

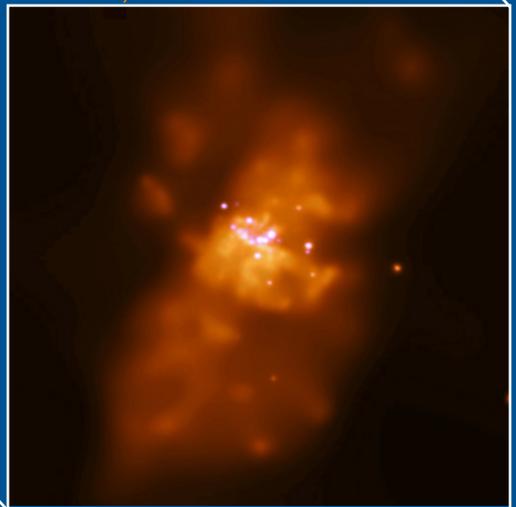
Galactic Flows: The Galaxy/IGM Ecosystem

Baltimore Workshop 7-9 March, 2005

M82 - Optical 9.4'x7.9' - R. Gendler



M82 - Xray 5'x5' - Chandra



Scientific Program and Abstract Booklet
Edited by: S. Savaglio, D. Calzetti, T. Heckman, & K Sembach



SPACE TELESCOPE SCIENCE INSTITUTE

Galactic Flows: The Galaxy/IGM Ecosystem

Science Rationale:

The main topic of the miniworkshop is the interplay between galaxies and the surrounding intergalactic medium (IGM). The primary emphasis will be to review and discuss the observational evidence for chemical, mechanical, and radiative flows in and out of galaxies in the low-redshift Universe. Additional discussions will compare this evidence to related processes in the high redshift Universe and to predictions of theoretical and numerical models. Agenda topics relating to the two-way exchanges of matter and energy between galaxies and their environments include:

1. The Physics of Starburst and AGN Feedback
2. Gas, Energy, and Photon Flows In and Out of Galaxies
3. The Baryonic and Energy Content of Galaxy Haloes and Groups
4. The Role of Environmental Effects (Tidal Interactions, Ram Pressure Stripping, etc.)

Enjoy!

*Daniela Calzetti
Tim Heckman
Sandra Savaglio
Ken Sembach*

Acknowledgments:

The organizers acknowledge financial and logistic support from the Space Telescope Science Institute, in particular from the Science Division.

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Program

Monday 7/3

0800: Light Breakfast

0845: Welcome and Logistics

0900: T. Heckman (I): Introduction: Setting the Stage

Session 1: Star Formation and Outflows

0940: D. Strickland (I): Collective Feedback from Massive Stars: the Status of Observational Data and Theoretical Models

1020: COFFEE BREAK

1100: R. Dettmar: Magnetic Fields, Gas and Dust in the Disk-Halo Interface

1130: R. Wyse: The Fossil Record in Dwarf Spheroidals

1200: D. Rupke: Galactic Winds in Local Star-Forming and Active Galaxies

1230: LUNCH

1400: D. Wang: Hot Gas and Outflows of Nearby Normal Galaxies

1430: J. Lockman: An Enormous HI Outflow from the Inner Disk of the Milky Way

1500: C. Hoopes: Imaging Dust in Starburst Outflows with GALEX

1530: COFFEE BREAK

Session 2: AGN-Driven Outflows

1600: M. Begelman (I): AGN Feedback into the Large-Scale Environment

1640: G. Kriss: UV and X-ray Observations of AGN Outflows and their Influence on the Surrounding IGM

1710: W. Forman: AGN Outbursts in the Gaseous Atmospheres of Galaxies, Groups and Clusters

1740: Poster Presentations

1830: RECEPTION

Chair: Ken Sembach

Chair: Jennifer Scott

Program

Tuesday 8/3

0800: Light Breakfast

Session 3: Inflows

0900: M. Putman (I): Local Examples of Gaseous Flows

0940: A. Fox: The Effect of Escaping Galactic Radiation on High-Velocity Clouds

1010: COFFEE BREAK

1050: M. Tosi: Infall and Outflows from the point of view of Galactic Chemical Evolution Models and Stellar Populations

