Clusters of Galaxies as Cosmic Laboratories

Monday 12 September 2011

Non-thermal Processes I - FD51 (09:30-12:30)

- Conveners: PFROMMER, Christoph

time	title	presenter
09:30	Welcome (Lars Bergström, Director of the Oskar Klein Centre) (00h15')	
09:45	Hard X-ray emission from clusters (00h45')	MADEJSKI, Greg
10:30	Non thermal Activity in Clusters of Galaxies (00h45')	PETROSIAN, Vahe
11:15	Coffee Break (00h30')	
11:45	Cosmic-ray Connections between the Interstellar and Intergalactic Medium (00h45') Galaxy clusters are expected to behave as reservoirs of cosmic-ray nuclei over billion-year timescales, thus creating a record of their non-thermal history since the time of their formation. One source population of such intergalactic cosmic rays are those initially accelerated in the galaxies themselves, which subsequently escape the interstellar medium of their parent galaxies. Gamma-ray telescopes allow us to study the acceleration and transport of cosmic-ray nuclei throughout our Milky Way and in external galaxies via photons created by the inelastic collisions of hadronic cosmic rays with ambient interstellar gas. I will discuss observations and analysis of non-AGN-dominated galaxies performed with the Large Area Telescope on the Fermi Gamma-ray Space Telescope, and suggest means by which these observations can be used to estimate the contributions of galaxies to the non-thermal hadrons of the intergalactic medium.	BECHTOL, Keith

Lunch Break - FD51 (12:30-14:00)

Non-thermal Processes II - FD51 (14:00-16:45)

- Conveners: BERGSTRÖM, Lars

time	title	presenter
14:00	Results from the "Phoenix" programme of very high resolution N-body simulations (00h45') I will present results from the "Phoenix" programme of very high resolution N-body simulations of cluster-size cold dark matter halos. I will discuss the mass distribution and internal structure of the halos and their subhalos. If the dark matter is made of supersymmetric particles, particle/anti-particle annihilation is likely to result in the emission of detectable gamma-ray radiation. I will discuss predictions from these simulations for the properties of this emission.	FRENK, Carlos
14:45	TeV observations of Galaxy Clusters - from now to CTA (00h45')	REIMER, Olaf
15:30	Coffee Break (00h30')	
16:00	Prospects for detecting gamma-ray emission from galaxy clusters (00h45')	PINZKE, Anders

Dinner: Swedish smörgåsbord - Verandan Restaurant, Grand Hotel, S. Blasieholmshamnen 8, 103 27 Stockholm (18:30-21:30)

Tuesday 13 September 2011

X-ray Surveys and Cosmology - FD51 (09:00-12:30)

- Conveners: JONES, Christine

time	title	presenter
09:00	Constraining dark energy and modified gravity with galaxy clusters (00h45') Using measurements of the abundance of galaxy clusters we obtain constraints on dark energy and gravity at cosmological scales. Our data set consists of 238 cluster detections drawn from the ROSAT All-Sky Survey and X-ray follow-up observations of 94 of those clusters. Using a new statistical framework we self-consistently and simultaneously constrain cosmology and observable-mass scaling relations accounting for survey biases, parameter covariances and systematic uncertainties. Allowing the linear growth index and the dark energy equation of state to take any constant values, we find no evidence for departures from GR+LCDM. If time permits, I will also present preliminary results on testing an alternative gravity model using our cluster data sets. Our results highlight the power of X-ray cluster studies to constrain cosmology.	RAPETTI, David
09:45	The XMM Cluster Survey: First Data Release and Initial Science Results (00h45') I will review the properties of the 504 clusters in the XCS-DR1 and, time allowing, explain some of the technical challenges that we have met whilst developing that catalog. I will then present science results based on the XCS-DR1 clusters, including those on Fossil Groups; AGN-ICM interactions; optical-to-X-ray scaling relations and the luminosity-to-temperature relation. I will preview other analysis work involving XCS-DR1 clusters that is now in progress (both inside and outside the XCS collaboration) and also how XCS can inform future cluster surveys (both X-ray and optical). Finally, and again time allowing, I will explain the challenges we face in the preparation of XCS-DR2 (3,4...) in the current funding climate.	ROMER, Kathy
10:30	Coffe Break (00h30')	
11:00	Cosmology with the XMM clusters (00h45')	CLERC, Nicolas
11:45	The XMM Cluster Survey: Future constraints (00h45') I will discuss expected future cosmological constraints from the utilization of the XMM Cluster Survey sample.	SAHLEN, Martin

