http://kicp-workshops.uchicago.edu/cosmicweb2013/

WORKSHOP PRESENTATIONS

The Kavli Institute for Cosmological Physics (KICP) at the University of Chicago will host "Galaxies within the Cosmic Web" workshop on June 17-21, 2013. The workshop will be held in the lecture hall 120 in the Kersten Physics Teaching Center (KPTC) on the University of Chicago campus.

During the last thirty years, studies of structure formation have played a key role in establishing the Cold Dark Matter (CDM) paradigm of structure formation in an expanding universe. In the CDM model the initial Gaussian density perturbations are shaped by gravity into a cosmic web of voids and filaments, at the intersection of which galaxies and galaxy clusters are mainly thought to form. Although the model has been a tremendous success in explaining the observed large-scale structure of the universe, many key aspects of how galaxies form and evolve within this cosmic web of dark matter and diffuse gas are still not understood. The gaps in our understanding not only hamper interpretation of the wealth of observational data on galaxy evolution, but also represent a major systematic uncertainty for cosmological probes of the accelerated expansion of the universe, the nature of gravity, and forecasts and interpretation of direct and indirect dark matter searches.

This workshop will assemble both observers and theorists (target size ~60-80 people) who work on all key aspects of galaxy formation to assess recent progress and, most importantly, to germinate new ideas for how to improve our understanding of galaxy formation, the relation between the baryonic mass of galaxies and their parent halos, the effects of galaxy assembly and associated feedback on the spatial distribution of dark matter, and the interpretation of galaxy clustering and bias from large surveys to constrain the evolution of dark energy. The focus of the meeting will be on the most rapidly developing and interesting topics of research, and the format will include ample time for discussion and unstructured interaction.

Scientific Organizing Committee

Charlie Conroy
University of California, Santa Cruz

Nickolay Gnedin
Fermilab

Andrey Kravtsov
The University of Chicago

Francisco Prada
Instituto de Fisica Teorica UAM, CSIC

Risa Wechsler
Stanford University

1. **Hector Aceves**, Instituto de Astronomia, UNAM
   Poster: ***A high redshift LCDM cosmological simulation***

   June 17 - 20, 2013

   We study by means of an N-body cosmological simulation the effects different terms in the full Hubble function have in a high redshift LCDM simulation. We start at z=500. We compare results with other simulations using quantities such as the power spectrum and mass function.

2. **Oscar Agertz**, KICP
   Talk: ***Towards realistic model of stellar feedback***

   June 20, 2013 (11:25 AM - 11:45 AM)

3. **Mehmet Alpaslan**, University of St Andrews, University of Western Australia
   Talk: ***Filaments and large scale structure in the Galaxy and Mass Assembly survey***

   June 17, 2013 (2:50 PM - 3:10 PM)

   Co-authors: Aaron Robotham, Simon Driver
   The Galaxy and Mass Assembly (GAMA) survey provides an unprecedented level of detail for studying the large scale structure of the nearby Universe, having up to 15 times the target density of the SDSS over an eventual area of 280 square degrees. By using an adapted minimal spanning tree algorithm, we are able to use this data to identify and classify the distribution of groups and galaxies into filaments and voids, as well as coherent substructures composed entirely of galaxies that penetrate into voids. This new data allows us to examine the effects of large scale structure on other galaxy properties such as stellar mass, star formation rates, colour, morphology, size, and metallicities by using existing data sets available within the GAMA survey, with supporting observations from GALEX, VST, VISTA, WISE and HERSCHEL. Further to this, by running this algorithm on simulated GAMA catalogues we compare the characteristics of large scale structure between observed and simulated data. This provides a probe of higher order distribution statistics not captured by the popularly used two-point correlation function.

4. **Kenza Arraki**, NMSU
   Talk: ***Effects of baryon removal on the structure of dwarf spheroidal galaxies***

   June 19, 2013 (4:50 PM - 5:10 PM)

   Co-authors: Anatoly Klypin, Surhud More and Sebastian Trujillo-Gomez
   Dwarf spheroidal galaxies (dSphs) are extremely gas poor, dark matter-dominated galaxies, which makes them ideal to test the predictions of the Cold Dark Matter (CDM) model. Although collisionless cosmological N-body simulations are often used to compare theoretical predictions and observations, these simulations assume that the baryon fraction is equal to the cosmic mean. We find that the combination of (i) the lower baryon fraction in dSphs compared to the cosmic mean and (ii) the concentration of baryons in the inner part of the Milky Way halo can go a long way towards explaining the observed circular velocity profiles of dSphs. In the likely scenario that baryons are blown away after the central ~200-500 pc region of the galaxies was formed, we show that the dark matter density in this region declines by a factor of (1 - f_b)^4 ~ 0.5, where f_b is the cosmological fraction of baryons. In addition, the enhanced baryonic mass in the central regions of the parent galaxy generates tidal forces, which are larger than those experienced by subhaloes in traditional N -body simulations. We show that these two effects are strong enough to bring the observed structure of dSphs into agreement with the predictions of the subhaloes in CDM simulations, regardless of the details of the baryonic processes.

5. **Guillermo Barro**, University of California Santa Cruz
*Talk: **The progenitors of compact quiescent galaxies at z~2***

June 18, 2013 (3:15 PM - 3:35 PM)

Co-authors: Faber, S; Perez-Gonzalez, P; Koo, D; Williams, C; Kocevski, D; Trump, J; Mozena, M; McGrath, E; van der Wel, A; Wuyts, S
The remarkably small and compact sizes of massive quiescent galaxies at z~2 has fueled multiple studies that investigate different evolutionary scenarios to explain how these galaxies formed. A missing part of the puzzle is the nature of their progenitors. Such progenitors are expected to be massive, compact, star-forming galaxies at higher redshifts. However, direct evidence for such counterparts has proven difficult to obtain using only the HST optical images, which probe the rest-frame UV at redshifts z > 2. UV morphologies can easily miss large, massive, red hosts. Such camouflaged components would, however, be easily visible in the near-IR. Using the deepest HST WFC3/F160W imaging data from the CANDELS survey, that probes the optical rest-frame bands at z>2, in combination with NIR spectroscopy from 3D-HST and Keck/MOSFIRE, we are able to identify a significant population of galaxies with similar structural properties as the quiescent population but without fully suppressed star-formation. The number density of these sources account for the observed increment in the density of massive quiescent galaxies between z=2 and 3, while their estimated luminosity-weighted ages are consistent with a formation epoch of ~1 Gyr. For some of these objects we detect prominent Balmer breaks and Balmer absorption lines that supports the post-starburst hypothesis. Interestingly enough, we also find a high rate of X-ray detections among these galaxies (> 40%) indicating that the triggering of an AGN could play a fundamental role in the quenching process.