1120: P. Natarajan: The Physics of Galactic Winds in Low Mass Galaxies

1150: W. Mathews (I): Galactic Circulation Flows

1230: LUNCH

Session 4: ICM/IGM

1400: C. Martin (I): The Impact of Galactic Winds on Galaxy Halos

1440: T. Tripp (I): Using QSO Absorption Lines to Study the Galaxy-IGM Ecosystem: Several Case Studies

1520: COFFEE BREAK

1550: D. Bowen (I): MgII QSO Absorption Line Systems: Cosmic Web or Galaxy Effluent?

1630: M. Donahue (I): X-ray Signatures of Feedback in Intracluster Gas

1710: M. Machacek: Probing the Dynamics of Galaxy/Gas Interactions in Groups and Clusters with Chandra and XMM-Newton

1740: Poster Presentations

1830: END

Chair: Evan Skillman

Chair: Anne Pellerin

Program

Wednesday 9/3

0800: Light Breakfast

Session 5: Flows in the Low-z and High-z Universe

0900: G. Kauffmann (I): What Feedback Effects are Required to Understand the Statistical Properties of the Galaxy Distribution in the Local Universe?

0940: K. Sembach (I): The Baryonic Structure Probe: Characterizing the Cosmic Web of Matter and its Interaction with Galaxies

1020: COFFEE BREAK

Session 6: The External Environment

1100: J. Hibbard (I): Interaction Driven Galaxy Evolution

1140: J. Kenney: Ram Pressure Stripping of Spiral Galaxies in the Virgo Cluster

1210: D. Schiminovich: GALEX-SDSS-FIRST Observations of Galaxies Undergoing Transformation

1240: R. Kennicutt (I): Summary Talk

1320: END

Chair: Sandra Savaglio

Introduction

Tim Heckman

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Introduction: Setting the Stage

I will summarize the major pieces of evidence for the flow of mass, metals, kinetic energy, and ionizing radiation between galaxies and the intergalactic medium (IGM). Galaxies have a strongly preferred mass scale and well-defined mass-metallicity relation that can only be understood in terms of the mediating effects of feedback on the two-way communication between galaxies and the IGM. Galaxies have ionized, chemically enriched, and mechanically heated the IGM. An inventory of the energy per baryon produced over a Hubble time by stellar nucleosynthesis, supernova explosions, radiative accretion onto black holes, and by jets and winds from black holes shows that stars and black holes may be of comparable importance in influencing the IGM.

Session 1: Star Formation and Outflows

Dave Strickland

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Collective Feedback from Massive Stars: the Status of Observational Data and Theoretical Models

I will review current observational constraints on models of collective massive star feedback (a.k.a supernova feedback) on galactic scales. I will attempt to summarize what we definitely do know, what we suspect to be true from models, and what we do not know. The pros and cons of different classes of theoretical modeling will also be discussed, along with a personal view of what are the most pressing problems worth tackling next.

Session 1: Star Formation and Outflows

Ralf J Dettmar

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Magnetic Fields, Gas and Dust in the Disk-Halo Interface

The structure of the magnetic field as deduced from a multiwavelength radio polarization study of several edge-on galaxies is surprisingly strong and regular in orientation. The correlation of substructure in the radio continuum distribution with hot gas observed with XMM and the comparison with H α imaging support models in which the distributed starformation activity in galactic disks drives outflows in very collimated structures. This finding is discussed in comparison to models.

Session 1: Star Formation and Outflows

Rosemary Wyse

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The Fossil Record in Dwarf Spheroidals

The dwarf spheroidal companion galaxies to the Milky Way are currently gas poor, but chemically unevolved, and are arguably the systems in which outflows have been most important in shaping their evolution. As part of a Large Programme with the ESO VLT, we have determined the metallicity distribution of stars in the Carina dSph. I will present our results and discuss implications for chemical evolution and flows.

Session 1: Star Formation and Outflows

David Rupke

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Galactic Winds in Local Star-Forming and Active Galaxies

A summary of the results from a comprehensive survey of powerful infrared-bright galaxies will be presented. The sample contains more than 100 objects, including about 25 active galaxies. The emphasis will be on comparisons between starburst- and AGN-driven winds.