Lunch Break - FD51 (12:30-14:00)

SZ Surveys, Mass Calibration and Cosmology - FD51 (14:00-18:15)

- Conveners: ROMER, Kathy

time	title	presenter
14:00	The Santa Barbara Cluster Standards Project (00h45') Cluster of galaxies have an excellent track record as probes of cosmology. However, if they are to remain competitive with other methods for constraining cosmological parameters, we will need to calibrate the relationships between cluster masses and the observable quantities used to trace mass to better than a few percent accuracy. If we are to succeed in that effort, we will need standard definitions for cluster observables and cluster masses, so that our efforts at percent-level calibration and comparisons with simulations do not become bogged down in sorting out subtle differences among those definitions. One of the outcomes of the recent KITP workshop in Santa Barbara was a set of wiki pages that will allow the cluster community to propose and discuss various standard definitions of cluster quantites. I will summarize the rationale for the project and its current status.	VOIT, Mark

14:45	The South Pole Telescope Galaxy Cluster Survey (00h45') We have carried out a multi-wavelength mm-wave survey of 2500 deg^2 in the southern extragalactic sky in search of Sunyaev-Zel'dovich Effect signatures from galaxy clusters. More than 600 cluster candidates have been selected from the mm-wave data, and we are currently characterizing these candidates to determine their redshifts and improve our understanding of their masses. This cluster sample is an approximately mass limited cluster sample extending to beyond redshift z=1 and it currently includes three of the four most massive discovered clusters beyond redshift z=1. Initial analyses of a small subset indicate that the cosmological constraints are in good agreement with other studies. Efforts at improved mass calibration of the SZE mass--observable relation include using mass indicators like Micm and Yx from Chandra and XMM and galaxy velocity dispersions from optical spectroscopy with Gemini, Magellan and the VLT. We are beginning a direct mass calibration using weak lensing observations from Hubble, the VLT and Magellan. We are working to complete an analysis of the sample of over 200 clusters detected in the 2008 and 2009 SPT observing seasons.	MOHR, Joe
15:30	Coffee Break (00h30')	
16:00	APEX SZ observations of galaxy clusters (00h45') I will present results from a Large Programme with APEX to map the Sunyaev-Zeldovich decrement at 2 mm with an angular resolution of 1 arcminute in about 50 galaxy clusters distributed over a large range of redshifts. The observations were done between 2007 and 2010. Both isolated and merging clusters were observed, as well as part of the XMM-LSS field. Individual clusters are studied and the sample will be used to constrain mass-SZ observable scaling relations. I will also present APEX observations of the 870 micron emission toward the Bullet Cluster; there, the extended SZ increment needs to be carefully separated from the background point sources (submm galaxies) gravitationally lensed by the mass distribution in the Bullet Cluster.	HORELLOU, Cathy
16:45	The cosmological implications of massive clusters (00h45') The existence of high redshift massive clusters is a good test of cosmology, because the theoretical cluster mass function is well known from simulations. After a brief overview of the history of this test, I describe the tension these clusters cause with LCDM and possible explanations.	HOYLE, Ben
17:30	Constraining Dark Energy with Cluster Strong Lensing (00h45') Current efforts in observational cosmology are focused on characterizing the mass-energy content of the Universe. We present results from a geometric test based on strong lensing in galaxy clusters. Based on Hubble Space Telescope images and extensive ground-based spectroscopic follow-up of the massive galaxy cluster Abell 1689, we used a parametric model to simultaneously constrain the cluster mass distribution and dark energy (DE) equation of state. Combining our cosmological constraints with those from X-ray clusters and the Wilkinson Microwave Anisotropy Probe 5-year data, we find that dark matter comprises a fraction Omega_m = 0.25 +/- 0.05 of critical density and that the DE parameter wx = -0.97 +/- 0.07, both consistent with results from other methods. Inclusion of our method with all other techniques available brings down the current 2- sigma contours on the dark energy equation of state parameter wx by about 30%.	NATARAJAN, Priyamvada

Wine and Cheese - FD51 (18:15-19:30)

Wednesday 14 September 2011

Cluster Dynamics I - FD51 (09:00-12:30)

