metallicity profile is flat. The gradients are already present in the oldest generation of star (10 Gyr). This implies, that the gradients had time to set up relatively fast, and that they were not erased. It was suggested (Koleva et al. 2009) that the absence of gradient in some of the galaxies may coincide with the presence of a disk.

In this presentation, we will discuss the mass vs. gradient relation and revisit the question of the diversity of these gradients using new observational results. What are the evidence for a relation between

the gradient and the disckyness? Does the environment play a role? What physical mechanisms control the gradients?

5.3 The origin of dwarf early-type galaxies in the Virgo cluster

Authors: E. Toloba, A. Boselli, J. Gorgas, R. Peletier **Oral contribution**

Abstract: With a sample of 21 dwarf early-type galaxies (dEs), 18 of which in Virgo and the rest in the field, we have made a systematic study of their kinematics to analyse their origin and evolution. Galaxies can be distinguished between rotationally supported and pressure supported dEs. Our analysis shows that rotationally supported systems are on average located at a higher distance from the cluster core and are younger than pressure supported objects. We interpreted these evidences as an index of a different origin and evolution of dEs. Those in the outskirts could be disc galaxies that, after a recent ram pressure stripping event, transformed into red quiescent systems, while those in the center of the cluster could have had a different origin: they could be disc galaxies transformed by the harsh cluster environment (ram pressure and/or harassment) or be true ellipticals formed in the core of the cluster.

5.4 The effect of local environment on cluster dwarf galaxies

Authors: Samantha J. Penny, Christopher J. Conselice, Sven De Rijcke, Enrico V. Held, John S. Gallagher III, Robert W. O'Connell **Oral contribution**

Abstract: Using Hubble Space Telescope ACS and WFPC2 imaging, we investigate the effect of local environment on the dwarf galaxy population of the Perseus Cluster. We compare the galaxy populations in both the dense core and sparser outer regions of the cluster, to a distance of 600 kpc from the cluster center. Dwarfs in both environments lie on the same red sequence, which closely matches that found for other nearby clusters. The morphologies of these dwarfs are examined by quantifying their light distributions. We find that dEs in the cluster outskirts are on average more disturbed than those in the core. Based on these results, we infer that these objects are "transition dwarfs", likely in the process of transforming from late-type to early type galaxies as they infall into the cluster, with their colours transforming before their structures.

5.5 Early-type Galaxies from Dwarfs to Giants: Observed Characteristics Meet Predictions from LambdaCDM

Authors: Joachim Janz and Thorsten Lisker **Poster**

Abstract: Based on the wealth of multiwavelength imaging data from the SDSS, we investigate whether dwarf and giant early-type galaxies in the Virgo cluster follow a continuum in their structural parameters and their stellar population characteristics. In particular, we study the relation between size and brightness and the color magnitude relation and find in both cases noticeable deviations from a simple joint behavior of dwarfs and giants. Nevertheless, we show that these findings alone are insufficient to rule out the possibility that both form as one family of objects within cosmological structure formation and share therefore one common origin.

5.6 Identifying the progenitors of dEs

Authors: Hagen T. Meyer, Thorsten Lisker **Poster**

Abstract: Dwarf galaxies are the most numerous type of galaxy in the Universe. In galaxy clusters, like the Virgo or Coma cluster, the most commen type of galaxies at small centre cluster radius or high density environment are early-type dwarf galaxies (dE). These dE do not form a homogenous class of galaxies, rather one find dEs with spiral structure, bars or disk features. While in regions with lower density one find gas rich spirals or irregular galaxies (late-type galaxies) with active star formation. Resent studies discussing the evolution of late-type galaxies into early-type dwarf galaxies and the different subclasses e.g. by ram-pressure stripping or harassment, but the physical processes and their influence on the transformation are not well understood at the moment. To investigated the properties and the future morphological evolution of Virgo cluster late-type galaxies, we derived their structural properties (such as effective radius, magnitude and surface brightness) and color characteristics from SDSS data. I will present the results of this project, thereby showing how the different types of late-type galaxies distribute

in the parameter space and how they compare to the Virgo dE population. Furthermore, I will present the time evolution of the derived colors by means of evolutionary synthesis model GALEV. The model grid contains a variety of star formation histories for different types of late-type galaxies, dust corrections and a chemical consistent treatment of the gas and stellar population of the galaxies. The evolutional tracks of these models will give interesting hints if the derived color space of the population of late-type galaxies will evolve into the color space of dEs.

5.7 Probing faint dwarf galaxies in nearby clusters: implications for galaxy evolution

Authors: Ingo Misgeld **Poster**

Abstract: The detailed morphological examination of faint dwarf galaxies has, until recently, been limited to the Local Group (LG) and the two very nearby galaxy clusters Virgo and Fornax. Here, we present the analysis of the early-type dE and dSph population in the more distant clusters Hydra I and Centaurus. With deep VLT/FORS1 images taken under excellent seeing conditions, we are able to study in-depth the photometric and structural parameters of a large number of dEs/dSphs, down to a limiting magnitude of about M_V=-10 mag, which is comparable to the LG dSph Sculptor. The colour-magnitude relation (CMR) defined by the brightest cluster galaxies is found to continue in a linear manner down to the faintest dEs. The CMRs in Hydra I and Centaurus are very similar to those observed in other galaxy clusters and the LG. This could imply that the present global photometric properties of dEs are predominantly determined by an evolutionary history similar to that of bright ellipticals, i.e. a major starburst at high redshift and a passive evolution since then. The dE sizes, given by their half-light radii, are compared to various other old stellar systems, such as giant elliptical galaxies, compact elliptical galaxies, globular clusters and ultra-compact dwarf galaxies.

5.8 A deep view on Virgo cluster dwarf galaxies

Authors: Stefan Lieder, Thorsten Lisker, Michael Hilker, Ingo Misgeld **Poster**

Abstract: We present an analysis of deep wide field imaging data (CFH12k) of the Virgo cluster center, down to the regime of galaxies with M_V=-10 mag. Dwarf galaxy candidates were identified using morphological and surface brightness selection criteria. We derived photometric and structural parameters of the candidates from the analysis of their surface brightness profiles. We trace fundamental scaling relations, such as colour-magnitude and magnitude-surface brightness relation in the low-mass regime. Specifically, we investigate the colour-magnitude relation of early-type galaxies over a large luminosity range, and construct the faint-end luminosity function of the Virgo cluster center.

5.9 SMAKCED - Stellar Populations, MAsses, and Kinematics of Cluster Early-type Dwarf Galaxies

Authors: T. Lisker, A. Boselli, R. Peletier, et al. **Poster**

Abstract: Once believed to be simple systems, early-type dwarf galaxies (dEs) were recently shown to exhibit an intriguing diversity in structure and stellar content. Do they have multiple origins, based on both environmental physics and LCDM structure formation? With the SMAKCED project we aim to use dEs of different subtypes as probes of galaxy evolution by means of a systematic characterisation, based on spectroscopy and multiwavelength imaging of a large, representative sample of Virgo cluster galaxies. The resulting fundamental scaling relations for dE subclasses will be a milestone for tracing back the origin of this dominant galaxy population in clusters.

5.10 3D Spectroscopy of dwarf elliptical galaxies

Authors: Olga K. Silchenko **Poster**

Abstract: I present results of 3D spectroscopy for a small sample of dwarf elliptical galaxies, mostly members of small groups. The galaxies under consideration have a typical absolute magnitude of -18 (B), and at the Kormendy's relation they settle within a transition zone between the main cloud of giant ellipticals and the sequence of diffuse ellipticals. By mapping the 'SSP-equivalent' ages and metallicities of stellar populations over the central parts of the sample galaxies, I have found evolutionary distinct

cores in all of them. Typically, the ages of these cores are 2-4 Gyr, and the metallicities are higher than the solar one. Outside the cores, the stellar populations are very old, T>12 Gyr, and the metallicities are subsolar. This finding implies that the well-known correlation between the stellar age and the total mass (luminosity) of field ellipticals (Trager et al. 2000, Caldwell et al. 2003, Howell 2005) may be in fact a direct consequence of a larger contribution of nuclear starbursts into the integrated stellar population in dwarfs with respect to giants, and does not relate to 'downsizing'.

5.11 A SAURON study of dwarf elliptical galaxies in the Virgo Cluster

Authors: Agnieszka Rys, Jesus Falcon-Barroso **Poster**

Abstract: Dwarf elliptical galaxies are the most common galaxy type in nearby galaxy clusters, yet they remain relatively poorly studied objects and many of their basic properties have yet to be quantified. Traditional long-slit observations are likely to miss more complicated kinematic features, but with the SAURON integral field unit on the William Herschel Telescope (La Palma) we are able to study both kinematics and stellar populations in two dimensions, obtaining an unprecedented view of the mass distribution and star formation histories.

In this contribution we will present the results of a SAURON study of five bright nucleated dwarf ellipticals (dEs) in the Virgo Cluster, drawn from the Lisker et al. (2007) list of all Virgo dEs. We will discuss the amount of kinematic and stellar population substructure present in our maps and compare them with the results coming from the SAURON survey for early-type (giant) galaxies. This will help us understand how the properties of these galaxies fit in the larger context of galaxy formation and evolution.

5.12 The stellar kinematics of the Phoenix dwarf galaxy

Authors: S.Zaggia, E. V. Held, et al. **Poster**

Abstract: The Phoenix dwarf galaxy is the nearest and most typical representative of the class of the so-called "transition" dwarf galaxies - i.e. dwarfs that show traits of dwarf spheroidal and irregular galaxies. Phoenix shows low-level recent star formation on top of a predominantly old and intermediate-age population (e.g., Hidalgo et al. 2009). Most interestingly, a small cloud of neutral gas seems to be physically associated to the stellar body (e.g., Young et al. 2007). To investigate the evolution of this paradigm dwarf galaxy, we have obtained medium- and high-resolution spectroscopy of more than a hundred member stars using FORS2, FLAMES and UVES at the ESO VLT. We present here precise velocity measurements from high-resolution spectroscopy allowing us to study the stellar kinematics and estimate the internal velocity dispersion and dark matter content of Phoenix. Our new results better constrain the physical and morphological evolution of this intriguing galaxy.

5.13 Photometric properties of dwarf galaxies in the Coma cluster

Authors: Mark den Brok, Reynier Peletier **Poster**

Abstract: The formation of dwarf galaxies in clusters is still an unsolved problem. Models of galaxy formation underpredict the number of observed dwarfs. Additionally, it is not clear which of the mechanisms that have been proposed to remove gas from dwarf galaxies dominates. In this talk, we present results from the Coma Cluster ACS Treasury Survey on photometric properties of dwarf galaxies, for which we have studied colours, colour gradients and structural parameters. Owing to the high sensitivity and resolution of our data, we are able to separate out the nuclear and the remaining components of dwarf galaxies and study the stellar populations of each component separately. Our results on colour gradients show that metallicity gradients in dwarf galaxies form a continuous sequence with elliptical galaxies, becoming shallower for fainter galaxies. I will discuss the relation between colour gradients and other photometric and structural properties, such as the presence of and stellar populations of nuclear star clusters.

6 Globular cluters, UCDs, cEs

6.1 The Dwarf galaxy–Ultra Compact Dwarf–Globular Cluster connection

Authors: Duncan Forbes **Oral contribution**

Abstract: Using an age-metallicity analysis, I will report recent results concerning the number of accreted dwarf galaxies and their globular cluster systems to the mass build-up of the Milky Way. This analysis suggests 6-8 accreted dwarf galaxies with 27-47 associated globular clusters. Turning to external systems, I will explore the connection between dwarf galaxies and ultra compact dwarf objects. In particular, highlighting the "missing link" region between the lowest mass dwarf galaxies and the highest mass ultra compact dwarfs. A census of dwarf galaxy populations is certainly incomplete without accounting for such objects. The exact nature of these transition objects also have a bearing on the question of dark matter and on the differences between small galaxies and star clusters (e.g. what is a galaxy?).

6.2 A census of ultra-compact dwarf galaxies in nearby galaxy clusters

Authors: M. Hilker **Oral contribution**

Abstract: Ultra-compact dwarf galaxies (UCDs) are predominatly found in the cores of nearby galaxy clusters. Besides the Fornax and Virgo cluster, UCDs have also been confirmed in the twice as distant Hydra I and Centaurus clusters. Having (nearly) complete samples of UCDs in these clusters allows the study of the bulk properties with respect to the environment they are living in. Moreover, the relation of UCDs to other stellar systems in galaxy clusters, like globular clusters and dwarf ellipticals can be investigated in detail with the present data sets. In particular, nucleated dwarf ellipticals are discussed as progenitors of UCDs due to the similarities between nuclear clusters and UCDs. In this presentation I will give an overview on our current knowledge about this special kind of dwarf galaxies.