6. **Peter Behroozi**, Stanford University
*Talk: **Star formation in individual galaxies***

June 18, 2013 (9:50 AM - 10:10 AM)

7. **Craig M Booth**, University of Chicago
*Talk: **Cosmic rays in a cosmological context: the physics of galactic superwinds***

June 20, 2013 (2:25 PM - 2:45 PM)

Co-authors: Oscar Agertz, Andrey Kravtsov, Nick Gnedin.

8. **Jo Bovy**, Institute for Advanced Study
*Talk: **New measurements of the structure and dynamics of the Milky Way's disk***

June 20, 2013 (4:50 PM - 5:10 PM)

Observations of the structure and dynamics of different stellar populations in the Milky Way's disk provide a unique perspective on disk formation and evolution. I will show recent results from a dissection into mono-abundance populations (MAPs) of the Galactic disk based on SDSS/SEGUE data. These results show that the individual components are simple, but exhibit very different spatial and kinematic structure. MAPs lend direct observational support for inside-out formation models for galactic disks. The MAP decomposition also shows that the vertical structure of the Milky Way's disk is very different from what was previously believed. I will also present results from a new analysis of the vertical kinematics of disk stars and I will discuss the implications of these results in terms of the distribution of dark matter near the Sun.

9. **Michael Boylan-Kolchin**, UC Irvine
*Talk: **Dark matter in the Milky Way and its satellites***

June 19, 2013 (2:00 PM - 2:20 PM)

The dark matter content of the Milky Way and its satellites has long been the subject of lively debate among both observers and theorists. It is only in the past few years that observations and numerical simulations have reached the point where detailed comparisons about the structure of the Milky Way's satellites can be made, however. I will discuss what these comparisons have revealed about the nature of dark matter and galaxy formation at the lowest masses, and what we have learned about the dark matter content of the Milky Way halo by pairing simulations with HST proper motion observations.

10. **Aaron D Bray**, Harvard University
*Talk: **The Luminosity and Color Dependence of Galaxy Clustering since z ~ 1 in PRIMUS***

June 17, 2013 (2:25 PM - 2:45 PM)

Co-authors: Mike R. Blanton, Alison L. Coil, Richard J. Cool, Daniel J. Eisenstein, John Moustakas, Guangtun Zhu
I will present new small-scale galaxy clustering measurements from PRIMUS as a function of color, luminosity, and redshift. The real-space clustering of ~60,000 galaxies from PRIMUS, over a redshift range $0.26 < z < 1.2$, is measured using a tracer population of galaxies drawn from imaging catalogs totaling ~545,000 photometric galaxies. I will show that, in agreement with previous work, we find strong clustering differences as a function of color, but not as a function of redshift. Further, our results show small luminosity-dependent clustering for ~L* galaxies, but also suggest that these luminosity trends are inhomogeneous with respect to color and physical scale. I will interpret our results in the context of clustering predictions from mock catalogs. I will also provide early comparisons, using the same clustering metrics but at low-redshift, to the cross-correlations of galaxies selected from the SDSS NYU-VAGC catalog with a SDSS DR9 photometric sample.

11. **Alyson Brooks**, U Wisconsin, Madison
*Talk: **The Influence of Baryons in Interpreting our Cosmological Model***

June 19, 2013 (4:25 PM - 4:45 PM)

The dwarf spheroidal satellites of the Milky Way are an important probe of our cosmological model. Predictions from simulations run within the Cold Dark Matter (CDM) paradigm have failed to match observational results, but I will show results from high resolution simulations that include both baryons and dark matter to show that baryonic physics can significantly alter the dark matter structure of galaxies. The inclusion of baryons revolutionizes our expectations for the observed structure of galaxies and satellites. I will make the case that baryons have the potential to solve the small scale crisis within CDM.

12. **Rodrigo A Canas**, Instituto de Astronomia, UNAM
*Poster: **High redshift simulations and subhalos***

June 17 - 20, 2013

Co-authors: H. Aceves
We study the number of subhalos in galactic size halos formed in a set of LCDM cosmological simulations starting at the very high redshift of z=500, and compare the results with those found from simulations starting a much lower redshifts (z~100). Some numerical differences are found in both kind of treatments that do not appear to be the result of numerical noise, but more likely of physical origin. A discussion and other preliminary results of this work are presented in this poster.

13. **Daniel Ceverino**, Universidad Autonoma Madrid
*Talk: **Early formation of galaxies in cosmological simulations***

June 20, 2013 (9:50 AM - 10:10 AM)

14. **Charlie Conroy**, University of California, Santa Cruz
*Talk: **Satellite Galaxies in Hierarchical Universe***

June 18, 2013 (2:00 PM - 2:20 PM)

15. **Alis Deason**, UC Santa Cruz
*Talk: **The Cold and Broken Milky Way Stellar Halo***

June 20, 2013 (4:25 PM - 4:45 PM)

Co-authors: Vasily Belokurov, Wyn Evans, Roeland van der Marel, Raja Guhathakurta
The phase-space structure of the Milky Way stellar halo is intimately linked to its accretion history. I will discuss the connection between the (broken) density profile of the stellar halo and its formation via the accretion of dwarf galaxies. I will also present a new measure of the velocity anisotropy of halo stars out to 30 kpc based on accurate proper motions from multi-epoch HST imaging. Intriguingly, the location of the 'break' in the stellar halo density profile is coincident with a tangential dip in the velocity anisotropy profile of the halo, which may suggest that there is a shell-type structure in this radial regime. Finally, I will discuss the surprisingly cold radial velocity dispersion of the most distant halo stars (beyond 100 kpc), and the implications this has for the total mass of our Galaxy.