Session 1: Star Formation and Outflows

Q. Daniel Wang

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Hot Gas and Outflows of Nearby Normal Galaxies

I will review results on diffuse hot gas around nearby normal galaxies, based on both X-ray imaging and spectroscopic studies. We have conducted a survey of nearby normal edge-on galaxies (Sd to Sa types). These galaxies have a broad range of star formation rates, but none of them is dominated by a nuclear starburst. The galaxies are all in directions of low Galactic foreground absorption. Extra-Planar diffuse soft X-ray emission is detected unambiguously from all the galaxies with reasonable rates of star formation. The thermal nature of the X-ray-emitting gas is well established, although its chemical and ionization states remain largely uncertain. The X-ray luminosity of the gas is proportional to the star formation rate and to the stellar mass of the galaxies. But the luminosity accounts for at most a few percent of the expected supernova mechanical energy input. Therefore, there is a "missing" energy problem for spiral galaxies. Much of the energy in late-type spirals may be converted and radiated in lower energy bands. But early-type ones most likely have outflows, which are powered primarily by Type Ia supernovae in galactic bulges. These galactic outflows may strongly affect both the dynamics and cooling of the intergalactic gas accretion, hence the evolution of the galaxies. The X-ray imaging observations of the nearby galaxies are complemented by X-ray absorption line spectroscopy of diffuse hot gas around our Galaxy. Absorption lines of O VII, O VIII, and/or Ne IX in diffuse hot gas have been detected firmly in the spectra of LMC X-3 as well as four AGNs and seven Galactic low-mass X-ray binaries. We have implemented an analysis tool, accounting for line saturation and allowing for joint fits to multiple absorption lines. Our analysis gives no significant detection of the absorption in an extended Galactic halo beyond the distance of the LMC. The bulk of the X-ray-absorbing gas resides in and near the Galactic disk. The existing measurements suggest a disk scale height of only about 1 kpc and an apparent enhancement toward the Galactic central region, consistent with the surface brightness distribution of the Galactic diffuse 3/4-keV background. Therefore, these X-ray-absorbing species, together with the well-known far-UV tracers (O VI, N V, C IV, and Si IV), suggest a trend of hot gas from high to low ionization states with the increasing distance from the Galactic plane. These results demonstrate the potential of X-ray absorption spectroscopy as a uniquely powerful tool in the study of the thermal, chemical, and ionization states as well as the spatial distribution of diffuse hot gas. I will discuss the implications of the results for the formation and evolution of galaxies.

Session 1: Star Formation and Outflows

Felix Lockman

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An Enormous HI Outflow from the Inner Disk of the Milky Way

We have detected a large HI feature in 21cm emission with the Green Bank Telescope which appears to be a neutral plume rising several kpc above the Galactic plane in the inner Milky Way.

Session 1: Star Formation and Outflows

Charles Hoopes

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Imaging Dust in Starburst Outflows with GALEX

Multiple lines of evidence suggest that superwinds contain dust, including optical imaging polarimetry and far-infrared imaging. However, the physical relationship between the cool, dust-bearing gas and the warm and hot outflowing gas remains unclear. Comparison of sensitive, high resolution images of the dusty material with images of optical and X-ray emission could shed light on this relationship. Dust is highly reflective in the ultraviolet (UV), so imaging of starburst superwinds in the UV can trace the location of dust. Toward this end, we have analyzed Galaxy Evolution Explorer (GALEX) images of the prototypical edge-on starburst galaxies M82 and NGC253. These images reveal a complex of UV filaments in the starburst-driven outflows in the galaxy halos. The UV luminosities in the halo are too high to be provided by shock-heated or photoionized gas except perhaps in the brightest filaments in M82, suggesting that most of the UV light is the stellar continuum of the starburst scattered into our line of sight by dust in the outflow. The morphology of the UV filaments in both galaxies shows a high degree of spatial correlation with H α and X-ray emission, indicating that these outflows contain cold gas and dust, some of which may be vented into the intergalactic medium (IGM). If starburst winds efficiently expel dust into the IGM, this could have significant consequences for the observation of cosmologically distant objects.