6.3 UCDs in the Coma Cluster

Authors: Kristin Chiboucas, R. Brent Tully, Ronald O. Marzke, Steven Phillipps, James Price, Eric W. Peng, Neil Trentham, David Carter **Oral contribution**

Abstract: As part of the HST/ACS Coma Cluster Treasury Survey, we have undertaken a Keck/LRIS spectroscopic campaign to determine membership for faint dwarf galaxies. In the process, we discovered a population of Ultra Compact Dwarf galaxies (UCDs) in the core region of the Coma cluster. At the distance of Coma, UCDs are expected to have angular sizes $0.01 < R_e < 0.2$ arcsec. With ACS imaging, we can resolve all but the smallest ones with careful fitting. Candidate UCDs were chosen based on magnitude, color, and degree of resolution. We spectroscopically confirm 27 objects as bona fide UCD members of the Coma cluster, a 60% success rate for objects targeted with $M_R < -12$. We attribute the high success rate in part to the high resolution of HST data and to an assumed large population of UCDs in Coma. We find that the UCDs tend to be strongly clustered around giant galaxies, at least in the core region of the cluster, and have a distribution and colors that are similar to globular clusters. This current study provides the dense environment datapoint necessary for understanding the UCD population. We discuss the properties of the Coma cluster UCD population and potential origins.

6.4 Central massive objects in dwarf galaxies

Authors: Alister Graham, Lee Spitler **Oral contribution**

Abstract: We have identified one dozen galaxies housing both a nuclear star cluster (NC) *and* a supermassive black hole (BH), and obtained their masses. We quantify the transition from NC-to-BH dominance at the centres of dwarf-to-giant galaxies as a function of increasing mass (Graham and Spitler 2009).

6.5 Observational properties of globular clusters in dwarf galaxies

Authors: M.E. Sharina, R. Chandar, T.H. Puzia, P. Goudfrooij, E.Davoust **Oral contribution**

Abstract: We analyse evolutionary parameters of globular clusters in dwarf galaxies obtained in our

medium-resolution spectroscopic observations, and their connection with the properties of the host galaxies. We found that 1) the metallicity spread in globular cluster systems is wider for larger galaxies; 2) metal-rich clusters are young and preferentially found in galaxies more massive than $\sim 10^9$ $M_\odot$; 3) intermediate-age globular clusters in early-type dwarf galaxies are richer in metals than star clusters representing dynamically cold gas-rich environments in dIrrs; 4) the AMR is special for each galaxy, and depends not only on its mass, but also on some other factors, probably environmental conditions.

6.6 Chemodynamics of Compact Stellar Systems in NGC 5128

Authors: Thomas H. Puzia **Oral contribution**

Abstract: We will present velocity dispersion measurements for luminous GCs in NGC 5128 derived from high-res. UVES spectra. The measurements are made with the pPXF code that parametrically recovers line-of-sight velocity dispersions. Combining the measured velocity dispersions with surface photometry and structural parameter data from HST enables both dynamical masses and M/L ratios to be derived. The fundamental plane relations of these clusters are investigated in order to probe the apparent gap between the relations of Local Group GCs and more massive early-type galaxies. It is found that the properties of these massive stellar systems match those of nuclear clusters in dwarf elliptical galaxies and UCDs better than those of Local Group GCs, and that all objects share similarly old (>8 Gyr) ages, suggesting a possible link between the formation and evolution of dE,Ns, UCDs and massive GCs. We find a very steep correlation between dynamical (M/L) ratio and dynamical mass of the form $(M/L)_{dyn} \sim M_{dyn}^{(0.24\pm0.02)}$ above $M_{dyn} = 2x10^6$ $M_\odot$. Formation scenarios are investigated with a chemical abundance analysis using absorption line strengths calibrated to the Lick/IDS index system. The results lend support to two scenarios contained within a single general formation scheme. Old, massive, super-solar [alpha/Fe] systems are formed on short (<100 Myr) timescales through the merging of single-collapse GCs which themselves are formed within single, giant molecular clouds. More intermediate- and old-aged (∼3-10 Gyr), solar- to sub-solar [alpha/Fe] systems are formed on much longer (∼Gyr) timescales through the stripping of dE,Ns in the 10^{13}-10^{15} $M_\odot$ potential wells of massive galaxies and galaxy clusters.

6.7 Wandering Globular Clusters: the First Dwarf Galaxies in the Universe?

Authors: M. G. Lee, H. S. Park, H. S. Hwang, S. Lim, N. Hwang **Oral contribution**

Abstract: In the last decade we witness an advent of new types of dwarf stellar systems including UCDs, ultra-faint dSphs, and exotic globular clusters, breaking the old simple paradigm for globular clusters and dwarf galaxies. These objects become more and more intriguing, and understanding of these new findings becomes more and more challenging.

Recently we discovered a new type of large scale structure in the Virgo cluster of galaxies: it is composed of globular clusters, neither of galaxies nor of hot gas (Lee et al 2010, Science Express, Mar 11). Globular clusters are found wandering between galaxies (intracluster globular clusters) as well as in galaxies. These intracluster globular clusters fill a significant fraction in the area of the Virgo cluster. The nature of these intracluster globular clusters is not yet known. These intracluster globular clusters may be closely related with the first dwarf galaxies in the universe. Implications of our discovery will be discussed.

6.8 Exploring the evolution of early-type dwarf galaxy nuclei and UCDs through a comparative study of their stellar populations

Authors: S. Paudel, T. Lisker **Poster**

Abstract: We present a comprehensive spectroscopic analysis of the stellar population properties (age, metallicity and alpha-element abundance [*alpha*/Fe]) of representative samples of early type dwarf (dE) galaxies and ultra-compact dwarf (UCD) galaxies of the Virgo cluster. Our study includes a careful separation of the central nucleus and the underlying dE galaxy, enabling us not only to compare their stellar populations with each other, but also to compare nuclei to UCDs, as their proposed descendants. Our measured ages for most dE nuclei are lower than the respective underlying galactic halo, with 3.5 Gyr difference on average. In addition to that, we also find the dE nuclei to be more metal-enriched as

compared to their host galaxy. Their alpha-element abundances are consistent with the solar value for both nuclei and galaxies.

The derived UCD ages, metallicities, and alpha-element abundances agree with previous studies: the ages are consistently in the range of 8 to 12 Gyr and the metallicities are mostly sub-solar. On the other hand, the alpha abundance ratios become slightly super solar. Therefore, we argue that, being younger and less [*alpha*/Fe]-rich than the UCDs, the nuclei of dEs are not the progenitors of UCDs. We suspect that dE nuclei form at later epochs, via continuous infall of the gas in the central potential well.

6.9 Is Palomar 1 really associated with the CMa dwarf galaxy?

Authors: Ivo Saviane, Lorenzo Monaco, et al. **Poster**
Abstract: Based on its position in the age-metallicity relationship, Palomar 1 has recently been associated with the putative Canis Majoris dwarf galaxy. Using Subaru/HDS spectra of its red-giant branch stars we obtained abundances of several metals, which allow us to test this claim and to assess the nature of this peculiar stellar cluster.

6.10 Photometric Variability along the MS Omega-Centauri "Dwarf"

Authors: Momany, Moni Bidin, Saviane, Bianchini, Zaggia, et al. **Poster**
Abstract: Omega-Centauri is one of the most puzzling globular cluster systems that it has been suggested to be an accreted dwarf galaxy. In light of recent discovery of multiple main sequences, we have conducted a photometric variability search for low-amplitude variables among the anomalous and "canonical" sequences. The results of a 10-nights monitoring at the NTT are presented.

6.11 A deep look into the dense core of an accreted dwarf galaxy: Omega Centauri

Authors: Donatella Romano **Poster**
Abstract: In this contribution, I discuss the chemical properties of the complex stellar population of the Galactic globular cluster Omega Centauri. I demonstrate that all the major observational constraints available for this object, namely its age-metallicity relation, stellar metallicity distribution function and the behaviour of several abundance ratios as a function of metallicity, can be reproduced in the framework of a model where the cluster is the remnant of a more massive progenitor system, a dwarf Galactic satellite swallowed by the Milky Way many Gyrs ago. Key condition to satisfy all these constraints is that a galactic-scale outflow develops in Omega Cen's precursor. This galactic wind must be differential, i.e. it must mostly retain the elements ejected through slow winds by stars of all masses and mostly expel the elements restored to the ISM through fast stellar winds and/or SN explosions. In this context, the existence of extreme He-rich stars and of the Na-O anticorrelation in the cluster can be explained as well.

6.12 Direct evidence of tidal stripping of three compact elliptical (cE) galaxies discovered in SDSS DR7

Authors: Huxor, A., Phillipps, S., Price, J. & Harniman, R. **Poster**
Abstract: We present two compact galaxies, found in a search of SDSS DR7, which exhibit clear evidence of tidal steams. The galaxies are low mass, have small effective radii, and their spectra indicate that they possess young to intermediate-age stellar populations. Additional CFHT and WHT imaging is used in these galaxies to derive detailed structural parameters. These cEs provide direct evidence for the process of tidal stripping that is believed to be the origin of M32-type galaxies, providing a "smoking gun". These compact galaxies are found in small groups, suggesting that we may be seeing the formation of such galaxies in dynamically young galaxy environments. This may be additional evidence of the 'pre-processing' of galaxies prior to the assembly into large clusters. One is found in a group not unlike the Local Group itself, and thus provides an additional model for understanding M32.

6.13 Detailed Chemical Abundances of Extragalactic Globular Clusters Using High Resolution Spectroscopy

Authors: Janet E. Colucci, Rebecca A. Bernstein, Scott Cameron, Andy McWilliam **Poster**

Abstract: We have developed a new technique that allows us to measure detailed abundances of globular clusters (GCs) in galaxies within 4 Mpc using high resolution spectra obtained with current telescopes and instruments. Our method is based on standard methods for analysis of single stars and has been tested with a "training set" of GCs with known properties in the Milky Way and LMC. This technique allows us to measure abundances of ∼20 elements in galaxies that are too distant for high resolution abundance analysis of individual stars. Here we present abundances for clusters in the Local Group dwarf galaxies NGC 6822, NGC 205, WLM, the SMC, and the LMC. Our results to date show that these samples have abundances consistent with the field stars in their respective galaxies (where such abundances are available), demonstrating an interesting connection between GCs, star formation history and galaxy evolution even in these low mass systems. In addition, our results show that low-resolution line indexes of GCs do not produce accurate results for alpha-element abundances in particular. Here we discuss our abundances for Fe, Fe-peak, alpha-, and light-elements in these clusters.

6.14 Ultra-Compact Dwarfs as Probes of the Merger Histories of Galaxies

Authors: Mark A. Norris, Sheila J. Kannappan **Poster**

Abstract: Ultra Compact Dwarfs (UCDs) are a class of stellar system with properties intermediate between those of Globular Clusters (GCs) and dwarf galaxies. We have discovered the first UCD that is clearly the result of the recent (< 3Gyr) stripping of a gas-rich dwarf galaxy. We demonstrate that it is possible to reliably identify such objects and separate them from a second population of UCDs resulting from massive star cluster formation in starbursts, thereby providing a probe of both the major and minor merger histories of individual galaxies. We go on to present a formation scenario that unifies the evolution of GCs, UCDs and dwarf nuclei.

6.15 The UV-metallicity Characteristics of UCDs, GCs and dEs in the Fornax Cluster

Authors: Arna M. Karick, Michael Gregg, Marla Geha **Poster**

Abstract: The remarkable variation of UV-optical ratios in elliptical galaxies suggests that the observed "UV-excess" may be uniquely sensitive to their star formation histories and chemical enrichment. While the stellar evolutionary phase responsible for creating this "excess" is fairly well understood (He-rich, hot-HB stars), the UV emission of an integrated stellar population and its dependence on global charactersitics such as metallicity is far more complex. Because they are mostly simple stellar populations with small dispersion in age and abundance, globular clusters (GCs) have been considered good calibrators for understanding these global characteristics.

Ultra-compact dwarf galaxies (UCDs) may provide an alternative, more luminous calibrator of the UV-excess in early-type galaxies. Near- and far-UV GALEX imaging provides tantalising hints that at least some UCDs exhibit a "UV-excess" comparable to the UV-luminous GCs in M87. We present the FUV$-Mg_2$ relation for Fornax Cluster UCDs (bright GCs) from GALEX imaging and our Magellan/IMACS spectroscopy, and compare them with fainter NGC1399 GCs and cluster dE,Ns. By combining GALEX imaging with our optical g,r,i imaging, we also show that the UV-optical properties of Fornax UCDs and NGC1399 GCs, provide an efficient tool for discriminating between new candidates and foreground stars in ground based images.