16. **Aleks Diamond-Stanic**, UC San Diego
*Talk: **Probing Gas Flows in the Cosmic Web with Background Galaxies***

June 20, 2013 (9:25 AM - 9:45 AM)

Co-authors: Alison Coil, John Moustakas, Christy Tremonti, Kate Rubin, James Bullock
I will present results from (1) "down-the-barrel" studies of high-velocity, galactic-scale outflows, and (2) absorption-line studies of the circumgalactic medium on 10-50 kpc scales using background--foreground galaxy pairs. In particular, I will highlight the result that star-formation feedback is capable of driving >1000 km/s winds that can quench star formation in massive galaxies (Diamond-Stanic et al. 2012). This has important implications for how feedback from star formation and active galactic nuclei regulates the cold gas supply and ejects metal-enriched gas into the cosmic web. I will also present the first example of high-resolution spectroscopy (based on Keck/HIRES data) of an extended background source (i.e., a galaxy rather than a quasar) that probes the halo gas of a foreground galaxy at an impact parameter of 30 kpc. Finally, I will discuss current and future prospects for global studies of the spatial distribution and kinematics of gas around galaxies as a function of stellar mass, star-formation rate, and impact parameter.

17. **Benedikt Diemer**, University of Chicago
*Poster: **Modeling the evolution of the stellar mass-halo mass relation***

June 17 - 20, 2013

Co-authors: Andrey Kravtsov, Surhud More
Understanding the stellar mass-halo mass relation (SHMR) and its evolution is critical for our understanding of how galaxies relate to their host halos and to larger scale structure, as we generally measure LSS through a biased tracer, galaxies. Although there has been much recent progress in quantifying the evolution of this relation both in observations and theoretically, we do not yet have a solid theoretical framework for interpreting the evolution of the SHMR in terms of the physical evolution of the luminous and dark components of galaxies. For example, the evolution of halo mass includes both physical accretion and merging, and "pseudo-evolution" due to the evolution of reference density (mean or critical density) with respect to which the mass is defined. For galaxy-sized halos, such pseudo-evolution can account for most of the halo mass growth between z=1 and z=0 (Diemer et al. 2013, ApJ 766, 25). I will present a model for the interpretation of the evolution of the SHMR which takes into account pseudo-evolution and the expected dissipationless evolution of the stellar components of galaxies.

18. **Andrey Doroshkevich**, ASC FIAN
*Talk: **Formation of the first galaxies and reionisation of the Universe***

June 20, 2013 (2:00 PM - 2:20 PM)

Co-authors: M. Demia'nski
The semi analytical model of DM halo formation is proposed. It allows us to estimate the redshift formation for observed DM dominated objects (such as clusters of galaxies and dSph galaxies) and to trace the evolution of the first galaxies at redshifts z>10. Other applications of such approach are also possible.

19. **Denis Erkal**, University of Chicago
*Poster: **Constraints on galaxy formation and feedback from Damped Lyman Alpha systems***

June 17 - 20, 2013

20. **Robert Feldmann**, Berkeley
*Poster: **The link between the star formation - gas relation and the equilibrium mode of galaxy evolution***

June 17 - 20, 2013

Observations show that star formation in galaxies is closely correlated with the abundance of molecular hydrogen. However, modeling this empirical relation from first principles proves challenging and the exact functional form of the relation is still debated. I study how the star formation - gas relation affects the cosmic star formation history and global galaxy properties. I show that a linear relation with an H_2 depletion time of ~2.5 Gyr, as found in studies of nearby galaxies, results in good agreement with current observations of galaxies at both low and high redshift. These observations include the evolution of the cosmic star formation rate density, the z~4-9 UV luminosity function, the evolution of the mass - metallicity relation, the relation between stellar and halo mass, and the gas-to-stellar mass ratios of galaxies. In contrast, the short depletion times that result from adopting a highly super-linear star formation - gas relation lead to large star formation rates, substantial metal enrichment (~0.1 solar), and low gas-to-stellar mass ratios already at z~10, in disagreement with observations. These results can be understood in terms of an equilibrium picture of galaxy evolution in which gas inflows, outflows, and star formation drive the metallicities and gas fractions toward equilibrium values that are determined by the dimensionless gas depletion time. In this picture, the cosmic modulation of the accretion rate is the primary process that drives the evolution of stellar masses, gas masses, and metallicities of galaxies from high redshift until today.

21. **Jonathan Freundlich**, LERMA, Observatoire de Paris
*Poster: **Towards a resolved Kennicutt - Schmidt law at high redshift***

June 17 - 20, 2013

22. **Marla Geha**, Yale
*Talk: **The Stellar Content of Milky Way Ultra-Faint Dwarf Galaxies***

June 19, 2013 (4:00 PM - 4:20 PM)

The Milky Way ultra-faint dwarf galaxies are the least luminous and most dark matter dominated galaxies in the known Universe. I will review recent results on the stellar content in these galaxies, including detailed chemical abundances, HST imaging suggesting that stars in these galaxies are exclusively older than 11 Gyr and evidence for a shallow low mass IMF.

23. **Oleg Gnedin**, University of Michigan
*Talk: **How baryons shape dark matter***

June 19, 2013 (9:25 AM - 9:45 AM)

Over the past decade, cosmological hydrodynamic simulations allowed detailed studies of the influence of baryons on the shape, concentration, and radial distribution of dark matter halos. Condensation of cosmic gas at the halo center, formation of dense stellar systems, and rotation of the galactic disks all play a role in modifying the predictions of collisionless models of dark matter distribution. I will review the progress in our understanding of these effects, and the challenges for future studies.

24. **Roberto Gonzalez**, University of Chicago
*Poster: **The Milky Way and Local Group mass***

June 17 - 20, 2013

Co-authors: Andrey Kravtsov, Nick Gnedin
We look for Milky Way (MW) and Local Group (LG) analogues in Bolshoi simulation. We compute the likelihood distribution for MW halo mass derived using the properties of the satellites similar to the Large and Small Magellanic Clouds (MCs), and taking into account the LG environment. We explore how the LG environment affects the properties of the MCs such as their velocities, and how the consideration of the MCs as a close pair affects the MW mass estimate. The MW satellite Leo I, if bound can also be used to impose a lower limit on the MW mass, we explore how the LG environment, in particular M31 presence may affect this estimate. Using the LG analogues we can also estimate the likelihood distribution of the MW+M31 pair mass including additional constraints such as the orbit configuration of M31 using recent proper motion measurements, and the local velocity dispersion.

25. **Stefan Gottloeber**, Leibniz-Institute for Astrophysics (AIP)
*Talk: **Constrained Simulations of the Local Universe***

June 19, 2013 (11:50 AM - 12:10 PM)

I will discuss constrained simulations performed within the CLUES project (http://www.clues-project.org/) to study the evolution of structures in the Local Universe.