Session 2: AGN Driven Outflows

Mitchell Begelman

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AGN Feedback into the Large-Scale Environment

TBD

Session 2: AGN Driven Outflows

Gerard Kriss

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UV and X-ray Observations of AGN Outflows and their Influence on the Surrounding IGM

More than half of all low-redshift AGN exhibit UV and X-ray absorption by highly ionized gas. The observed UV and X-ray absorption lines are almost always blue-shifted at velocities of hundreds of km/s, indicating that the absorbing gas is outflowing from the active nucleus. In some cases the inferred mass flux rivals the Eddington limit of the central black hole, an indication that these outflows are intimately related to the mass accretion and energy generation mechanism in AGN. The ejected material affects both the interstellar medium of the host galaxy and the surrounding intergalactic medium. Over the past several years, coordinated UV and X-ray observations of several bright AGN at high spectral resolution using HST, FUSE, Chandra, and XMM-Newton have contributed greatly to our understanding of these outflows. I will give an overview of these recent observations, and interpret them in the context of models of winds from accretion disks and thermally driven winds originating from the obscuring torus.

Session 2: AGN Driven Outflows

Bill Forman

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AGN Outbursts in the Gaseous Atmospheres of Galaxies, Groups, and Clusters

We present Chandra, ROSAT, and XMM-Newton observations, combined with detailed radio maps, to study the impact of AGN outbursts on gaseous atmospheres in early type galaxies, groups, and clusters. We focus the discussion on M87 where many X-ray features appear to be a direct result of repetitive AGN outbursts. In particular, the X-ray cavities around the jet and counter jet are likely due to the expansion of radio plasma, while rings of enhanced emission at 14 and 17 kpc are probably shock fronts associated with outbursts that began about 10-20 million years ago. The effects of these shocks are also seen in brightenings within the prominent X-ray arms. For M87, the mean power driving the shock outburst is three times greater than the radiative losses from the entire "cooling flow". Even in the absence of other energy inputs, outbursts every 30 million years are sufficient to quench the flow. We also investigated outbursts in individual early-type galaxies. We have studied in detail Cen A, several galaxies in Virgo including NGC4636, and the dumbbell galaxies NGC4782/4783. We are completing a survey of the nuclear X-ray emission in 100 galaxies observed with Chandra and find that about 90% of elliptical galaxies show nuclear emission as well as extended soft emission from hot gas.

Session 3: Inflows

Mary Putman

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Local Examples of Gaseous Flows

The galaxies of the Local Group are important tracers of the methods galaxies obtain and lose gas. This talk will focus on two methods galaxies obtain gas, satellite destruction and the accretion of the intergalactic medium. The Milky Way is our best source to study these processes in detail. Clear examples of the accretion of gas from satellite destruction are presented, and indirect evidence for cooling, accreting IGM are discussed.

Session 3: Inflows

Andrew Fox

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The Effect of Escaping Galactic Radiation on High-Velocity Clouds

I will discuss the interpretation of FUSE and HST/STIS absorption line observations of high-velocity clouds (HVCs), many of which are at unknown distance. CLOUDY photoionization modeling of these HVCs can be used to relate their observed levels of ionization (e.g C III / CII, Si III / Si II) to the escaping ionizing radiation from the Milky Way. I will show new models of the escaping radiation from the spiral arms of the Milky Way, for both soft ($>912 \text{ \AA}$) and hard ($<912 \text{ \AA}$) photons. Measurement of HVC abundances also provides information on metal enrichment in the vicinity of spiral galaxies. Collaborators: Blair D. Savage, Bart P. Wakker, Kenneth R. Sembach, Todd M. Tripp, Joss Bland-Hawthorn.

Session 3: Inflows

Monica Tosi

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Infall and Outflows from the point of view of Galactic Chemical Evolution Models and Stellar Populations

I will summarize the reasons why chemical evolution models require significant long-lasting infall of metal-poor gas in spiral galaxies and galactic winds in dwarf galaxies. The interesting case of the two windy late-type dwarfs NGC1569 and NGC1705 will be presented.