6.16 Old Halo Star Clusters in Nearby Starburst Galaxy M82

Authors: Sungsoon Lim, Myung Gyoon Lee, and Narae Hwang **Poster**

Abstract: M82 is a mysterious starburst dwarf galaxy in the nearby universe. Because of its notable starburst activity, most previous studies of this galaxy focused on young stellar populations and various types of interstellar medium. Star clusters are also an excellent probe to study the evolution of starburst galaxies. Numerous star clusters with young to intermediate age were found in the disk region as well as in the central region of M82, and they were used for studying the star formation history of M82 disk in

several studies. However, little is known about star clusters in the halo of M82. M82 is almost edge-on so that it is a good target to study the halo population of a galaxy. We present a study of star clusters in the halo of M82. We found about 10 compact star clusters (including two previously known clusters) in the halo region of M82 using the HST/ACS images. They are located at 1-4 kpc from the galactic plane, and some of them show several resolved stars. These clusters are found to be older than 3 Gyrs and metal-poor so that they are probably old globular clusters belonging to the halo. Implications of these results will be discussed.

6.17 Formation Efficiencies of Old Globular Clusters - form dwarf to giant galaxies

Authors: Iskren Y. Georgiev, Thomas H. Puzia, Paul Goudfrooij, Michael Hilker **Poster**

Abstract: When the number, luminosity or mass of the entire globular cluster (GC) system is normalized to the host galaxy luminosity or mass this defines the fundamental quantities specific frequency (S_N), luminosity (S_L) and specific mass (S_M) of GCs. These indicate how efficiently galaxies form GCs per unit of their luminosity or mass. Dwarf galaxies seem to form very efficiently GCs. This efficiency of GC formation decreases with increasing galaxy mass to a minimum at absolute galaxy magnitude of M_V = -20.5 mag ($L_V = 10^{10}$ $L_\odot$) and rapidly increases for giant galaxies. The two extreme galaxy mass regimes, dwarfs and giants, seemingly form old GCs in similar proportions. We investigate this surprising trend with observations of GC populations of faint, mainly late-type dwarf galaxies (M_V = -16 mag) in low-density environments with HST/ACS. In order to sample the entire range in galaxy mass (M_V = -10 to -23 mag = 10^6-10^{11} $L_\odot$), environment, and morphology we augment our sample with data of spiral and elliptical galaxies from the literature, in which old GCs (t>4 Gyr) are reliably detected. This large dataset confirms that, irrespective of galaxy type, the increase of the specific frequencies of GCs above and below galaxy magnitude of $M_V \sim$ -20.5 mag and that the S_L value of early-type galaxies is twice that of late-type systems at a given luminosity and mass. To investigate the observed trends which have not yet been conclusively explained for the entire galaxy mass range, we derive theoretical predictions of GC system scaling parameters as a function of the total host galaxy mass based on the models of Dekel & Birnboim (2006) in which star-formation processes are regulated by stellar/supernova feedback below a stellar mass of 3*10^{10} $M_\odot$, and by virial shocks above it. We find that our analytical model describes remarkably well the shape of the GC system scaling parameter distributions with a universal specific GC formation efficiency, eta, which relates the total mass in GCs to the total galaxy halo mass. The observed deviation in eta values compared to what is expected from the mean model prediction reflects variations in the individual galaxy SFH, merging history, different conditions of cluster formation and destruction for the entire range in galaxy mass, as well as the stochastic nature of star formation dominant in low-mass galaxies.

6.18 Internal Dynamics of the Most Luminous Fornax Cluster Ultra-compact Dwarf

Authors: M. Frank, M. Hilker, S. Mieske, H. Baumgardt, E. K. Grebel **Poster**

Abstract: Within the past decade, a new morphological class of compact stellar systems, the so-called ultra-compact dwarfs (UCDs), has been established. With luminosities of $-14 < M_V < -11$ mag, half-light radii of $10 < r_h < 100$ pc, dynamical masses of $2times10^6 < m < 10^8$ solar masses and predominantly old stellar populations, UCDs populate a regime intermediate between classical early-type dwarf galaxies and globular clusters. Accordingly, different formation scenarios have been proposed in which UCDs either originate in galaxies or represent genuine star clusters. In this context, we present spatially resolved kinematics of the most luminous UCD in the Fornax cluster, observed under excellent seeing conditions with the ARGUS integral-field unit of the GIRAFFE spectrograph on the VLT. We compare the observed kinematical maps with predictions form dynamical models derived via Jeans modeling from a luminosity profile based on HST imaging. This allows us to constrain the dark matter content in this object and discuss the implications on its likely origin.

6.19 An analysis of the composite stellar population in M32

Authors: Coelho, P.; Mendes de Oliveira, C.; Cid Fernandes, R. **Poster**

Abstract: We obtained long-slit spectra of high signal-to-noise ratio of the galaxy M32 with the Gemini Multi-Object Spectrograph at the Gemini-North telescope. We analysed the integrated spectra by means of full spectral fitting in order to extract the mixture of stellar populations that best represents its composite nature. Three different galactic radii were analysed, from the nuclear region out to 2arcmin from the centre. This allows us to compare, for the first time, the results of integrated light spectroscopy with those of resolved colour-magnitude diagrams from the literature. As a main result we propose that an ancient and an intermediate-age population co-exist in M32, and that the balance between these two populations change between the nucleus and outside one effective radius (1reff) in the sense that the contribution from the intermediate population is larger at the nuclear region. We retrieve a smaller signal of a young population at all radii whose origin is unclear and may be a contamination from horizontal branch stars, such as the ones identified by Brown et al. in the nuclear region. We compare our metallicity distribution function for a region 1 to 2arcmin from the centre to the one obtained with photometric data by Grillmair et al. Both distributions are broad, but our spectroscopically derived distribution has a significant component with [Z/Zsolar] <= -1, which is not found by Grillmair et al.

6.20 Resolving the stellar populations of M32 with HST ACS/HRC

Authors: Antonela Monachesi, Scott C. Trager, Tod R. Lauer, Wendy Freedman, Alan Dressler, Carl Grillmair, Ken Mighell **Poster**

Abstract: We present the deepest optical color-magnitude diagram (CMD) to date of Messier 32(M32), obtained from F435W and F555W photometry based on HST ACS/HRC images. The CMD of M32 displays a wide color distribution of red giant branch stars indicating an intrinsic spread in metallicity with a peak at [Fe/H] $\sim$ -0.2, a strong red clump – expected for metal-rich populations – and asymptotic giant branch stars rising to M_{F555W} $\sim$ -2.0. We detect for the first time a red giant branch bump and an asymptotic giant branch bump in M32 which, together with the red clump, allow us to constrain the age and metallicity of the dominant population in this region of M32. There is not a noticeable presence of blue horizontal branch stars, suggesting that an old population with [Fe/H] < -1.3 does not significantly contribute to the light or mass of M32 in our observed fields. The detection of a blue component of stars (blue plume) may indicate the presence of a young stellar population, with ages of the order of 0.7 Gyr, in this galaxy.

7 Distribution and Luminosity Functions of Dwarfs

7.1 The Galaxy Luminosity Function in Groups

Authors: Brent Tully **Invited talk**

Abstract: The luminosity function in groups of galaxies has been explored with wide field imaging with the Canada-France-Hawaii Telescope. Groups have been given attention that are dominated by both ellipticals and spirals and range in mass from 10^{12} to 10^{14} M$\odot$. The luminosity functions for dynamically evolved groups have slightly steeper faint end slopes. However, small differences have less to do with the relative populations of dwarfs and more to do with the numbers of intermediate luminosity systems. Luminosity functions everywhere are much flatter than the mass spectrum anticipated by theory.

7.2 Groups of dwarf galaxies in the Local Supercluster

Authors: D. Makarov, R. Uklein **Oral contribution**

Abstract: We present a project on study of groups composed of dwarf galaxies only. We selected such structures using HyperLEDA and NED databases with visual inspection on SDSS images and on digital copy of POSS. The groups are characterized by size of few tens of kpc and line-of-sight velocity dispersion about 15 km/s. Our groups similar to associations of nearby dwarfs from Tully et. al. (2006). This specific population of multiple dwarf galaxies such as I Zw 18 may contain significant amount of dark matter. It is very likely that we see them at the stage just before merging of its components. We are

performing Halpha and spectroscopic survey of dwarfs on Russian 6-m telescope. Analysis of chemical composition and star formation rates reveals evolution of these interesting groups.

7.3 The HST/ACS Coma Cluster Treasury Survey: The nature of dwarf galaxies deep in the heart of Coma

Authors: Arna M. Karick, Ehsan Kourkchi, Habib Khosroshahi and David Carter **Oral contribution**

Abstract: The HST/ACS Coma Cluster Treasury Survey aims to address many outstanding issues concerning galaxy formation and provides a fundamental low-redshift reference and comparison for cluster studies at high redshift. I will present Lick absorption line measurements for forty cluster dwarf galaxies (Mr > -15.5) in the dense cluster core, selected from our ACS images and observed using the the Keck/DEIMOS spectrograph (blue 370nm -730nm setup). These results complement our velocity dispersion analysis which is based on similar Keck/DEIMOS (red 750nm -900nm setup) spectroscopy. Combined with accurate structural information from our ACS imaging, velocity dispersions facilitate a detailed analysis of the fundamental galaxy "scaling laws" for cluster dwarf galaxies, and by inference their dark matter content. These observations help constrain galaxy formation models and provide further insight into the formation and evolution of dwarf galaxies in dense environments.

7.4 Ages and element abundances on the faint red sequence

Authors: Russell Smith **Oral contribution**

Abstract: I will present results from deep MMT spectroscopy of hundreds of red-sequence galaxies in the core and outskirts of the Coma cluster, spanning six magnitudes in luminosity from giant ellipticals to M*+4 dwarfs.

This talk will focus on (1) the age distribution of dwarfs and the role of environment in shaping the faint end of the red sequence and (2) the element abundance ratios, and their puzzling correlations with mass and metallicity.

In Coma, the ages of dwarf galaxies correlate primarily with distance from the cluster centre, consistent with quenching of star-formation on infall to the cluster. (By contrast the ages of giants are independent of cluster-centric radius, at fixed mass.) The age-vs-radius trend is not restricted to the the in-falling NGC 4839 group, but instead applies throughout the cluster.

The element abundance patterns confirm earlier hints of intriguing planar correlations of X/Fe with velocity dispersion and Fe/H. At fixed velocity dispersion, the alpha element ratios Mg/Fe and Ca/Fe anti-correlate with Fe/H, as seen for individual stars, tracing the production of Fe in SNIa. C/Fe and N/Fe show no trend with Fe/H suggesting C and N are produced on the same timescale as Fe. At fixed Fe/H, the Mg/Fe, C/Fe and N/Fe ratios all increase steeply with velocity dispersion, while Ca/Fe is anomalously flat. These correlations are undoubtedly trying to tell us something important - an aim of this talk is to stimulate efforts to interpret them!

7.5 How the environment influences nearby (5-50Mpc) dwarfs

Authors: K. S. A. Hansson, T. Lisker, E. K. Grebel and J. S. Gallagher **Poster**

Abstract: A detailed study of environmental impact on the properties of dwarf galaxies is presented. We focus on a volume complete sample of dwarfs ($-18.2 < M_r < -15.7$ mag) selected from the SDSS within 50Mpc. The mechanisms proposed to influence dwarf galaxy characteristics are typically related either to cluster/group environments or to giant neighbours, making comparisons between environments of low and high density extremely valuable. We quantify the environment as projected distances to nearest giants, as well as through group and cluster membership, properties that are determined using a combination of the SDSS, HyperLEDA and NED databases. Our careful treatment of SDSS imaging data guarantees accurate u, g, r, i and z band photometry of *sim*2000 dwarfs, which we fit to GALEV evolutionary synthesis models. We present how the environment influences the morphology, shape, star formation and star formation history of dwarfs, and discuss the underlying physical mechanisms.

7.6 Pre-main-sequence Turn-On as a Chronometer for Young Clusters: NGC 346 as a Benchmark

Authors: Cignoni, M.; Tosi, M.; Sabbi, E.; Nota, A.; Degl'Innocenti, S.; Prada Moroni, P. G.; Gallagher, J. S. **Poster**

Abstract: We present a novel approach to deriving the age of very young star clusters, by using the Turn-On (TOn). The TOn is the point in the color-magnitude diagram (CMD) where the pre-main sequence (PMS) joins the main sequence (MS). In the MS luminosity function (LF) of the cluster, the TOn is identified as a peak followed by a dip. We propose that by combining the CMD analysis with the monitoring of the spatial distribution of MS stars it is possible to reliably identify the TOn in extragalactic star-forming regions. Compared to alternative methods, this technique is complementary to the turnoff dating and avoids the systematic biases affecting the PMS phase. We describe the method and its uncertainties and apply it to the star-forming region NGC 346, which has been extensively imaged with the Hubble Space Telescope (HST). This study extends the LF approach in crowded extragalactic regions and opens the way for future studies with HST/WFC3, the James Webb Space Telescope and from the ground with adaptive optics.