26. **Fabio Governato**, University of Washington
*Talk: **Shining Light on on the Properties of Dark Matter: Coupling Baryon and Dark Matter Physics in Galaxy Formation Models***

June 20, 2013 (11:00 AM - 11:20 AM)

27. **Martha Haynes**, Cornell University
*Talk: **The ALFALFA Census of Gas-Bearing Galaxies at z=0***

June 18, 2013 (9:00 AM - 9:20 AM)

Capitalizing on the huge collecting area of the Arecibo telescope and the survey capability of the 7-beam Arecibo L-band Feed Array (ALFA), the Arecibo Legacy Fast ALFA (ALFALFA) extragalactic HI 21cm line survey is producing a census of HI-bearing objects out to z < 0.06. ALFALFA provides the first robust count of gas-bearing halos over a cosmologically significant volume. I will review first results of a coordinated multiwavelength program designed to probe how some massive galaxies maintain huge gas reservoirs without converting their gas into stars and how isolated low mass halos are able to retain some HI gas despite their fragile thermal state and shallow potential wells.

28. **Andrew Hearin**, Fermilab
*Talk: **The Dark Side of Galaxy Color***

June 18, 2013 (2:25 PM - 2:45 PM)

Co-authors: Doug Watson, Reina Reyes
I introduce a simple, physically-motivated model for assigning galaxy color to dark matter halos. When applied to the Bolshoi simulation, the model accurately predicts a variety of statistics of the galaxy distribution, including the color-binned two-point clustering signal seen in SDSS. I will discuss the implications of the model for the physics of star formation and quenching.

29. **Amina Helmi**, Kapteyn Institute, Groningen
*Talk: **Dynamical models of dSph in the Local Group***

June 19, 2013 (2:50 PM - 3:10 PM)

I will present a review of the status of the dynamical modeling of dSph satellites of the Milky Way, highlighting some recent results concerning their dark matter distribution and internal orbital structure. I will also discuss some open questions and possible future directions for the field.

30. **Yuko Kakazu**, University of Chicago, KICP
*Poster: **COSMOS-DEIMOS: Metallicity and Kinematics Studies of Star-Forming Galaxies at 0 < z < 6***

June 17 - 20, 2013

Co-authors: Peter Capak, Nicholas Scoville (Caltech), Ryan Mallery (UC Riverside), Daniel Masters (UC Riverside), Mara Salavto (Max Planck), and Bahram Mobasher
We present the metallicity and kinematics studies of star-forming galaxies at $4 < z < 5$ in the COSMOS field based on deep rest-frame ultraviolet spectra of sim400 galaxies obtained with the Keck/DEIMOS spectrograph. Majority of bright galaxies ($z'_{AB} < 25$) in our sample exhibit prominent P Cygni stellar wind lines of CIV and SiIV, suggesting the ubiquity of Galactic outflow among massive star-forming galaxies (log$(M/M_odot)sim10.5$, $langle SFR ranglesim60 M_odot/yr$) at high-redshift. The composite spectrum of 216 galaxies at $< z_{spec} >= 4.6$ with Ly$alpha$ emission shows remarkably similar absorption profiles of both low ionization (SiII$lambda1260$, SiII$lambda1525$, OI$lambda1302$, CII$lambda1335$) and high ionization interstellar lines (SiIV$lambdalambda1393, 1402$, CIV$lambdalambda1548, 1550$) to the stacked spectrum of $zsim3$ Lyman break galaxies of Shapley et al. CIV P Cygni profile in our composite spectrum is consistent with constant star formation with a Salpeter initial mass function and a metallicity $Z sim 0.4 Z_sun$. The HST/ACS images show that they are compact and have very high star formation surface density We further split our galaxy sample based on various galaxy parameters (such as UV luminosity, stellar mass, Ly$alpha$ equivalent width, SFR density, selection criteria) and investigate systemic effects of these paramters on absorption line strengths and physical properties of galaxies.

31. **Anatoly Klypin**, NMSU
*Talk: **LSS simulations for cosmology***

June 17, 2013 (11:20 AM - 11:40 AM)

32. **Jaswant Kumar**, National Astronomical Observatory, CAS- Beijing
*Poster: **Effect of interaction and environment on galaxy properties***

June 17 - 20, 2013

Co-authors: Changbom Park
We inspect the coupled dependence of physical parameters of the Sloan Digital Sky Survey DR7 galaxies on the small-scale (distance to and morphology of the nearest neighbor galaxy) and the large-scale (background density smoothed over 20 nearby galaxies) environments. The impacts of interaction on galaxy properties are detected at least out to the neighbor separation corresponding to the virial radius of galaxies, which is typically between 200 and 400 h^{-1} kpc for the galaxies in our sample. We show that there are two characteristic neighbor-separation scales where the galaxy interactions cause abrupt changes in the properties of galaxies. The first scale is the virial radius of the nearest neighbor galaxy $r_{rm vir,nei}$. The second scale is at $r_p approx 0.05 r_{rm vir,nei} = 10 -20 h^{-1}$ kpc, and is the scale at which the galaxies in pairs start to merge. We find that late-type neighbors enhance the star formation activity of galaxies while early-type neighbors reduce it, and that these effects occur within $r_{rm vir,nei}$. The hot halo gas and cold disk gas must be participating in the interactions at separations less than the virial radius of the galaxy plus dark halo system. Our results also show that the role of the large-scale density in determining galaxy properties is minimal once luminosity and morphology are fixed.

33. **Noam I Libeskind**, Leibniz Institute for Astrophysics
*Talk: **Cosmic vorticity and the origin halo spins***

June 17, 2013 (4:50 PM - 5:10 PM)

Co-authors: Y Hoffman, M Steinmetz, S Gottloeber, S Hess, A Knebe
In the standard model of cosmology, structure emerges out of a non-rotational flow and the angular momentum of collapsing halos is induced by tidal torques. The growth of angular momentum in the linear and quasi-linear phases is as- sociated with a shear, curl-free, flow and it is well described within the linear framework of tidal torque theory (TTT). However, TTT ceases to be applicable as haloes approach turn-around when their ambient flow field becomes rotaional. Subsequently, halos become embedded in a vortical flow field and the growth of their angular momentum is affected by the vorticity of their ambient velocity field. Using a cosmological simulation, we have examined the importance of the curl of the velocity field in determining halo spin, finding a significant alignment between the two: the vorticity tends to be perpendicular to the axis of the fastest collapse of the velocity shear tensor (e1). This is independent of halo masses and cosmic web environment. Our results agree with previous findings on the ten- dency of halo spin to be perpendicular to e1, and of the spin of (simulated) halos and (observed) galaxies to be aligned with the large-scale structure. It follows that angular momentum growth proceeds in two distinct phases. First, the an- gular momentum emerges out of a shear, curl-free, potential flow, as described by TTT. In the second phase, in which haloes approach virialization, the angular momentum emerges out of a vortical flow and halo spin becomes partially aligned with the vorticity of the ambient flow field.