Session 3: Inflows

Priya Natarajan

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The Physics of Galactic Winds in Low Mass Galaxies

Galactic winds are being recognized increasingly as a fundamental aspect of galaxy formation. They can be an important mechanism for heating the gas in clusters and the inter-galactic medium; for ejecting metals produced in stars into the Lyman- α forest; and for providing feedback energy that regulates the infall of gas into galaxies. Lower level activity of this type may also be responsible for the redistribution of mass and angular momentum *within* an individual galaxy as well, with important consequences for the final structure of spiral and elliptical galaxies. Despite their manifest importance, a detailed study of the underlying physics of this phenomenon is still lacking. While some studies have examined limited regions of the parameter space (Bregman 1996; Bregman 2004), there has yet to be a detailed theoretical analysis of the underlying physics that covers both the range of galaxy masses and address evolution in a cosmological context. We present recent results on application of galactic winds to lower mass galaxies. Of particular importance is the fact that winds are produced in the inner regions of a galaxy, where the gravitational potential is dominated not by dark matter but by baryons. Thus, over the course of the the galaxy's history, the expulsion of significant mass which some authors, such as Binney, Gerhard & Silk (2001) estimate to be >50%, will change the background potential and thus the kinematics of the underlying stellar source population. We present recent results on application of galactic winds to lower mass galaxies.

Session 3: Inflows

William Mathews

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Galactic Circulation Flows

Some global X-ray properties of the hot gas in elliptical galaxies and galaxy groups resemble those of traditional cooling flows. But X-ray spectra and relatively low central black hole masses are inconsistent with wholesale central cooling to low temperatures. Cooling and mass inflows can be arrested if the central black holes are assumed to create bubbles of super-heated (iron-rich) gas that buoyantly rise upstream through an interbubble cooling inflow, creating a circulation flow. Nevertheless, it is likely that some of the dusty gas ejected from mass-losing red giant stars cools in the cores of elliptical galaxies, possibly providing a modest but dependable source of mass to the central black hole.

Session 4: ICM/IGM

Crystal Martin

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The Impact of Galactic Winds on Galaxy Halos

X-Ray and H α imaging of starburst galaxies routinely show galactic winds extending several kpc above the galactic disks. The importance of these winds for enriching the IGM, heating the IGM, and suppressing star formation depends largely on how far the winds travel. Fortunately, absorption-line measurements provide sensitive probes of wind/halo gas kinematics and column densities on far larger spatial scales than direct imaging alone. I will discuss three approaches that use new absorption-line observations of galaxies and quasars. First, in nearby starbursts, simultaneous measurements of the velocity of cool gas and the temperature of coronal gas reshape our dynamical picture of how winds work, with consequences for their predicted evolution at large distances. Second, resonance absorption profiles mapped across ultraluminous starbursts show coherent velocity fields over 20 kpc scales, which may indicate this cool gas is the same material seen in intervening ALS. Third, I will discuss the predicted impact of winds on the coherence scale of intervening absorption line systems and the prospects for testing the hypothesis that winds influence the size of metal-line systems.

Session 4: ICM/IGM

Todd Tripp

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Using QSO Absorption Lines to Study the Galaxy-IGM Ecosystem: Several Case Studies

QSO absorption lines provide a sensitive tool for the study of low-density gas. Indeed, many gas clouds that are readily detected in absorption in QSO spectra are difficult or impossible to observe by any other means with current facilities. The challenge with QSO absorbers is to understand how the information measured on the pencil beam to the background light bulb can usefully be related to the broader context in which the absorption arises in order to learn about galaxies, the IGM, and cosmology. This is a daunting challenge when dealing with high-redshift absorbers, but in the low- z arena, we can use deep imaging and spectroscopy of objects in the field of the QSO to investigate the environment and nature of the absorbers. This talk will present the main results of several studies of QSO absorption systems for which we have obtained high-quality UV spectra and deep imaging and spectroscopy of objects in vicinity of the absorbers. The talk will present measurement of physical conditions, abundances, and gas masses in a variety of locations. In some cases, these measurements are quite surprising, and it will be argued that UV capability for study of low- z galaxies is a crucial component for future observational efforts to understand galaxy evolution.