7.7 Toward a Better Mass Census of Dwarf Galaxies in the Local Universe

Authors: Kathleen D. Eckert, Sheila J. Kannappan, Mark. A. Norris, and the RESOLVE Team **Poster**

Abstract: Dwarf galaxies dominate the galaxy luminosity function, yet their numbers and masses remain uncertain. The RESOLVE (REsolved Spectroscopy of a Local VolumE) Survey is aimed at addressing this problem. As a volume limited survey, RESOLVE will create a mass census of ∼53,000 cubic Mpc of the local universe, accounting for all objects with baryonic mass greater than $\sim 1.5 \times 10^9$ $M_\odot$. I will present a preliminary baryonic mass function for completed areas of our survey with attention to the baryonic mass contribution from dwarf galaxies at key mass scales such as the bimodality mass (below which star formation histories become "bursty") and the threshold mass (below which galaxies become gas dominated). To measure atomic gas masses for RESOLVE, we use both ALFALFA 21 cm data and photometric gas fractions, i.e., gas fractions estimated from color and surface brightness. We have developed an adapted photometric gas fractions technique, which is optimized for dwarf galaxies. Looking to the future, RESOLVE will use custom instrumentation to measure dynamical masses for > 1000 galaxies, allowing us to determine their non-luminous mass contribution to the local universe.

7.8 The faint galaxy population in fossil groups of galaxies

Authors: Paul Eigenthaler, Werner W. Zeilinger **Poster**

Abstract: Numerical simulations as well as optical and X-ray observations over the last few years have shown that poor groups of galaxies can evolve to what is called a fossil group. Dynamical friction as the driving process leads to the coalescence of individual galaxies in ordinary poor groups leaving behind nothing more than a central, massive elliptical galaxy supposed to contain the merger history of the whole group. Due to merging timescales for less-massive galaxies and gas cooling timescales of the X-ray intragroup medium exceeding a Hubble time, a surrounding faint-galaxy population having survived this galactic cannibalism as well as an extended X-ray halo similar to that found in ordinary groups, is expected. Recent studies suggest that fossil groups are very abundant and could be the progenitors of brightest cluster galaxies (BCGs) in the centers of rich galaxy clusters. However, only a few objects are known to the literature. Complementary to previous research, the SDSS and RASS surveys have been cross-correlated to identify new fossil structures yielding 34 newly detected fossil group candidates. Multi-object spectroscopy with VIMOS has been performed to study the faint galaxy population of one fossil system.

7.9 Ultraviolet Properties of Dwarf Galaxies in Fornax Cluster and Ursa Major Group

Authors: Youngdae Lee, Soo-Chang Rey, Mina Pak, Suk Kim, Eon-Chang Sung **Poster**

Abstract: We present ultraviolet (UV) properties of dwarf galaxies in Fornax cluster and Ursa Major

group in comparison with Virgo cluster using GALEX UV photometric data. We construct UV color-magnitude relations (CMRs) of dwarf galaxies matching with available optical photometry and SDSS data. Majority of dwarf galaxies in Fornax cluster show sequence in UV CMRs consistent with that of normal dwarf ellipticals (dEs) in Virgo cluster, indicating similar population properties of dEs in two clusters. In contrast to the Fornax cluster, most dwarf galaxies in Ursa Major group are located in the blue cloud of UV CMRs showing recent or on-going star formation, and few galaxies show characteristics of dEs. We discuss relationship between UV properties of dwarf galaxies and different environments of clusters.

7.10 On the lack of stellar bars in Coma dwarf galaxies. Implications for the presence of cold stellar disks

Authors: J. Mendez-Abreu, R. Sanchez-Janssen, J. A. L. Aguerri **Poster**
Abstract: We present a study of the bar fraction in the Coma cluster galaxies based on a sample of ∼190 galaxies selected from the Sloan Digital Sky Survey Data Release 6 (SDSS-DR6) and observed with the Hubble Space Telescope (HST) Advanced Camera for Survey (ACS). The unprecedented resolution of the HST-ACS images allow us to explore the presence of bars, detected by visual classification, throughout a luminosity range of 9 magnitudes (-23 < Mr < -14), permitting us to study the poor known region of dwarf galaxies. We find that bars are hosted by galaxies in a tight range of both luminosities (-22 < Mr < -17) and masses ($10^9 < M^*/M_\odot < 10^{11}$). In addition, we find that the bar fraction does not vary significantly when going from the center to the cluster outskirts, implying that cluster environment plays a second order role in bar formation/evolution. The shape of the bar fraction distribution with respect to both luminosity and mass is well matched by the luminosity distribution of disk galaxies in Coma, indicating that bars are good tracers of cold stellar disks, and that there is a lack of such disks in the dwarf population of Coma. In this talk, I will discuss the implications of the non-existence of bars in dwarf galaxies on their current formation and evolution scenarios.

7.11 Fundamental and Photometric Plane of dwarf galaxies in Coma

Authors: Kourkchi, E.; Khosroshahi, H. G.; Carter, D.; Chiboucas, K. and Coma Collaboration **Poster**
Abstract: We study the fundamental and the photometric plane of a sample of ∼50 dwarf galaxies within the core of Coma cluster observed with DEIMOS on Keck II down to R-band luminosity of -15 Magnitudes. Deimos with sampling rate of 0.3 Angstrom per pixel and FWHM resolution of 1.6 Angstrom is suitable for observations of very faint dwarf galaxies and small velocity dispersions. It enables us to measure the velocity dispersions down to ∼10 km/s for the wavelength range between 7500 to 10,000 Angstrom. Calcium triplet lines in this range allow us to obtain the velocity dispersion for the sample galaxies with high precision. We also performed a comprehensive error analysis to better estimate the uncertainties of this key observable. We also carried out a galaxy structure modeling using the ACS I-band images for a larger sample. We found larger velocity dispersions for fainter dwarfs than what expected from mass-luminosity trends of brighter Coma galaxies. In addition, fainter galaxies do not lie on the fundamental plane of brighter dwarf galaxies and their deviations from the fundamental plane increases as their luminosities, central velocity dispersions and Sersic indices decrease. We also noticed that those faint galaxies, which are outliers in the fundamental plane relation, have excess light at their central region with respect to their corresponding Sersic model. Photometric plane for the sample galaxies shows reduced scatter around the plane at the faint end, in comparison to the same in the fundamental plane.

7.12 Near-Infrared Properties of Dwarf Irregular Galaxies in Nearby Galaxy Groups

Authors: V. D. Ivanov, I. Saviane, E. Held **Poster**
Abstract: We have obtained deep NIR imaging of Irregular Dwarf Galaxies in Cen A, M81 and Sculptor groups. We report here the integral properties of these galaxies: luminosities, colors, and structural parameters. Their contribution to the overall group mass, luminosity, and star formation rate is discussed. The properties of dwarfs in groups are compared with those of dwarfs in other environments.

8 Satellites, streams, ultra-faint galaxies

8.1 Satellites in the Local Group and other nearby groups

Authors: Eva K. Grebel **Invited talk**

Abstract: In recent years the census of known satellites in our own Local Group and in nearby galaxy groups has increased substantially due to sensitive wide-area surveys. In the Local Group these surveys have more than doubled its galaxy content and extended the galaxy luminosity function to very faint total magnitudes. Deep ground-based imaging and spectroscopic observations as well as high-resolution imaging with the Hubble Space Telescope have revolutionized our understanding of the chemical evolution and star formation histories of the satellites. We often find long-lasting star formation episodes with slow star formation efficiencies. There is evidence for localized, stochastic enrichment, and recent searches are now beginning to uncover even extremely metal-deficient stars. In many satellites evidence for two or more distinct subpopulations is found. Differing fractions of old populations have been detected in all satellites studied in sufficient detail so far. Kinematic measurements support a picture in which satellites are dark-matter dominated, although recent results indicate that the once proposed common mass scale for low-mass satellites may not hold. When considering satellite ensembles, we find global morphology - distance and gas-content - distance relations in all groups studied thus far, but individual star formation histories seem to also strongly depend on a given satellite's intrinsic properties.

8.2 The SPLASH Survey: Comparing Internal Kinematics, Abundances, and Dynamical Masses of Milky Way and M31 dSphs

Authors: Kalirai, J. S., Beaton, R. L., Geha, M. C., Gilbert, K. M., Guhathakurta, P., Kirby, E. N., Majewski, S. R., Ostheimer, J. C., Patterson, R. J., Wolf, J. **Oral contribution**

Abstract: We present the first systematic comparison of the detailed properties, including internal kinematics, chemical abundances, sizes, and dark matter masses, of Milky Way and M31 dSphs as a part of the SPLASH Survey (Spectroscopic and Photometric Landscape of Andromeda's Stellar Halo). Through Keck/DEIMOS spectroscopy of several hundred individual red giants in a half dozen M31 galaxies, our results indicate both similarities and differences between the family of dSphs in the Milky Way and M31. For example, we find that the luminosity-metallicity relation of dSphs in the two hosts is very similar between L = 10^5 and 10^7 $L_\odot$, the size distribution of M31 dSphs extends to larger values at the same luminosity compared to Milky Way counterparts (especially at the bright end), and that the dark matter masses of M31 dSphs are slightly smaller than similar luminosity Milky Way galaxies. These results have several implications for understanding the chemical evolution and formation of dSphs, and the connection between the properties of satellite galaxies and their host environments.

8.3 The comparative anatomy of dwarf galaxies: a tool for understanding galaxy evolution

Authors: Alan McConnachie **Oral contribution**

Abstract: The majority of our detailed understanding on the structure, dynamics and star formation histories of dwarf galaxies arises from studies of the Milky Way subgroup. Here, I will compare and contrast this subgroup with the latest results from analysis of the M31 system and some isolated Local Group dwarf galaxies. In particular, I will discuss ongoing searches for new dwarf galaxies and their impact on our understanding of the spatial distribution of satellites and the parameter space occupied by dwarfs. I will demonstrate how observations of some of the most isolated dwarf galaxies aid our interpretation of the properties of dwarf satellite galaxies. Finally, I will show how differences in results for the structure, dynamics and stellar population content of the M31 subgroup compared to the MW may be highlighting fundamental differences in the formation times and accretion histories of these galactic systems.

Observational results discussed in this talk stem from the Pan-Andromeda Archaeological Survey using CFHT/MegaPrime, as well as pointed Subaru-SuprimeCam data for the 20 known M31 dSphs and selected isolated dwarfs, and Keck/DEIMOS spectroscopy of a subset of these systems.

8.4 The complexity of faint Local Group dwarf galaxies

Authors: Nicolas Martin **Oral contribution**

Abstract: The number of known Local Group dwarf galaxies has more than doubled over the last 6 years, thanks to numerous discoveries within the Sloan Digital Sky Survey (SDSS) and the Pan-Andromeda Archaeological Survey (PAndAS). I will present both comprehensive analyses from survey data and dedicated follow-up on 8m-class telescope of some of these dwarf galaxies.They reveal that the systems are both complex in their stellar population (that can contain intermediate age/young stars) and morphology (they are significantly flatter than their brighter counterpart). Some systems could even be tidal remnants or stellar streams in formation. Our analyses show that detailed properties of "ultra-faint" galaxies are necessary before their true nature can be properly ascertained.

8.5 The structure and star formation history of the new Milky Way satellites

Authors: D. Sand, D. Zaritsky, B. Willman, E. Olszewski **Oral contribution**

Abstract: In the local universe, studying the resolved stellar populations of dwarf galaxies can place constraints on their star formation history (SFH) and metallicity. In particular, the recent discovery of *sim*20 new, faint satellite systems around the Milky Way (MW) presents an opportunity to study their SFH and metallicity as a function of local environment (i.e. radial distance from the MW) and satellite luminosity. Thus motivated, we have undertaken a large, wide-field imaging program to study the new MW satellites with 6-8 meter class telescopes, in order to measure their structural properties and star formation history via color-magnitude diagram fitting techniques. In this talk, we present initial results from this survey.