34. **Heidi Lietzen**, Tartu Observatory
*Poster: **Galaxies in groups within the supercluster-void network***

June 17 - 20, 2013

Properties of galaxies depend on the environment. Galaxies in dense environments are redder, more luminous, more likely to be elliptical, and form less stars than galaxies in less dense environments. These density relations have been observed on different scales from the very local galaxy density to the supercluster-scale environments. In Lietzen et al. (2012, A&A, 545, A104) we studied the morphology and star-forming activity of galaxies in groups within different large-scale environments. Our result suggested that star-forming activity may depend on both the group-scale and the supercluster-scale environment. Galaxies in superclusters are less likely to be star forming than galaxies in low-density environments even if they belong to groups with the same richness. I will present our results on how the location in the cosmic web can affect the galaxies in groups.

35. **Marilena Loverde**, University of Chiago
*Poster: **Neutrinos in large-scale structure***

June 17 - 20, 2013

36. **Piero Madau**, UC Santa Cruz
*Talk: **The baryon cycle of dwarf galaxies***

June 20, 2013 (9:00 AM - 9:20 AM)

37. **Jorge Moreno**, University of Victoria
*Poster: **Close Galaxy Pairs: Insights from Cosmological Simulations***

June 17 - 20, 2013

Co-authors: Sara Ellison, David Patton, Asa Bluck, Paul Torrey
In the hierarchical scenario of galaxy formation, mergers play a fundamental role: they build up galactic mass, shape morphology and internal structure, initiate bursts of star formation and even activate nuclear supermassive black holes. Unfortunately, most recent models have concentrated primarily on the late post-merger aftermath. On the other hand, the physical importance of galactic interactions in the early stages of a merger is revealed by many observations, such as (1) enhanced star formation; (2) suppression of gas metallicities in the central regions; and (3) the triggering of dual active galactic nuclei (dual AGN). In this talk, I will describe an interactive catalogue of virtual galaxy pairs, which I constructed using the Millennium Simulation and abundance-matching techniques. Unlike traditional mock catalogues in the literature, this scheme allows the user to track any particular galactic configuration backward and forward in time, in order to identify its past merger history and its future dynamical fate. More concretely, I will present recent (unpublished) results focused on the connection between (simulated) close galaxy pairs in six-dimensions (3D-separation and 3D-velocity) and the types of pairs one could observe in surveys where only three dimensions are accessible (projected 2D-separation on the sky plus line-of-sight velocity difference). Throughout the talk, I will present my results in the context of central and satellite galaxies, and their connection to the LCDM picture (dark matter haloes versus sub-haloes). I will argue that selecting close pairs by merely focusing on their projected separation (with appropriate line-of-sight velocity cuts) might not be the optimal way to identify interacting galaxies. I present preliminary evidence pointing to the notion that it is essential to incorporate viral-radius information to this approach. Finally, I will briefly address currently ongoing work, including: (1) wide galaxy pairs and contamination from interlopers in crowded environments (with my cosmological interactive scheme), and (2) galaxy pair configurations capable of producing the strongest star-formation enhancements (with hydrodynamical simulations of binary mergers).

38. **Surhud More**, Kavli IPMU
*Talk: **Pseudo-evolution of the halo mass-stellar mass relation***

June 18, 2013 (11:50 AM - 12:10 PM)

Co-authors: Benedikt Diemer, Andrey Kravtsov
Halos are often defined as regions enclosing a fixed overdensity with respect to a reference density, which evolves with redshift. This causes haloes to grow in mass with time, even without any physical accretion, an effect which we call "pseudo-evolution" of halo mass. We show that for halos of mass M < 10^13 Msun, pseudo-evolution is the dominant channel of growth since z=1. Given that the star formation efficiency (M*/Mh) peaks at halo masses which undergo substantial pseudo-evolution, it is important to account for it, when drawing physical conclusions from the evolution of the stellar mass-halo mass relation. I will present the baseline expectation for how stellar mass-halo mass relation for centrals (and satellites) should evolve, given this pseudo-growth of halo mass.

39. **Benjamin P Moster**, MPA, Garching
*Talk: **Connecting galaxies and dark matter haloes: star formation and gas accretion***

June 18, 2013 (9:25 AM - 9:45 AM)

Co-authors: Simon White, Thorsten Naab, Rachel Somerville
Despite substantial progress, ab initio galaxy formation models (hydrodynamic simulations and semi-analytic models) still employ simplified and uncertain recipes to model the physical processes that drive the evolution of the baryonic components. An alternative approach is to link galaxies and haloes statistically using the 'subhalo abundance matching' method. To this end we employ a redshift dependent parameterization of the stellar-to-halo mass relation, populate haloes and subhaloes in the Millennium simulations with galaxies and require that the observed stellar mass functions at different redshifts be reproduced simultaneously. The resulting relation is used in combination with merger trees extracted from the simulations in order to predict the mean assembly histories of the stellar mass components. Furthermore we use the observed relation between cold gas and stellar mass to study the mass evolution of the condensed baryonic component in the centre and how efficiently gas can cool from the halo in systems of different mass. I will discuss how this method can constrain the physical processes of galaxy formation, and present predictions of galaxy properties at high redshift such as galaxy clustering and cosmic variance.

40. **Nikhil Padmanabhan**, Yale University
*Talk: **Constraints from the Baryonic Acoustic Oscillations***

June 17, 2013 (10:30 AM - 10:50 AM)

41. **Emmanouil Papastergis**, Cornell University
*Talk: **Testing the LambdaCDM halo mass function with the ALFALFA 21cm survey***

June 19, 2013 (9:00 AM - 9:20 AM)

Co-authors: Ann M. Martin, Riccardo Giovanelli, Martha P. Haynes
We use data from the ALFALFA blind 21cm survey to measure the number density of galaxies as a function of their 21cm linewidth ("velocity width function of galaxies"). The 21cm velocity width is determined entirely by the orbital motion of atomic hydrogen in the galactic potential, and therefore it traces directly the dynamical mass of the galaxy within the extent of its HI disk. We compare the measured distribution to the predictions of semi-analytic galaxy models based on high-resolution LambdaCDM simulations, and find substantial disagreement at low widths (a factor of ~8 at w~50 km/s). We consider possible solutions to the discrepancy, including a warm dark matter (WDM) scenario, as well as the possibility that the measured HI velocity of dwarf galaxies greatly underestimates the true mass of the host halo. We show that this latter case implies that no galaxies detectable by the ALFALFA survey should be hosted by halos less massive than Mh = 5 10^9 Msun. However, a recent study of dwarf galaxy rotation curves seems to contradict this assertion, possibly raising an important new challenge to LambdaCDM on small scales ("field too-big-to-fail problem").