Session 4: ICM/IGM

David Bowen

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MgII QSO Absorption Line Systems: Cosmic Web or Galaxy Effluent?

Well, we don't know yet. However, we will present some new results from an SDSS-related program which was designed to: a) identify redshift $z > 0.3$ galaxies which lie close to higher- z background QSOs, then b) search for MgII absorption in the QSO spectra at the redshift of the foreground galaxies. This is the 'inverse' of the work carried out over a decade ago by other researchers who identified absorbing galaxies from *known* MgII systems. Although the expectation, based on the prior work, was that 100% of galaxies would show MgII absorption lines, we in fact find that only 50% do. This talk will present a potted history of the subject, discuss the new results, and briefly outline possible explanations for the discrepancy.

Session 4: ICM/IGM

Megan Donahue

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X-ray Signatures of Feedback in Intracluster Gas

I will discuss what X-ray observations of clusters of galaxies have revealed about the feedback of AGN and star formation in clusters. The signatures I will review are entropy distributions, X-ray surface brightness, and the X-ray luminosity-temperature relationship. I will also review what X-ray telescopes have revealed regarding the mean metallicity of clusters, the change of metallicity with redshift, and the relative abundances of $[\alpha]/\text{Fe}$ elements.

Session 4: ICM/IGM

Marie Machacek

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Probing the Dynamics of Galaxy/Gas Interactions in Groups and Clusters with Chandra and XMM-Newton

X-ray observations of galaxies in groups and clusters show features including surface brightness edges, trailing wakes and tails. These offer powerful probes of the galaxy's dynamical motion through and interaction with the surrounding medium. Using Chandra and XMM-Newton observations of nearby galaxies that span a range of galaxy types and ICM/IGM gas temperatures, including the spiral galaxy NGC 6872 in the Pavo Group and elliptical galaxies NGC 1404 in Fornax and NGC 4552 in Virgo, we demonstrate how precision X-ray measurements of temperature, density and metallicity across edges and in tails constrain the three dimensional motion of the galaxy through the surrounding IGM. For these galaxies, we will discuss the relative importance of ram-pressure, turbulent viscosity, and Bondi-Hoyle-Lyttleton accretion to the interaction of the galaxy with its environment.

Session 5: Flows in the Low-z and High-z Universe

Guinevere Kauffmann

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What Feedback Effects are Required to Understand the Statistical Properties of the Galaxy Distribution in the Local Universe?

I will discuss what we have learned from analyzing the correlations between different galaxy properties in large redshift surveys such as the SDSS. I will also discuss how this is now being linked into phenomenological models of galaxy formation in a standard LCDM cosmology and how this is producing interesting constraints on the feedback processes that are necessary to produce consistency between theory and observations.

Session 5: Flows in the Low-z and High-z Universe

Ken Sembach

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The Baryonic Structure Probe: Characterizing the Cosmic Web of Matter and its Interaction with Galaxies

TBD

Session 6: The External Environment

John Hibbard

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Interaction Driven Galaxy Evolution

Galaxy-Galaxy interactions lead to an exchange of material between galaxies and the intergalactic medium primarily through two mechanisms: starburst driven outflows (covered extensively in earlier talks), and tidal ejection. Both of these processes differ depending on the local environment, with processes such as "pre-processing", "harassment", and "threshing" occurring in denser environments. The evolution of tidally ejected material also depends on the local environment. The implication for the evolution of the remnant systems is discussed.

Session 6: The External Environment

Jeffrey Kenney

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Ram Pressure Stripping of Spiral Galaxies in the Virgo Cluster

We report observational results on ram pressure stripping of spiral galaxies in the Virgo Cluster, from our ongoing Virgo Cluster VLA HI Survey, as well as optical broadband and H α imaging. Many spiral galaxies show evidence of ongoing stripping, including extraplanar gas tails and asymmetric disk gas distributions. Some also show extraplanar HII regions in the stripped gas. We give general results as well as cases of particular interest, including optical (including HST) observations of dust showing dense (molecular) cloud ablation due to ram pressure stripping, and nuclear AGN and starburst outflows interacting with stripped disk gas. With this data we are able to address questions such as: 1. Can galaxies in different phases of interaction be identified? 2. Does gas fall back after peak ram pressure? 3. When does star formation occur in stripped gas? 4. How does the stripping rate compare to the SFR? 5. How does ICM ram pressure affect nuclear outflows from AGN and starbursts?