8.6 The Formation of the Magellanic Stream

Authors: G. Besla, N. Kallivayalil, L. Hernquist, R. P. van der Marel, T.J. Cox **Oral contribution**

Abstract: One of the most surprising results to come out of HST in recent years is that the Large and Small Magellanic Clouds are moving faster than previously believed (Kallivayalil et al 2006a,b) and may be on their first passage about the Milky Way (MW) (Besla et al 2007). Such a drastically different orbital history overturns a paradigm that has existed for decades and consequently demands a revision of our understanding of the interaction history of the Clouds and the accretion history of the MW and Local Group. In particular, the Magellanic Stream (MS), a coherent stream of HI filaments that trails the Clouds 100 degrees across the sky, can no longer be considered a product of MW tides or ram pressure acting on the Clouds.

We propose an alternative mechanism for the formation of the MS in which material is removed by LMC tides acting on the SMC before the system is accreted by the MW. Here the orbit of the Clouds is not assumed to be a free parameter and is instead determined by the new HST proper motions. Furthermore, both Clouds are modeled as live systems instead of assuming that one is a fixed potential (or absent) as all previous models have done. The proposed scenario clearly demonstrates that it is possible to explain the properties and origin of the MS under the assumption that the Clouds have not been long term satellites of the MW. In addition, this study provides new insight into the hierarchical build up of galaxies, late accretion events, gas stripping mechanisms from satellites and dwarf-dwarf galaxy interactions.

8.7 Local kinematics in the solar neighborhood and the formation of the Magellanic Stream

Authors: Adam Ruzicka, Christian Theis, Jan Palous **Oral contribution**

Abstract: The most recent proper motion measurements for the Large (LMC) and the Small (SMC) Magellanic Clouds (Kallivayalil et al. 2006a, Kallivayalil et al. 2006b) put them on significantly larger galactocentric velocities. Ruzicka et al. (2009) confirmed the failure of the tidal stripping models of the Milky Way (MW)-LMC-SMC interaction in such a case. That happened due to the interaction timescale reduced as the Clouds' orbital periods. become comparable to the Hubble time. Shattow & Loeb (2009) have resolved the orbital issue by increasing the MW circular velocity. It affected both the LMC/SMC spatial motion and the MW total mass, leading to multiple perigalactic passages for the Clouds. We

have analyzed the parameter space of the Magellanic interaction by a robust search algorithm (genetic algorithm, GA) combined with a fast 3D N-body model of the tidal interaction involving a flattened dark matter halo of the Galaxy. The LSR circular velocity was varied between 210km/s and 260km/s and linked with the LSR galactocentric distance by the LSR angular rotation rate of 29.45km/s/kpc (Reid & Brunthaler 2004). Under such assumptions the Clouds were able to stay confined in the MW halo virial radius for well over 4Gyr, and the neutral hydrogen (HI) Magellanic Stream was reproduced quite well over the entire range of the LSR circular velocities. The tidal model worked with the new LMC/SMC proper motions over the MW halo mass range of 1-3 10e12 Msun In agreement with Ruzicka et al. (2007), an oblate (flattening < 1.0) logarithmic halo was preferred. However, the modeled Magellanic Stream was displaced in its projected position up to some extent compared to the observations. Introducing the LSR angular rotation rate by Reid et al. (2004) increases the Galaxy mass and reduces the LMC/SMC galactocentric velocity vectors both in their magnitude and direction, and so the tidal model comes back to play.

8.8 Ultra faint dwarf galaxies in the Next General Virgo cluster Survey

Authors: Pierre-Alain Duc on behalf of the NGVS collaboration **Oral contribution**

Abstract: The Next Generation Virgo cluster Survey (NGVS) is a CFHT Large Program that uses the wide-field of view capabilities of the MegaCam camera to map the entire virgo Cluster at an incomparable depth. The observing strategy has been optimized to detect very low surface brightness structures in the cluster, including intracluster stellar streams and faint dwarf spheroidal galaxies. I will present the current status of this on-going survey, with an emphasis on the detection, distribution and properties of the very low mass galaxies in the cluster that have been disclosed by the NGVS.

8.9 Searching for tidal remnants in the Milky Way: photometric survey of globular clusters

Authors: J. A. Carballo-Bello, D. Martínez-Delgado & A. Sollima **Poster**

Abstract: The picture of building the Milky Way halo from merging protogalactic fragments is considered the local manifestation of the hierarchical galaxy formation process. In this scenario, some studies have suggested that the outer young Galactic halo globular cluster population might be associated (or even the nuclei) to tidal disrupted dwarf spheroidals, now extinct galaxies. If this hypothesis is true, these systems might be still surrounded by a distinct and detectable stellar population asocciated to their progenitor galaxies. We have designed a systematic photometric survey of Galactic globular clusters convering the galactocentric distance range 15kpc $<$ R gc $<$ 40kpc in both hemispheres. We have used wide field instruments in La Palma and in La Silla observatories to obtain deep photometry of wide areas around these interesting objects to unveil the possible remnants of the systems where they were formed and estimate their contibution to the halo.

8.10 The dSph population of M31: A twist in the tale of galaxies on the smallest scales

Authors: Michelle Collins, Scott Chapman, Mike Irwin, Mike Rich **Poster**

Abstract: Recent results from both Collins et al. (2010) and Kalirai et al. (2010) demonstrate that a number of the dwarf spheroidals (dSphs) of M31 exhibit colder dynamics, lower masses and lower central densities than their Milky Way counterparts. These results suggest that significant differences exist between both the evolutionary histories of these populations, and the properties of their dark matter halos. In this contribution I will discuss these results, and present new spectroscopic and photometric results from the on-going Pan-Andromeda Archaeological Survey (PAndAS), which has discovered numerous new dSphs in the halo of M31. I will also place these peculiar galaxies in the context of the Milky Way dSphs and the evolution of the M31 system.

8.11 Andromeda and the 5 dwarfs: Photometric follow-up of among the faintest galaxies

Authors: Crystal Brasseur, Nicolas Martin, Hans-Walter Rix **Poster**

Abstract: We present deep color-magnitude diagrams of 5 Andromeda dwarf galaxies, And X, And XX, And XIX, And XVII, and And XVIII from observations with the wide-field Large Binocular Telescope and Subaru. Reaching down to the horizontal branch, these observations allow for accurate distance determinations and RGB analysis reveal the photometric metallicities and spreads of these systems.

8.12 Satellites of Local Spiral Galaxies

Authors: Clare Ivory **Poster**

Abstract: I am studying star forming satellites of spiral galaxies in the local universe (20 - 80 Mpc). An image data set of more than 300 field spiral galaxies with Hubble type later than S0a have been searched for satellite companions.These data were observed in the broad R-band and the continuum subtracted Hydrogen alpha narrow band. The integrated properties of the satellites, R-band luminosities, Star Formation Rates and Star Formation Timescales, their radial separation from the host galaxy and estimated merging timescales and estimated total gas mass are being investigated. Spectroscopic observations of a subsample give excellent agreement between the satellite and host galaxies, confirming Ha narrow band selection efficiently finds true satellites, while excluding foreground and background sources.

8.13 A new simultaneous multi-band technique to detect LSB dwarf galaxies

Authors: Etienne Ferriere, Pierre-Alain Duc, François Bonnarel, Christophe Collet, M. Louys, Benjamin Perret, Wim van Driel, Bernd Vollmer **Poster**

Abstract: The Next Generation Virgo cluster Survey (NGVS) uses the wide-field of view capabilities of the MegaCam camera on the Canada-France-Hawaii Telescope to map the virgo Cluster at an uncomparable depth (1s surface brightness limit of $\mu_g \sim 29$ mag arcsec-2). The observing strategy has been optimized to detect very low surface brightness structures in the cluster, including faint dwarf spheroidal galaxies.

We have developed a new scale-free simultaneous multi-band technique able to automate the extraction of low surface brightness (LSB) objects from the sky background, in order to perform statistical studies of their properties. We present here our software, MARSIAA (MARkovian Statistical Image Analysis for Astronomy). It uses a markovian approach, assigning pixels in an image to different classes, one of which contains potential LSB galaxies just above the sky noise. MARSIAA has the unique property that it can be applied simultaneously to multiple photometric bands, which significantly improves its LSB galaxy detection and recognition abilities.

8.14 The End of a Global Common Mass Scale

Authors: Joe Wolf, Louis E. Strigari, James S. Bullock, Manoj Kaplinghat, Rachael L. Beaton, Marla Geha, Karoline M. Gilbert, Puragra Guhathakurta, Jason S. Kalirai, Evan N. Kirby, Steven R. Majewski, Richard J. Patterson, Daniel B. Zucker **Poster**

Abstract: Much attention has been focused on the result of Strigari et al. (2008), which surprisingly found that the mass within 300 parsecs for all of the Milky Way (MW) dSphs does not vary as a function of luminosity for over five orders of magnitude. By analyzing the recently published kinematics of the M31 dSphs (Kalirai et al. 2009) with an improved LCDM prior on our mass models, we find that the M31 dSphs do not follow the same trend as the MW dSphs. The properties of these dSphs have not been reproduced in any of the many published galaxy formation models that have claimed success in reproducing the properties of the MW dSphs. Lastly, we perform an in-depth kinematic analysis of the Kalirai et al. (2009) data. We find peculiar properties that are not shared in the MW dSphs, including possible evidence for tidal disruption in And I (given the shape of its dispersion profile) and rotation in And II.

8.15 Are some ultra-faint dwarf galaxies stellar streams? An examination of the Hercules stellar system

Authors: Shoko Jin **Poster**

Abstract: We investigate the possibility that Hercules, a recently discovered Milky Way satellite, is a stellar stream in the process of formation. This hypothesis is motivated by Hercules' highly elongated shape as well as the measurement of a tentative radial velocity gradient along its body (Adén et al. 2009). The application of simple analytical techniques (Jin & Lynden-Bell 2007) on radial velocity data of its member stars provides tight constraints on the tangential velocity of the system (–22 km/s, relative to the Galactic Standard of Rest (GSR)). Combining this with its large receding velocity (145 km/s) and distance (138 kpc) yields an orbit that would have taken Hercules to within 7 kpc of the Galactic centre approximately 0.5 Gyr ago. This very small perigalacticon can naturally explain the violent tidal destruction of the dwarf galaxy in the Milky Way's gravitational potential, inducing its transformation into a stellar stream.

8.16 A CFHT/MegaCam Survey of Substructures in the Galactic Halo

Authors: R. Munoz, P. Cote, P. Stetson, M. Geha, J. Simon & G. Djorgovski **Poster**

Abstract: During the past few years, the SDSS has dramatically altered our understanding of the Galactic halo, uncovering many new substructures with low luminosity and low surface brightness. I will present the results of a deep, wide-field imaging survey of Halo substructure carried out with CFHT/MegaCam. This is intented to be the most comprehensive and homogeneous study to date of the spatial structure of all known stellar overdensities in the outer Galactic halo (RG > 25 kpc) visible from CFHT (DEC > -30 deg) irrespective of morphological classification.

8.17 Satellites of late-type spiral galaxies

Authors: I.A.Yegorova, A.Pizzella, P.Salucci **Poster**

Abstract: Using VIMOS (VLT) we carried out a spectroscopic survey around seven late-type spiral galaxies and we discovered 55 satellites in the luminosity range -19 < Mr < -16. After obtaining the radial velocities and spatial distribution of the satellites, we analyze their properties. In addition using r-band luminosity form Sloan Digital Sky Survey we study their luminosity function.

8.18 Kinematics and Metallicities of Anticenter Stream Debris in Kapteyn's Selected Area 76

Authors: Jeffrey L. Carlin **Poster**

Abstract: We present the mean 3-D kinematics of stars in Kapteyn's Selected Area (SA) 76 that were selected to be members of the Anticenter Stream (ACS; see Grillmair 2006) on the basis of their radial velocities, proper motions, and location in the color-magnitude diagram. Mean motions are determined from a total of 31 mostly main sequence turnoff ACS members we have identified, and yield a velocity dispersion that is typical for a remnant of a disrupted dwarf galaxy. At a distance to the ACS of ∼10 kpc, our measured kinematical quantities produce an orbit that deviates by 30 degrees from the well-defined swath of stellar overdensity constituting the Anticenter Stream in the western portion of the SDSS footprint. This motion is oriented roughly along the western "tributary" identified by Grillmair (2006); we thus suggest that our data in SA 76 are measuring the motion of a kinematically cold substream among the ACS debris, which was likely a fragment of the same infalling structure that created the larger ACS system. The orientation of our measured ACS motion is also aligned with the Eastern Banded Structure (EBS), lending further credence to the suggestion by Grillmair, Carlin & Majewski (2008) that the EBS may be associated with the ACS on a subsequent orbital wrap. We present a comparison of the kinematics and metallicities of the ACS and the well-known Monoceros ring structure in this region; with the data in hand, we are unable to either confirm or rule out an association between the ACS and Monoceros.