42. **Sergey Pilipenko**, Lebedev Physical Institute
*Poster: **Effect of small-scale density perturbations on the formation of dark matter halo profiles***

June 17 - 20, 2013

Co-authors: Doroshkevich, A. G.; Lukash, V. N.; Mikheeva, E. V.
With the help of a set of toy N-body models of dark halo formation, we study the impact of small-scale initial perturbations on the inner density profiles of haloes. We find a significant flattening of the inner slope a to a=-0.5 in some range of scales and amplitudes of the perturbations (while in the case of absence of these perturbations, the Navarro-Frenk-White profile with a=-1 is reproduced). This effect may be responsible for the formation of cuspless galactic haloes.

43. **Jennifer Piscionere**, Vanderbilt
*Poster: **Modeling the Very Small Scale Angular Clustering of SDSS Galaxies***

June 17 - 20, 2013

Co-authors: Andreas Berlind, Cameron McBride
We measure the very small-scale angular clustering of galaxies in volume-limited luminosity samples drawn from the SDSS DR7. We model this clustering using mock galaxy catalogues produced from the LasDamas simulations and the Halo Occupation Distribution (HOD) framework. In order to probe the spatial distribution of galaxies within dark matter halos, we adopt a flexible HOD that allows galaxies to have a biased density profile with respect to the dark matter. We find that luminous galaxies have a steep correlation function, and are thus more centrally concentrated in halos than the underlying dark matter. Lower luminosity galaxies, however, have s density profile that is consistent with that of dark matter.

44. **Francisco Prada**, Instituto de Fisica Teorica UAM, CSIC
*Talk: **Cosmology from Al-Andalus to BOSS***

June 17, 2013 (10:55 AM - 11:15 AM)

45. **Joel R Primack**, UCSC
*Talk: **Assembling Galaxies of Resolved Anatomy (AGORA) Simulation Comparison Project***

June 20, 2013 (2:50 PM - 3:10 PM)

AGORA is a collaboration of about 90 computational astrophysicists to run and compare high-resolution hydrodynamic galaxy simulations using a variety of code platforms. The simulations share common initial conditions and a common basic astrophysics package, and the outputs will be analyzed and compared using a common analysis toolkit (yt). The goals of the AGORA project are to raise the realism and predictive power of galaxy simulations and the understanding of the feedback processes that regulate galaxy metabolism.

46. **Reina Reyes**, KICP
Talk: ***Is LambdaCDM consistent with the Tully-Fisher Relation?***

June 19, 2013 (9:50 AM - 10:10 AM)

Co-authors: Jim Gunn, Rachel Mandelbaum
We consider the question of the origin of the Tully-Fisher relation in LambdaCDM cosomology. Reproducing the observed tight relation between stellar masses and rotation velocities of disk galaxies presents a challenge for semi-analytical models and hydrodynamic simulations of galaxy formation. Here, our goal is to construct a suite of galaxy mass models that is fully consistent with observations, and that also reproduces the observed Tully-Fisher relation. We take advantage of a well-defined sample of disk galaxies in SDSS with measured rotation velocities (from long-slit spectroscopy of H-alpha), stellar bulge and disk profiles (from fits to SDSS images), and average dark matter halo masses (from stacked weak lensing of a larger, similarly-selected sample). The primary remaining freedom in the mass models come from the final dark matter halo profile (after contraction from baryon infall and, possibly, feedback) and the stellar IMF. We find that the observed velocities are reproduced by models with Kroupa IMF and NFW (i.e., unmodified) dark matter haloes for galaxies with stellar masses 10^9-10^10 M_sun. For higher stellar masses, models with contracted NFW haloes are favored. A scenario in which the amount of halo contraction varies with stellar mass is able to reproduce the observed Tully-Fisher relation over the full stellar mass range of our sample from 10^9 to 10^11 M_sun. We present this as a proof-of-concept for consistency between LambdaCDM and the Tully-Fisher relation.

47. **Tanja Rindler-Daller**, The University of Texas at Austin
Poster: ***Cosmology and Structure Formation with Scalar-Field Dark Matter***

June 17 - 20, 2013

Co-authors: Bohua Li, Paul R. Shapiro
The unknown nature of cosmological dark matter is a key problem in modern cosmology and particle physics. For any dark matter variant to be a viable alternative to the massive, collisionless elementary particles usually assumed in the standard Cold Dark Matter (CDM) model, it must preserve the successes of large-scale structure formation in that model. However, on small scales, inside halos, standard CDM may not be so successful. The discrepancy between CDM-predicted cuspy-core halo density profiles and observed mass profiles inferred from dwarf galaxy rotation curves, and the over-abundance of CDM subhalos relative to observations of the Local Group are two well-known examples of the small-scale structure problems of CDM. While these problems may reflect baryonic processes that alter the underlying dark-matter structure, they may, instead, indicate that we must seek an alternative to this standard form of CDM. We shall consider a model involving scalar field dark matter (SFDM), in which ultra-light bosonic particles form a Bose-Einstein condensate (BEC-CDM), which behaves as a quantum fluid with an effective pressure force that can change the small-scale structure inside halos while preserving CDM-like large-scale structure, including the cosmic web. Previous literature has revealed the richness of this candidate in terms of its power to explain astrophysical and cosmological observations, from the background cosmological evolution to galactic rotation curves. However, much remains to be done to find out which part of the parameter space of SFDM is able to explain observations on all scales self-consistently. We find that the background universe with SFDM evolves through four phases, an early phase of relativistic scalar-field domination, followed by the more familiar radiation-, non-relativistic-matter-, and lambda-dominated phases. The timing of the transitions between these phases places important constraints on the particle mass and self-interaction strength. We also revisit classical problems of structure formation in the context of SFDM, including spherical top-hat collapse, virial shocks, and cosmological secondary infall, in order to find viable model parameters which preserve the observed properties of galaxy and large-scale structure while also satisfying these constraints from the evolution of the background universe.