Session 6: The External Environment

David Schiminovich

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GALEX-SDSS-FIRST Observations of Galaxies Undergoing Transformation

GALEX observations of galaxies experiencing on-going ram-pressure stripping (quenching), radio jet or merger activity provide insight into the effect of transformative events on the recent star formation history of galaxies. These processes may also be linked to the detection of star forming clusters and knots found at large galactocentric distances (10-100 kpc) in both quiescent and rapidly evolving galaxies. We present GALEX and SDSS DR3 spectroscopic observations of new samples of optically-selected and radio-selected galaxies experiencing transformation and describe unique signatures of each population.

Summary

Robert Kennicutt

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Summary Talk

TBD

Posters

- [1] – Dominik Bomans, *Astronomical Institute, Ruhr-University Bochum*
A giant gas halo around the dwarf starburst galaxy NGC 625?
- [2] – John Cannon, *Max Planck Institute for Astronomy*
The Neutral and Coronal Gas Outflow in the Dwarf Starburst Galaxy NGC 625
- [3] – George Chartas, *Penn State*
Quasar Feedback
- [4] – Doron Chelouche, *Institute for Advanced Study*
Constraining the Mass Loss Rate from Active Galactic Nuclei
- [5] – Hugh Crowl, *Yale University*
VLA Observations of Stripped Edge-On Virgo Cluster Galaxies
- [6] – Robert Gibson, *MIT CSR*
The Outflow and the Warm Absorber of the QSO MR 2251-178
- [7] – Andrea Gilbert, *MPE*
Feedback from Massive Stellar Clusters in Starbursts
- [8] – Volker Heesen, *Astronomical Institute of the Ruhr-University Bochum (AIRUB)*
The Radio Halo of the Starburst Galaxy NGC 253
- [9] – Knud Jahnke, *Astrophysikalisches Institut Potsdam*
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- [10] – Lorenza Levy, *University of North Carolina at Chapel Hill*
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- [11] – Suzanne Linder, *STScI*
Dust Extinction in IRAS 13349
- [12] – Greg Madsen, *Anglo-Australian Observatory*
A Search for Emission from Ionized Gas on the Outskirts of M31, M33, and the Milky Way
- [13] – Biman Nath, *JILA, University of Colorado and Raman Research Institute, India*
Entropy of the intracluster medium and the role of AGNs
- [14] – Yurii Pidopryhora, *NRAO & Ohio U*
An Enormous HI Outflow from the Inner Disk of the Milky Way

Posters

- [15] – Antonio Pipino, *Dipartimento di Astronomia, Università di Trieste*
Galactic winds: a link between Ellipticals and the chemical enrichment of the Intracluster Medium.
- [16] – Jennifer Scott, *Laboratory for Astronomy and Solar Physics*
Probing AGN Outflows: Intrinsic Absorption in Mrk 279 and NGC 7469
- [17] – Ming Sun, *Harvard/CFA*
The galaxy X-ray coronae in the rich cluster environments
- [18] – Rodger Thompson, *Steward Observatory*
Galactic Flows in SBS 0335-052
- [19] – Janine van Eymeren, *Astronomisches Institut der Ruhr-Universität Bochum*
Giant Outflows from Irregular Dwarf Galaxies
- [20] – Rik Williams, *Department of Astronomy, Ohio State University*
Probing the Local Group Medium Toward Mkn 421 with Chandra and FUSE
- [21] – Emily Xanthopoulos, *UC Davis & LLNL*
Linear Radio Structures in Selected Seyfert and LINER galaxies
- [22] – Emily Xanthopoulos, *UC Davis & LLNL*
Jet-induced star formation in Seyfert galaxies unveiled through radio-UV correlations