9 Models of formation and evolution

9.1 The formation and morphological evolution of dwarf galaxies in a hierarchical Universe

Authors: Lucio Mayer **Invited talk**

Abstract: Dwarf galaxies have become a major testbed for the current model of structure formation. The missing satellites problem and the shallow rotation curves of dwarfs, possibly signaling the presence of a core in the density distribution, have challenged the basis of the CDM model. I will present the results of recent numerical simulations that allow to produce for the first time a field dwarf galaxy with a realistic rotation curve and mass distribution, i.e. matching observed dwarf irregulars, within the CDM model. Supernova-driven outflows combined with a realistic star formation model that accounts for the inhomogeneous structure of the interstellar medium at scales of tens of parsecs naturally produce a dwarf with an exponential baryonic surface density profile, a high mass-to-light ratio, no bulge and a slowly rising rotation curve. The underlying density profile deviates from the cuspy profile of CDM halos as a result of rapid expansion of the dark matter driven by impulsive mass loss during outflows. We then discuss the possible morphological evolution of such field dwarfs into dwarf spheroidals via tidal stirring, ram pressure and heating by the cosmic UV background. We conclude with implications of such processes, and on the core-lile distribution found in the simulations, on the missing satellites problem.

9.2 The morphological origin of dwarf galaxies

Authors: Gerhard Hensler **Invited talk**

Abstract: As an extention of the massive Hubble-type galaxies, since their sufficiently broad archiving also dwarf galaxies (DGs) have been tried to be classified according to their morphology. Detailed and more comprehensive studies of DGs have however spotted a much larger variety and complexity of their structures to exist and much stronger evolutionary effects to act continuously. In contrast to the prediction from the LCDM cosmology, it is highly questioned that at least the baryonic dwarf galactic portion has formed at first and that DGs have hierarchically fed the major galaxies. At least it is clear, that they have not at all finished their morphological determination, but undergo morphological transitions. On the one hand, their low gravitational potential allows strong influences of internal as well as external perturbations on their evolution, as there are e.g. gas expulsion by galactic winds and reaccretion of intergalactic gas. Since galaxies, in general, change their environment, DGs can e.g. pass through denser cluster locations and change their morphology. Another since recently emerged from observations and highly attractive is the subsequent DG formation based on the findings of star cluster formation associated with tidal arm condensations in galaxy merging. This talk will focus on our theoretical understanding of DG morphologies and their causes for transitions and will highlight possible observational signatures that allow to trace the various prehistorical evolution.

9.3 Dwarf Spheroidal Galaxies : from observations to models and vice versa

Authors: Yves Revaz, Pascale Jablonka **Oral contribution**

Abstract: In this talk, I will address how the state of the art chemo-dynamical simulations, combined with the results of recent ESO/Large programs dedicated to chemical abundances of hundreds of individuals stars, such as DART, have radically changed our understanding of the formation and evolution of dwarf spheroidal galaxies (dSphs). In particular, I will discuss how the large variety in the dSph properties can now be understood in a single framework, when carefully taking into account the dominant physical processes at work. These well constrained models can now bring crucial clues on a number of critical parameters such as the supernova feedback, or the shape of the IMF etc., resulting in a deep impact on the final dSph abundance patterns. Supported by new simulations, I will demonstrate how on can bring information on the origin on yet poorly understood nucleosynthetic processes such as the r-process. New prospects of improvements in chemo-dynamical modelings will be finally discussed.

9.4 The smallest galaxies in the Local Group

Authors: J. Bland-Hawthorn, T. Karlsson, R. Sutherland **Oral contribution**

Abstract: A widely held view is that a "mini halo" with much less than 10^8 $M_\odot$ in dark matter is unlikely to retain any baryons because even a single SN event is expected to sweep out all of the gas. But we show that a clumpy medium is much less susceptible to SN sweeping (particularly if it is off-centred) because the coupling efficiency of the explosive energy is much lower than for a diffuse interstellar medium. With the aid of the sophisticated 3D hydro code Fyris, we show that baryons are retained and stars are formed in dark matter haloes down to 3.10^6 $M_\odot$. The gas survives the SN explosion and is enriched with specific abundance yields of the discrete events. The smallest galaxies may not contribute a large fraction of baryons and dark matter to the formation of galaxies. But they are likely to carry important chemical signatures that were laid down in the earliest epochs of star formation, as we show. These signatures should allow us to distinguish a genuinely small galaxy (or a globular cluster) from one that was stripped down to its present size due to tidal interaction. We also show that the star clusters that form within dwarf galaxies of any mass leave behind a distinct chemical signature that should be detectable with 8m class data. These signatures provide important information on the initial cluster mass function with cosmic time.

9.5 The anisotropy of cluster dwarf galaxy populations

Authors: Sven De Rijcke, Pieter Buyle, Emmanuel Van Heze **Oral contribution**

Abstract: The question whether cluster dwarf galaxies are, broadly speaking, an "indigenous" or an "acquired" population is a focal point of much recent research, both observational and theoretical [e.g. Lisker et al. 2009, Boselli et al. 2008, Van Zee et al. 2004, Conselice et al. 2001]. If the cluster dwarf population is mostly an old one that originated in situ, one would expect most dwarfs to move on rather circularized orbits. If, instead, cluster dwarfs are accreted onto galaxy clusters, one would expect them to move on radial, infalling orbits. Clearly, the anisotropy of the orbital distribution of cluster dwarfs holds important clues to their origin.

Usually, one does not have many observables to constrain the orbital distribution of the dwarf galaxy population in a cluster other than the projected dwarf galaxy density profile and the dwarf galaxy velocity dispersion. To overcome this problem, we add another observable: the ratio of late to early type dwarfs as a function of radius. Since the density of the intracluster medium (ICM) rises rapidly towards the cluster center only dwarfs on orbits that bring them close to the cluster center (i.e. radial orbits) are affected by ram-pressure stripping. The more radially anisotropic the cluster dwarf galaxy orbital distribution, the lower the central density of late-type dwarfs and the slower the late to early type ratio rises as a function of radius. Thus, the late to early type ratio allows us to estimate the orbital anisotropy and hence to constrain the origin of the Virgo and Fornax cluster dwarf populations.

We present a study of the impact of ram-pressure stripping on the composition of the dwarf galaxy populations of the nearby Virgo and Fornax clusters [De Rijcke et al. in prep.]. We have borrowed state-of-the-art techniques [Van Hese et al. 2009] from galaxy dynamics and applied them to the case of dwarf galaxies orbiting inside a cluster's gravitational potential. For each cluster, the gravitational potential and the ICM density profile were derived from published X-ray studies. For a range of anisotropies, we constructed distribution functions that describe the spatial distribution and motion of the dwarf galaxies in the Virgo and Fornax clusters. These reproduce the projected density profile of the whole dwarf galaxy population in a given cluster. Labeling all dwarfs on orbits that bring them sufficiently close to the cluster center to encounter a ram pressure strong enough to remove their gas as "early type" and all others as "late type", we have estimated the radial run of the late to early type ratio for different anisotropies. We propose to present our conclusions based on our comparison of these theoretical late to early type ratios with the observed ratios drawn from the Fornax and Virgo cluster catalogs.

9.6 A stellar population picture of galaxy harassment

Authors: Franco, I.; Spurzem, R.; Lisker,T. **Oral contribution**

Abstract: We aim to understand the formation of early-type dwarf galaxies through the so-called galaxy harassment scenario. We perform N-body simulations in which a three-component galaxy (disk + bulge + halo) enters a galaxy cluster in an eccentric orbit. While the galaxy is falling, it gets tidally disrupted by

close encounters with other galaxies that populate the cluster. Such encounters are sufficiently vigorous to morphologically transform the galaxy into an early-type dwarf.

Through a combined N-body and stellar population approach, we assign multiple stellar generations to the simulated galaxy and trace their evolution. This allows us to extract observable quantities, in particular integrated colours, in order to compare the simulation results to observed Virgo cluster early-type dwarfs. Based on this analysis we discuss whether harassment is able to form typical early-type dwarf galaxies.

9.7 Kelvin-Helmholtz instabilities in Smoothed Particle Hydrodynamics

Authors: S. Valcke, S. De Rijcke, E. Rödiger & H. Dejonghe **Poster**

Abstract: In order to theoretically study the interaction between dwarf galaxies and their environment, the adopted hydrodynamics solver (SPH, AMR, ...) must be able to cope with contact discontinuities, such as between a dwarf galaxy's interstellar medium (ISM) and its host cluster's intracluster medium (ICM). Specifically: in order to calculate through the ram-pressure stripping of a dwarf galaxy with any fidelity, one must be able to follow the development of Kelvin-Helmholtz (KH) instabilities at the ISM/ICM interface since these play a key role in determining the total mass loss from the dwarf.

Recently, doubt has been cast upon whether SPH is able to completely capture the physics of contact discontinuities (agertz 2007). In order to elucidate the reasons for standard SPH's apparent failures and to attempt solving its problems, we have performed a thorough examination of the "shearing layers" test. This is a crucial test for examining the potential of SPH to properly treat KH instabilities (Valcke et al, submitted).

We show that each failure of SPH to show KH waves can be traced back to two causes: i) shockwaves travelling through the simulation box and ii) particle clumping, or more generally, particle noise. The first problem can be remedied by using initial conditions that are SPH-smooth, and therefore free from density discontinuities, from the outset. Moreover, we introduce the LInear Quartic (LIQ) kernel which overcomes the particle clumping problem. We also show that while artificial conductivity is necessary to avoid SPH developing a spurious surface tension, it does not help in any way to produce KH waves. In sensitive hydrodynamical simulations great care is needed in selecting the AC signal velocity, with the default formulation leading to too much energy diffusion. We present new signal velocities that lead to less diffusion.

9.8 Flat metallicity profiles in rotating dwarf galaxies

Authors: Joeri Schroyen, Sven De Rijcke, Sander Valcke **Poster**

Abstract: From observations, we know that dwarf irregulars (dIrr) and flat, rotating dwarf ellipticals (dE) generally possess flat metalllicity profiles [Koleva et al (2008)] while round dEs show strong metallicity gradients. dIrrs also exhibit ongoing star formation - which in most cases is compatible with a roughly constant or at least continuous star formation history (SFH) [Dolphin (2005)].

We show results based on a large suite of Nbody-SPH simulations of flat dwarf galaxies, both rotating and non-rotating, to investigate the possible causes for these observations. These simulations show that using rotation to flatten a dwarf galaxy is particularly efficient in turning a so-called "breathing" SFH [Valcke et al (2008)] into a more or less constant SFH with superposed small oscillations [see e.g. Stinson et al (2008)] and in producing flat metallicity profiles. Non-rotating dEs in a flattened dark-matter halo do not show these characteristics.

Thus, it appears that flattening by rotation is key to reproducing the observed characteristics of flat dwarf galaxies. Rotation causes a "centrifugal barrier" which slows down the infall of gas, so that the low-level star formation is not centrally concentrated but occurs galaxy-wide, and thus prevents large-scale oscillations in the SFR. This mechanism of smearing out the star formation in time and space proves to be the principal reason for the flat metallicity profiles of dIrrs and flat dEs, instead of the often referred to "fountain mechanism" [De Young & Heckman (1994); Barazza & Binggeli (2002)].

9.9 Scaling Relations and Evolution of Early-type galaxies in the Red-sequence

Authors: Jesus Falcon-Barroso and the SAURON Team **Poster**

Abstract: I will report results from the SAURON Survey on the scaling relations of early-type galaxies in

the optical and Spitzer 3.6um and 8.0um wavebands. In this talk I will present photometric observations of the representative galaxies of the SAURON Survey. I will discuss the relation of the main structural measurements with our recent kinematical classification for early-type galaxies (i.e. Slow/Fast rotators), morphology of the star-formation (Widespread/Circum-nuclear), or kinematic substructure (i.e. inner disks, KDCs,...). This information allows us to understand the location of these galaxies in the main scaling relations and to study their evolution on the red sequence.

9.10 A chemical evolution of Draco dwarf galaxy: monolithic or merger scenario?

Authors: Nykytyuk Tetyana V. **Poster**

Abstract: A chemical evolution of the Local Group dwarf galaxy Draco is considered. The stellar metallicity distribution function of Draco was calculated in the framework of both the monolithic and the merger scenario. The observed metallicity distribution isn't reproduced quite well by monolithic collaps for this galaxy. The use of a merger of several fragments allows to obtain a better resemblance between modelled and observed stellar metallicity distributions.