48. **Manodeep Sinha**, Vanderbilt University
Talk: ***Towards an Accurate Relation between Galaxies and their host Dark Matter Halos***

June 17, 2013 (4:00 PM - 4:20 PM)

Co-authors: Andreas Berlind, Cameron K. Mcbride
The last decade has seen an explosion in large galaxy surveys, like the SDSS, providing high precision measurements of several galaxy clustering statistics like n-point correlation functions, group statistics, etc. This clustering data can allow us to obtain highly accurate constraints on the detailed relation between galaxies and dark matter halos, as well as perform a stringent test of the LCDM model. However, to harness the full constraining power of the data, we must simultaneously use multiple clustering statistics, and have a detailed understanding of the statistical and systematic uncertainties in both data and models. We will present the LasDamas suite of simulations that have been carefully designed to address these modeling issues, and present preliminary results from simultaneous fits to multiple galaxy clustering statistics.

49. **Ramin A Skibba**, University of California, San Diego
*Talk: **Quantifying the Cosmic Web: Measures of Galaxy Environment***

June 17, 2013 (4:25 PM - 4:45 PM)

Co-authors: Ravi Sheth, Darren Croton, Stuart Muldrew, Ummi Abbas, Frazer Pearce, Genevieve Shattow
Galaxies form and evolve in particular regions of the cosmic web, which consists of a variety of filaments and knots, as well as voids and underdense regions. The influence of a galaxy's environment on its evolution has been studied and compared extensively in the literature, although differing techniques are often used to define 'environment'. Most methods fall into two broad groups: those that use nearest neighbors to probe the underlying density field and those that use fixed apertures. The differences between them and dark matter halo mass inhibit a clear interpretation of results and their constraints on models. I will assess a variety of measures of environmental correlations, using mock galaxy catalogs constructed for that purpose. I will introduce a new method for quantifying environmental correlations, 'mark clustering statistics'. I find that mark correlation functions are able to detect even a small dependence of galaxy properties on the environment, while such a small dependence would be difficult to detect by traditional methods. I show that rank ordering the marks and using the rank as a weight is a simple way of comparing the correlation signals for different marks. With this I quantify how fixed-aperture overdensities are sensitive to large-scale halo environments, nearest-neighbor overdensities are sensitive to environments within haloes, and color is a better tracer of overdensity than is luminosity.

50. **Matthias Steinmetz**, Leibniz Institute for Astrophysics Potsdam (AIP)
*Talk: **The Wobbly Galaxy: kinematics north and south with RAVE***

June 20, 2013 (4:00 PM - 4:20 PM)

Co-authors: Mary Williams, the RAVE collaboration
The RAVE survey, combined with proper motions and distance estimates, can be used to study in detail stellar kinematics in the extended solar neighbourhood (solar suburb). Using the red clump, we examine the mean velocity components in 3D between an R of 6 and 10 kpc and a Z of -2 to 2 kpc, concentrating on North-South differences. We confirm the recently discovered gradient in mean Galactocentric radial velocity, VR, finding that the gradient is more marked below the plane, with a Z gradient also present. The vertical velocity, VZ, also shows clear structure, with indications of a rarefaction-compression pattern, suggestive of wave-like behaviour. The complex three-dimensional structure of velocity space presents challenges for future modelling of the Galactic disk, with the Galactic bar, spiral arms and excitation of wave-like structures all probably playing a role.

51. **Tomer Tal**, UC Santa Cruz
*Talk: **The non-evolving galaxy distributions in groups since z=1.6***

June 18, 2013 (2:50 PM - 3:10 PM)

Co-authors: Pieter van Dokkum, Marijn Franx, Joel Leja, David Wake, Katherine Whitaker
We present a statistical study of the environments of massive galaxies at $0.04 < z < 1.6$, using data from SDSS and NMBS. We measure the projected radial distribution of galaxies in cylinders around a constant number density selected sample of massive galaxies and utilize a statistical subtraction of contaminating sources. Our analysis shows that massive primary galaxies typically live in group halos and are surrounded by 2 to 3 satellites with masses more than one-tenth of the primary galaxy mass. The cumulative stellar mass in these satellites roughly equals the mass of the primary galaxy itself. We further find that the radial number density profile of galaxies around massive primaries has not evolved significantly in either slope or overall normalization in the past 9.5 Gyr. This result suggests that there exists a tight balance between mergers and accretion of new satellites such that the overall distribution of galaxies in and around the halo is preserved. This is supported by a comparison to a semi-analytic model, which shows a similar constant average satellite distribution over the same redshift range.

52. **Francisco Tamayo**, Universidad Naciolnal Autonoma de Mexico (UNAM)
*Poster: **Intragroup Dark Matter Distribution in Small Galaxy Group-Like systems***

June 17 - 20, 2013

Co-authors: F.J. Tamayo and H. Aceves
Using a set of cosmological simulations in a LCDM model we study the distribution of dark matter in small groups. We calculate the Intragroup dark matter mass (IGM) to total mass of the group and characterize its distribution (of intragroup dark matter). We find that all our groups have rather flat profiles with a logarithmic slope of $\hat{I}^3 = -0.2$. In intermediate and loose galaxy associations the IGDM tends to be < 50 % and in compact associations is < 20% within their group radius. The intragroup dark matter does not follow the same cuspy tendency that haloes of galaxies have ok and do not have massive common dark matter haloes.

53. **Sebastian Trujillo-Gomez**, NMSU
*Talk: **Stellar mass assembly in galaxies with realistic star formation and feedback***

June 20, 2013 (11:50 AM - 12:10 PM)

Co-authors: Anatoly Klypin, Pedro Colin, Daniel Ceverino, Joel Primack
We investigate the role of a more realistic model of star formation and stellar feedback in the assembly of galactic baryons, focusing on the baryonic fraction and the star formation histories of simulated galaxies. Our realistic feedback model is based on observations of star forming regions and includes the dominant contribution from radiation pressure, as well as thermal energy from supernova explosions and stellar winds. In order to properly model feedback, we also implement a realistic model of star formation in which stars form deterministically with a small efficiency per free-fall time, following the results of Krumholz & Tan (2007). We find that radiation pressure from young clusters has a strong effect on the star formation process in galaxies, especially at high redshift. In galaxies with masses ranging from dwarfs to massive spirals, feedback efficiently suppresses star formation by dispersing and heating high density gas, mostly in the central regions, with the potential to completely suppress the formation of a bulge. For the first time in simulations, we observe the process of galaxy "downsizing", in which the early regulation of the star formation due to feedback is responsible for the longer delay of star formation in low mass vs high mass galaxies. In addition, the cold baryon fractions in simulated galaxies with radiative feedback are several times smaller than those obtained with only standard supernova thermal feedback and are also consistent with observations over a broad range of masses.

54. **Sarah Tuttle**, McDonald Observatory
*Poster: **VIRUS and detecting the IGM***

June 17 - 20, 2013

Co-authors: Emily McLinden, Steve Finkelstein, Gary Hill
VIRUS is the massively replicated spectrograph being built for HETDEX, the Hobby Eberly Telescope Dark Energy Experiment. With 33,000 fibers across 22 arcminutes, VIRUS is designed to be a powerful survey instrument. The initial survey will collect 800,000 Lyman alpha emitters to constrain dark energy between $3.5 < z < 2$. It will also observe a wide range of other objects during the blind survey. We are preparing for this onslaught of data using pilot survey data from the VIRUS-P(rototype) instrument to develop a method to search for emission between galaxies in the IGM/CGM. Here we present initial results.

55. **Monica Valluri**, University of Michigan
*Talk: **The effect of baryons on the orbital properties and shapes of dark matter halos***

June 19, 2013 (11:00 AM - 11:20 AM)

Co-authors: Victor P. Debattista, Greg Stinson, Jeremy Bailin, Tom Quinn, Rok Roskar, H.M.P Couchman, J. Wasdley
For over a decade simulations have shown that the condensation of baryons into dark matter halos makes them rounder and flatter than dark matter halos in collisionless simulations. In a series of papers we have investigated the shapes and orbital structures of halos arising from controlled simulations and cosmological hydrodynamical simulations with the goals of understanding (a) why halo shapes change in the presence of baryons, (b) how the orbital structure of halos is modified, (c) what the orbital properties of halo stars can tell us about the phase space distribution of the dark matter halo. In this presentation I will summarize the results of these studies.

56. **Pieter van Dokkum**, Yale
*Talk: **The growth of Milky Way-like galaxies since z~2.5***

June 18, 2013 (11:00 AM - 11:20 AM)

57. **Marco Velliscig**, Leiden Observatory
*Talk: **What shapes the halo mass function? The effects of baryonic physics on the total mass and mass profile of haloes***

June 19, 2013 (11:25 AM - 11:45 AM)

Co-authors: Joop Schaye, Marcel van Daalen
The halo mass function (HMF), i.e. the number density of haloes as a function of their mass, is a key cosmological observable. Measurements of cosmological parameters based on the HMF rely on comparisons with predictions derived from dark matter only simulations. Hence, such analyses implicitly assume that the presence of baryons does not change the masses of haloes significantly. We have used a suite of large hydrodynamical simulations to investigate how the inclusion of baryonic processes such as metal-line cooling, supernovae and feedback from AGN can change the HMF over four orders of magnitude in halo mass. I will show that the large-scale winds driven by feedback from star formation and AGN can reduce the masses of haloes by over 20 per cent with respect to dark matter only simulations. At the high-mass end the effects are largest in the simulation that includes AGN feedback, which we require to reproduce X-ray and optical observations of clusters of galaxies. In this model the reduction of the HMF relative to a dark matter only simulation is still ~10 per cent at 10^14 Msun and remains significant up to the highest masses probed by our simulation (~10^14.5 Msun). We conclude that upcoming surveys aiming to do precision cosmology using the HMF may be severely limited by the accuracy with which we can predict the effects of galaxy formation.

58. **Matthew Walker**, CfA, Harvard
*Talk: **Galactic Dynamics as a Test of Cold Dark Matter***

June 19, 2013 (2:25 PM - 2:45 PM)

59. **Douglas F Watson**, KICP/U. of Chicago
*Talk: **The strikingly similar relation between satellite and central galaxies and their dark matter halos since z=2***

June 18, 2013 (11:25 AM - 11:45 AM)

Co-authors: Charlie Conroy

60. **David H. Weinberg**, Ohio State University
*Talk: **Overview***

June 17, 2013 (9:00 AM - 9:40 AM)

61. **Gustavo Yepes**, U. Autonoma, Madrid
*Talk: **JUBILEE: a suite of large LSS simulations***

June 17, 2013 (11:45 AM - 12:05 PM)

62. **Idit Zehavi**, Case Western Reserve University
*Talk: **Galaxy Clustering in the Sloan Digital Sky Survey***

June 17, 2013 (2:00 PM - 2:20 PM)

Co-authors: Zheng Zheng, David Weinberg, Hong Guo, Santiago Patiri
The Sloan Digital Sky Survey (SDSS) has been immensely useful for studying the large-scale structure of the universe. We present recent measurements of galaxy clustering from the completed SDSS-I/II redshift survey and from the ongoing SDSS-III BOSS survey. The SDSS is particularly suitable for investigating the dependence of clustering on galaxy properties, and we focus on the dependence of the two-point correlation function on color and luminosity. We interpret the measurements using contemporary models of galaxy clustering exploring the galaxy-halo connection. This provides physical insight into the nature of the observed trends and informative tests for galaxy formation and evolution.

63. **Yuanyuan Zhang**, University of Michigan
Poster: ***Studying Galaxy Filaments Through Stacking gmBCG Galaxy Cluster Pairs***

June 17 - 20, 2013

Co-authors: Joerg Dietrich, Timothy McKay, Alex Nguyen, Erin Sheldon
We present a method to study the photometric properties of galaxies in filaments by stacking the galaxy populations found between pairs of gmBCG galaxy clusters. Using Sloan Digital Sky Survey data, this method can detect the inter-cluster filament galaxy overdensity with a significance of 5 out to z = 0:40. Using this approach, we study the g - r color and luminosity distribution of filament galaxies as a function of redshift. Consistent with expectation, filament galaxies are bimodal in their color distribution and contain a larger blue galaxy population than clusters. Filament galaxies are also generally fainter than cluster galaxies. More interestingly, the observed filament population shows redshift evolution at 0:12 < z < 0:40: the blue galaxy fraction in filaments increases at higher redshift: a possible "Butcher Oemler Effect" in filaments. We test the dependence of the observed filament density on the richness of the cluster pair: richer clusters are connected by higher density filaments. We also test the spatial dependence of filament galaxy overdensity: this quantity decreases when moving away from the inter-cluster axis between a cluster pair. This method provides an economical way to probe the photometric properties of filament galaxies and should prove useful for upcoming projects like the Dark Energy Survey.