9.11 Evolution of the Milky Way by accretion of its dwarf satellite galaxies

Authors: Mykola Petrov, Gerhard Hensler **Poster**

Abstract: From the hierarchical merging paradigm of structure formation and due to the satellite accretion scenario it can simply be concluded that the galactic halo stars are the relics of already disrupted and incorporated satellite galaxies of the Milky Way and should therefore reveal abundance similarities with the present-day dwarf spheroidal galaxies. Although several studies support this possibility from the agreement of modeled and observed metallicity distribution of halo stars, the major challenge are the deviating abundance ratios in the dSphs, in particular, their low O/Fe. In reality, however, the halo stars should dominantly be formed during the very early formation epoch and thus cannot be compared to the present-day existing dSphs because the conditions of the accreted population of subhalos should have been different from those having survived. By means of chemo-dynamical simulations of satellite galaxy systems around forming host galaxies taken from CDM cosmological simulations we explore their star-formation history, gain and loss of gas, and their stellar abundance evolution in the early universe until their accretion into the massive galaxy. Since the evolution of each individual satellite is determined by its mass but also its environmental conditions like tidal field of the host, the orbit and proximity of the satellite, etc., we explore the differences of the early accreted satellite population to simplified parametrised correlations of baryonic mass and star-formation rates with the masses of the DM subhalos.

9.12 XUV Disks Around Low-mass E/S0 Galaxies: A Surprising Dependence on Color

Authors: Amanda Moffett, Sheila Kannappan, et al. **Poster**

Abstract: We have identified a high ∼45% frequency of Type 1 XUV disks, representing recent outer disk star formation, in a sample of 29 E/S0s with stellar masses primarily below 5×10^{10} solar masses. This identification rate is more than twice the ∼20% fraction that has been reported for late-type galaxies. Intriguingly, in the dwarf mass regime (below 5×10^{9} solar masses, equivalent to $V_{\rm rot}$∼120 km/s) where gas fractions rise, Type 1 XUVs make up ∼83% of red-sequence E/S0s but only ∼22% of "blue-sequence E/S0s," a recently identified class of gas-rich E/S0s actively rebuilding disks. This surprising association of red color and Type 1 XUV disks in E/S0s could indicate that Type 1 XUVs are primarily related to inefficient star formation in outer disks rather than to efficient star formation that could drive substantial morphological transformation. This interpretation is consistent with the high ∼70% rate of XUV disks in massive low surface brightness galaxies, which are known for inefficient star formation (Boissier et al. 2008). Thus, Type 1 XUV morphology, now found to occur over a wide range of galaxy types and masses, may be best understood as a signpost of low-level, inefficient disk building due to minor gas or satellite accretion events, in contrast to the efficient disk growth typical of populations with low XUV frequency, such as normal late types and blue-sequence E/S0s.

9.13 The red halo phenomenon

Authors: Genoveva Micheva, Erik Zackrisson, Göran Östlin, Nils Bergvall **Poster**

Abstract: Deep optical/near-IR surface photometry has revealed extended faint structures in the outskirts of blue compact dwarf galaxies, as well as in spiral and cD galaxies. These structures display colors much too red to be due to stellar populations with reasonable metallicities and normal stellar initial mass functions. For most detections, these red structures, dubbed "red halos", have persisted despite attempts to explain them as instrumental effects. Explanations that have proven successful in reconciling the observed colors instead advocate exotic stellar initial mass functions and extragalactic background light effects. Other scenarios manage to explain the red halos around specific types of galaxies but not around others. Here we review the current status of the red halo phenomenon to reflect recent changes in stellar evolutionary models, the availability of deep new observations in the optical and NIR and, in some cases, new red halo detections around blue compact galaxies.

9.14 Chemical evolution models for Leo 1 and Leo 2 dSph galaxies

Authors: Gustavo A. Lanfranchi and Francesca Matteucci **Poster**

Abstract: We investigate the chemical evolutionary history of the dwarf spheroidal galaxies Leo 1 and Leo 2 by means of predictions from a detailed chemical evolution model compared to observations. Each galaxy model is specified by the prescriptions of the star formation rate and by the galactic wind efficiency chosen to reproduce the main features of these galaxies, in particular the stellar metallicity distributions and several abundance ratios. These parameters are constrained by the star formation histories of the galaxies as inferred by the observed color-magnitude diagrams, indicating extended star formation episodes occurring at early epochs, but also with hints of intermediate stellar populations. The main observed features of the galaxies Leo 1 and Leo 2 can be very well explained by chemical evolution models according to the following scenarios: the star formation occurred in two long episodes at 14 Gyr and 9 Gyr ago that lasted 5 and 7 Gyr, respectively, with a low efficiency ($nu = 0.6Gyr^{-1}$) in Leo 1, whereas the star formation history in Leo 2 is characterized by one episode at 14 Gyr ago that lasted 7 Gyr, also with a low efficiency ($nu = 0.3Gyr^{-1}$). In both galaxies an intense wind (nine and eight times the star formation rate - $w_i = 9$ and 8 in Leo 1 and Leo 2, respectively) takes place which defines the pattern of the abundance ratios and the shape of the stellar metallicity distribution at intermediate to high metallicities. The observational constraints can only be reproduced with the assumption of gas removal by galactic winds.

9.15 Star Formation Histories of Dwarf Galaxies: Comparing Simulations and Observations

Authors: M. Ryan Joung, Mary Putman, Jana Grcevich **Poster**

Abstract: Previous numerical models based on dark matter only simulations underpredicted the level of recent star formation (SF). We use an adaptive mesh refinement code, Enzo, to simulate a disk galaxy of about the Milky Way mass in a cosmological setting and examine the effect of baryonic physics radiative cooling, stellar feedback, and ram pressure stripping. We show examples of simulated dwarf galaxies having particular trends observed in SF histories of nearby dwarf galaxies, e.g., a recurrent SF at late times or a sudden drop in the SFR. We attempt to explain them by tracing their orbits, gas masses, and merger histories. Finally, we propose that the radius within which HI is undetected in dwarfs, $\sim$270 kpc, may indicate where cold streams are truncated and mixed with the halo gas.

9.16 Satellites of simulated Milky Way-like galaxies

Authors: Yang-Shyang Li, Gabriella De Lucia, Amina Helmi **Poster**

Abstract: We combine a series of high-resolution simulations with semi-analytical galaxy formation models to follow the evolution of a system resembling the Milky Way and its satellites. The semi-analytical model is based on that developed for the Millennium Simulation, and successfully reproduces the properties of galaxies on large scales as well as those of the Milky Way. In this model, we are able to reproduce the luminosity function of the satellites around the Milky Way by preventing cooling in haloes with Vvir $< 16.7\mathrm{kms}^{-1}$ (i.e. the atomic hydrogen cooling limit) and including the impact of

the reionization of the Universe. The physical properties of our model satellites (e.g. mean metallicities, ages, half-light radii and mass-to-light ratios) are in good agreement with the latest observational measurements. We do not find a strong dependence upon the particular implementation of supernova feedback, but a scheme which is more efficient in galaxies embedded in smaller haloes, i.e. shallower potential wells, gives better agreement with the properties of the ultrafaint satellites.

10 Cosmology and Dark matter

10.1 Dark Matter in Dwarf Spheroidal Galaxies

Authors: Matthew Walker **Invited talk**

Abstract: The dwarf spheroidal (dSph) galaxies orbiting in the Milky Way's halo are the smallest, faintest and darkest known objects for which internal kinematics imply a dark matter component. Here I review empirical constraints on the mass profiles of dSph dark matter halos as derived from observed stellar kinematics, and I assess the validity and effects of various modeling assumptions. I consider realistic observational uncertainties in the context of efforts to detect dark matter indirectly in the form of high-energy photons released during decay or self-annihilation events.

10.2 The CLUES-project: Constrained Local UniversE Simulations

Authors: S. Gottloeber, G. Yepes, Y. Hoffman **Oral contribution**

Abstract: Cosmological simulations must cover a large dynamical and mass range. A representative volume of the universe should be large, but this comes at the expense of the resolution. A complementary approach to consists of using observations of the nearby universe as constraints imposed on the initial conditions of the simulations. The resulting constrained simulations successfully reproduce the local large scale structure, where 'local' means a few tens of megaparsec around the Milky Way. Simulations performed within the CLUES-project (http://www.clues-project.org/) are the numerical analog of the 'Near Field Cosmology', and provide a laboratory for studying the formation of our Local Group and its environment. I will review our constrained simulations and compare predictions of the cold and warm dark matter scenarios for the dwarf population in local voids with recent observations.

10.3 The impact of dark matter cusps and cores on the dSph population

Authors: J. Penarrubia, A. Benson, M. Walker, G. Gilmore, A. McConnachie & L. Mayer **Oral contribution**

Abstract: In this talk I will show the results of N-body simulations that study the effects that a divergent (i.e. "cuspy") dark matter (DM) profile would introduce on the tidal evolution of dSphs orbiting around spiral galaxies. I will also show how changing the slope of the inner halo profile affects the global properties of the dSph population. When these models are applied to a Milky Way (MW)-like galaxy we find that the size-mass relationship established from MW dwarfs strongly supports the presence of cusps in the majority of these systems, as cored halo models systematically underestimate the masses of the known Ultra-Faint dSphs. We also examine whether our modelling can constrain the mass threshold below which star formation is suppressed in DM haloes. We find that luminous satellites must be accreted with masses above $10^8 - 10^9$ $M_\odot$ in order to to explain the size-mass relation observed in MW dwarfs.

10.4 Predicting which dwarfs are young and which are old

Authors: Gary Mamon, Dylan Tweed, Trinh Thuan **Oral contribution**

Abstract: Relative to giant galaxies, dwarf ellipticals and irregulars have younger stellar populations (downsizing) and lower metallicities. Yet dwarf spheroidals have old stellar populations and even lower metallicities. We apply a very simple model of galaxy formation run on top of very high mass resolution merger trees of halos down to 10 million solar masses, which explains these trends and quantifies the fraction of galaxies with mostly young stellar populations (less than 1 Gyr, such as I Zw 18) as a function of stellar mass.

10.5 The role of feedback in Milky Way satellite galaxy formation using high resolution simulations

Authors: Sam Geen **Oral contribution**

Abstract: We use sub-parsec resolution hydrodynamic simulations of the Milky Way at high redshift to investigate the formation of the Milky Way satellite galaxies. We analyse the influence of supernova feedback on dwarf galaxy formation, and the efficiency of reionisation in suppressing star formation in the smallest galaxies. By locating galaxies in our high redshift simulation and tracking them to z=0 using a halo merger tree, we can compare our results to present-day observations and comment on the hypothesis that reionisation halts star formation in the lowest mass halos. We also consider the effect of adding gas physics to simulations of the formation of dwarf dark matter halos, and the impact this has on the missing satellite problem.

10.6 From dwarf Spheroidals to cDs: simulating the full galaxy population in a LCDM cosmology

Authors: Qi Guo **Oral contribution**

Abstract: By combining the very large Millennium and Millennium-II simulations we follow galaxy formation over a stellar mass range of more than five orders of magnitude throughout representative cosmological volumes. These are the first simulations to address the abundance and spatial distribution of galaxies ranging from cD's down to dSph's. The two dark matter simulations differ in mass resolution by a factor of 125, allowing us to test the numerical convergence properties of our semianalytic simulation techniques. We demonstrate that stronger feedback is needed than in previous models, both at high and at low mass, if the SDSS stellar mass function is to be matched in a LCDM universe. Models which satisfy this constraint also reproduce the observed abundance of faint dwarfs around the Milky Way and M31. Only the very faintest objects are significantly affected by the treatment of reionisation. Our models improve over earlier generations of such simulations with respect to the treatments of galaxy size and of environmental effects. By following stripping and disruption processes we are able to address the origin and history of intracluster light, exploring systematics as a function of cluster mass. Problems remain with respect to the stellar age distributions and kinematics of dwarfs.

10.7 Is there a "Found" Satellites Problem? MW/LMC Analogs in LCDM and the SDSS

Authors: E.J. Tollerud, E.J. Barton, J.S. Bullock, and C. Trinh **Poster**

Abstract: The "missing satellites problem" of LCDM is the existence of too much dark matter substructure around Milky Way-sized halos compared to the observed number of MW satellites. Detection biases for faint satellites can, however, account for these missing satellites. On the bright end, recent simulations suggest the opposite problem. Subhalos large enough to host such luminous satellites are very uncommon, so the existence of the Large Magellanic Cloud orbiting the Galaxy can be a problem. Hence, we describe a search for analogs to an isolated galaxy pair like the Milky Way/LMC system in the SDSS and interpret these results with cosmological simulations. We note that while the LMC may not be terribly unusual based on its luminosity, it is remarkably blue for such satellites. Thus, color may have implications for the LMC's orbital history. We discuss use of these methods as general tools for interpreting similar satellites in a cosmological context.

10.8 Using Mock Velocity Field Observations to Determine the Dark Matter Distribution in Dwarf Galaxies

Authors: Rachel Kuzio de Naray **Poster**

Abstract: High resolution velocity fields provide important observational constraints on the dark matter distribution in dwarf galaxies. These data show that dark matter-dominated galaxies tend to be more consistent with cored halos than cuspy halos, at odds with theoretical expectations. I will discuss how mock IFU velocity field observations of simulated disk galaxies can be used to test if cusps can hide in triaxial dark matter halos. Using N-body/smoothed particle hydrodynamics simulations of galaxy formation in cuspy spherical and triaxial dark matter halos, as well as cored dark matter halos, we

"observe" the galaxies under a variety of realistic observing conditions and determine how well the underlying dark matter halo can be recovered.

10.9 What is the Matter with Dwarf Galaxies?

Authors: Till Sawala **Poster**

Abstract: The difference between the predicted number of haloes and subhaloes in cold dark matter (CDM) simulations, and the observed number of dwarf galaxies, has been described as a challenge to the Lambda-CDM paradigm. It has since been shown that this "Missing Satellites Problem" may be removed by astrophysical processes, which explain why not all dwarf-sized dark matter haloes contain stars, and those that do can have very high mass-to-light ratios.

I present cosmological hydrodynamical simulations of the formation of six dwarf galaxies in a representative sample of haloes extracted from the Millennium-II Simulation. For haloes with a mass of $\sim 10^{10}$ solar masses, our simulations produce stellar masses in the range 5×10^{7}–10^{8} solar masses, consistent with other published work. However, by matching the abundance of similar mass haloes in the Millennium-II simulation to the observed stellar mass function, we find that the dwarf galaxies formed in ours, as well as all other current hydrodynamical simulations, are almost two orders of magnitude more luminous than expected for haloes of this mass in a Lambda CDM cosmology. I discuss possible implications of this result.

10.10 Chemodynamics of the dwarf galaxies: from cuspy to flat dark matter density profiles and metallicity gradients

Authors: Pasetto, S.; Grebel, E. K.; Berczik, P.; Spurzem, R.; Dehnen, W. **Poster**

Abstract: The chemodynamical evolution of spherical multi-component self-gravitating models for isolated dwarf galaxies is studied. We compare their evolution with and without feedback effects from star formation processes. We find that initially cuspy dark matter profiles flatten with time as a result of star formation, without any special tuning conditions. Thus the seemingly flattened profiles found in many dwarfs do not contradict the cuspy profiles predicted by cosmological models. We also calculate the chemical evolution of stars and gas, to permit comparisons with observational data. A forthcoming work preview on Carina dwarf galaxy is also presented.

10.11 A simulated universe of dwarf galaxies: the early days

Authors: Darren Reed **Poster**

Abstract: We use cosmological hydrodynamic simulations to model galaxy formation at redshift 5 and higher. We explore how galaxies populate early dwarf-massed dark matter halos in a range of different environments. The clustering strength and other properties of high redshift dwarf galaxies can provide a unique probe of the physics of star and galaxy formation. We discuss implications of the early stages of dwarf galaxy formation on the present-day galaxy population.

10.12 Comparing the Local and Cosmic Star Formation Histories: Galaxy Evolution as a Function of Mass and Environment

Authors: Igor Drozdovsky and the LCID team **Poster**

Abstract: Given the many recent advances in our understanding of the star formation history (SFH) of the Local Group (LG) and other nearby galaxies, and in the evolution of star formation with redshift, we present an updated comparison of the comoving space density of the star formation rate as a function of look-back time for the Local and Distant Universe. The Local SFH is derived from analysis of resolved stellar populations ("fossil records") in individual nearby galaxies, based on our own estimations as well as available in the literature. While the preliminary comparison of SFHs is found to be broadly consistent, the detailed discrepancies still remain, including excess of the Local star formation rate density in the most recent epoch. While the recent episodic star formation activity is observed in dwarf galaxies, most dwarfs in the Local Group and its surroundings are also dominated by the old stellar populations with no apparent evidence for the 'downsizing' effect in the galaxy evolution. The overall trend of star formation density from the LG supports a fairly flat evolution of the SFR without showing the turnover implied by

the Lyman dropout measurements. This suggests factors of ∼10 extinction correction to high-redshift UV-based measures. However, while the Local Group is a fairly representative sample of the local mean, an extension of "fossil records" studies to at least of 5 Mpc radius sphere will provide a more robust comparison of the Local and Cosmic evolution.

10.13 Dwarf Galaxy Simulations

Authors: Greg Stinson, Chris Brook, Kate Pilkington, Brad Gibson, Sijing Shen, James Wadsley **Poster**

Abstract: Recent advances in smoothed particle hydrodynamic galaxy formation simulations have shown that it is possible for baryonic processes to flatten cuspy density profiles. We examine the mechanism that drives this process and some of the other ramifications (including the formation of star clusters).

11 Dwarf galaxy studies in the future

11.1 Looking Forward to the Future of Dwarf Galaxy Studies

Authors: Julianne Dalcanton **Invited talk**

Abstract: The coming decades should see many advances in our theoretical and observational capabilities. To take advantage of these opportunities, we should invest our efforts in the areas that offer the greatest potential for advancing our understanding. I will present a comprehensive assessment of where past dwarf galaxy studies have taken us. I will then discuss where I see the most fertile ground for understanding the formation and evolution of dwarfs, and for exploiting the use of dwarf galaxies as constraints on larger astrophysical questions.

11.2 Searches for resolved ultra-faint galaxies in the next decade

Authors: Beth Willman **Oral contribution**

Abstract: The last five years has provided a wild ride in the field of ultra-faint galaxies. Since 2005, we have learned of dozens of previously unseen galaxies within the Local Group. Many of these are less luminous than any galaxy previously known to, or even thought possible to, exist. Not merely "missing satellites", the ultra-faint dwarf galaxies have been shown to include the most dark matter dominated ($(M/L)_{1/2} \sim 1000$) and the least chemically evolved ([Fe/H] < -2.5) galaxies yet known. Their resolved stellar populations provide a unique opportunity to reconstruct the formation of the objects at the very bottom of the galaxy formation hierarchy. The post-SDSS landscape of this field will provide the opportunity for us to go from the excitement of discovery to the statistical samples of objects needed to truly learn about galaxy formation and dark matter at the extremes. I will review the observational biases still present in our census of ultra-faint systems, and then look ahead to how these observational biases may be overcome in the next decade. I will highlight our current search of the RCS2 dataset, our upcoming search of the imminent Southern Sky Survey, and the role that the future Large Synoptic Survey Telescope may play in this field.

11.3 Spectroscopy of resolved stellar populations in dwarf galaxies with the European Extremely Large Telescope

Authors: Giuseppina Battaglia **Oral contribution**

Abstract: Large samples of line-of-sight velocities and metallicities for hundreds individual red giant branch stars in Milky Way satellite galaxies have been obtained in the recent past thanks to wide-area multi-object spectrographs on 8m-10m class telescopes. In this respect, the use of the near-infrared CaII triplet lines from intermediate resolution spectroscopy has proven to be a valuable tool for providing accurate line-of-sight velocities and [Fe/H] measurements over a wide [Fe/H] range. These samples have allowed us to greatly improve our knowledge of the large scale metallicity and kinematics properties of the Milky Way satellites, uncovering in several of these systems the presence of metallicity and velocity gradients, multiple stellar components and allowing more accurate mass determinations.

With the current instrumentation this kind of studies are already challenging at the outskirts of the Local Group, limiting the variety of galaxy types and environments that we can explore at a similar degree of detail.

In this contribution I will discuss the possibility of using future ground-based facilities such as the European Extremely Large Telescope (E-ELT) to carry out studies of similar kind of current surveys of Milky Way satellites. With its 42m diameter, the E-ELT represents the project for the largest optical-infrared telescope in the world. In particular, I will present results from simulations I have carried out aimed at exploring the feasibility of intermediate resolution spectroscopy in the CaII triplet region for large samples of individual red giant branch stars in galaxies at the outskirts of the Local Group and beyond.

11.4 MUSE: Observation of dwarf galaxies

Authors: Philippe Prugniel, Roland Bacon & Mina Koleva **Oral contribution**

Abstract: MUSE is an integral field spectrograph that will equip the VLT in 2013. It is presently under construction in Observatoire de Lyon. It will provide a 1 arcmin field with spatial elements of 0.2 arcsec and a wavelength coverage from 4600 to 9300 A at a resolution between R=2000 and 3600.

Several programs of interest for the study of dwarf galaxies are envisioned: Observation of nearby galaxies resolved into individual stars and of their globular clusters. Observations of the star and gas in dwarf galaxies at different distances.

In nearby dwarf galaxies (10-50 Mpc), fossil record studies using line-of-sight integrated spectra will reach fainter dSph galaxies, thanks to the high sensitivity and 3D nature of the instrument. In more distant galaxies, z=0.3-0.6, with the same methods, it will become possible to resolve in time the main epoch of star formation in dwarf galaxies.

11.5 The Milky Way's Faintest Companions in the Southern Hemisphere

Authors: Jerjen, Da Costa, Willman, Walker and the SMS collaboration **Poster**

Abstract: the past decade of wide-field digital imaging has revolutionised the way we can map the 3-D structure of the Milky Way. The tomographic studies facilitated by the Sloan Digital Sky Survey revealed a stunning class of previously unknown satellite galaxies orbiting our Milky Way. These ultra-faint, extreme low surface brightness stellar systems already account for more than the total number of classical Milky Way companions and challenge traditional concepts about the low mass threshold of galaxy formation.

Stimulated by these findings we are now looking with great anticipation to the start of the next major program in this field: The Stromlo Milky Way Satellites (SMS) Survey is searching for ultra-faint dwarf galaxies over the entire 20,000 sqr deg of the Southern hemisphere to SDSS photometric sensitivities. It opens the truly enthralling prospect of detecting and physically characterising as many as 30-40 more Milky Way satellites, through high resolution, multi- wavelength imaging and spectroscopy follow-up observations. This five year program will enable to critically review questions such as (i) what is the range in dark halo mass at a given galaxy luminosity? (ii) what is the minimum dark matter halo mass in which primordial hydrogen gas has cooled and formed stars? (iii) what role, if any, have the ultra-faint galaxy satellites played in the formation of the Milky Ways halo? and (iv) were all extreme metal-poor halo stars once members of ultra-faint dwarf satellites?

The poster presents background information and strategies of the SMS Survey, and discusses the main objectives of systematically characterising these new systems.

Imaging data used for the SMS Survey is obtained with the ANU SkyMapper telescope. For more details see poster by Da Costa.

11.6 The SkyMapper Southern Sky Survey Project: An Update

Authors: G S Da Costa, H. Jerjen, S. Keller, B. P. Schmidt, M. S. Bessell, P. Francis, P. Tisserand
Poster

Abstract: The Australia National University's 1.3m SkyMapper telescope at Siding Spring Observatory is poised to commence a multi-band, multi-epoch survey of the southern sky. The survey (PI Schmidt) will be carried out with a camera consisting of an array of 32 2k×4k CCDs giving a field of 2.4×2.4

degrees at a sampling of 0.5"/pixel. The entire array is readout in 15 seconds at a read noise of less than 5 electrons. The survey will use 6 bands (uvgriz) and fields will be imaged with a cadence of hours, days, weeks, and years to allow searches for variable and moving objects. The 3-epoch combined data will reach typically 0.5 mag fainter than the northern hemisphere SDSS. The full survey will take 5 years to complete. Among the science programs to be tackled with the SkyMapper survey is a search for the Southern Hemisphere analogues of the Ultra-Faint dwarf galaxy companions to the Milky Way discovered in the SDSS. Based on the SDSS statistics, approximately 30-40 new ultra-faint dwarf galaxies will be discovered in the survey (PI Jerjen). The follow-up of these systems will provide new constraints on structure formation and evolutionary processes on galactic and cosmological scales. The SkyMapper camera has been installed on the telescope and the system is undergoing final commissioning. Images taken with the camera will be presented.

11.7 Dwarf galaxies and the magnetisation of the IGM

Authors: U. Klein **Poster**

Abstract: I will review the properties of the synchrotron radio emission and magnetic fields in dwarf galaxies. Given that these make up for the majority of the first building blocks in the universe, they could have efficiently injected relativistic particles and magnetic fields into the IGM. With LOFAR becoming operational in due course, there is an excellent instrument to earch for low-frequency radio halos around dwarf galaxies in the local universe and beyond; such halos would eflect pools of formerly highly relativistic particles stemming from periods of intense star formation.

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