- Conveners: MADEJSKI, Greg

time	title	presenter
09:00	Blazar Heating - The Rosetta Stone for Structure Formation? (00h45') It has been realised only recently that TeV emission from blazars can significantly heat the intergalactic medium by pair-producing high-energy electrons and positrons, which in turn excite vigorous plasma instabilities, leading to a local dissipation of the pairs' kinetic energy. This heats the intergalactic medium and dramatically increases its entropy after redshift z~2, with important implications for the formation of galaxy clusters and dwarf galaxies. This suggests a scenario for the origin of the cool core (CC)/non-cool core (NCC) bimodality in galaxy clusters and groups. Early forming galaxy groups are unaffected because they can efficiently radiate the additional entropy, developing a CC. However, late forming groups do not have sufficient time to cool before the entropy is gravitationally reprocessed through successive mergers - counteracting cooling and raising the core entropy further. Hence blazar heating works different than feedback by active galactic nuclei (AGN), which balances radiative cooling but is unable to transform CC into NCC clusters due to the weak coupling to the cluster gas. Similar to AGN feedback, blazar heating suppresses the Sunyaev-Zel'dovich power spectrum on angular scales smaller than 5' due to the globally reduced central pressure of groups and clusters forming after z~1. This allows for a larger rms amplitude of the density power spectrum, sigma_8, and may reconcile SZ-inferred values with those by other cosmological probes even after allowing for a contribution due to patchy reionization.	PFROMMER, Christoph
09:45	The AGN-Galaxy Connection: The interaction between supermassive black holes and their host galaxies (00h45') Feedback between supermassive black holes (SMBH) and their host galaxies is needed to explain a variety of observational "facts", e.g., the tight relationship between SMBH mass and host galaxy properties, the galaxy luminosity function, the absence of significant star formation in "cooling flow" clusters and groups. Only through X-ray observations of early-type galaxies, groups, and clusters that contain hot gaseous atmospheres, that "capture" the SMBH outburst, can we observe feedback in the present epoch Universe. We present observations of SMBH outbursts from galaxies to rich clusters to understand the properties of these outbursts. We focus on a sample of early type galaxies (e.g., NGC5813, NGC5846, Fornax A), M87, and compare outbursts in these systems to those in rich clusters.	FORMAN, William
10:30	Coffee Break (00h30')	
11:00	The Outer Limits of Galaxy Clusters: Observations to the Virial Radius with Suzaku (00h45')	MILLER, Eric
11:45	Shocks, Cold Fronts and Sloshing: The Growth of Clusters of Galaxies through Mergers (00h45') The formation and evolution of large scale structures is a central issue for cosmology. Located at nodes of the cosmic web, clusters of galaxies are the largest collapsed structures in the Universe with over 80% of their mass in the form of dark matter. With hot gas comprising the bulk of the baryonic mattter, in clusters we observe the interactions between the hot and cold baryonic matter and the dark matter. One of the major advances in our understanding of large scale structures from the X-ray images was that clusters were not relaxed systems, but are often scarred by shock fronts and contact discontinuities ("cold fronts") produced by an ongoing merger or "near miss" of a subcluster. The collisions of galaxy clusters are unique experiments that allow us to study the properties of normal and dark matter that are inaccessible by other means. This presentation reviews our current understanding of the growth of clusters through mergers, including recent studies of the merging clusters A115 and RXJ1347, examples of Planck SZ selected clusters and propects for future cluster surveys from the eRosita mission.	JONES, Christine

Lunch Break - FD51 (12:30-14:00)

Cluster Dynamics II - FD51 (14:00-16:15)

- Conveners: TBD

time	title	presenter
14:00	The Sunyaev-Zel'dovich effect in the Bullet Cluster (00h45') The Sunyaev-Zel'dovich (SZ) effect offers an opportunity to probe the properties of the intracluster plasma in galaxy clusters through its interaction with the cosmic microwave background radiation. I will present the detection of the SZ effect at 870 micrometers in the Bullet Cluster of Galaxies, at redshift 0.3. I will discuss the techniques used to remove background submillimeter galaxies and the filtering applied to extract the extended SZ emission. By modeling the data the distribution and properties of the hot gas in the cluster can be constrained.	SIGURDARSON, Haukur
14:45	Extreme galaxy clusters and non-Gaussianity (00h45') I will discuss how to quantify the rareness of extreme galaxy clusters without bias. I will also discuss the use of non- Gaussian halo mass functions deep into the tail of their distributions. In each case I will show how to resolve certain problems that have been pointed out in recent literature.	HOTCHKISS, Shaun
15:30	Prospects for High-resolution Spectroscopy of Galaxy Clusters (00h45') A decade ago, high-resolution X-ray spectroscopy of galaxy clusters with XMM-Newton and Chandra led to profound changes in our understanding of physical processes governing the state of the plasma in cluster cores. Within the next few years, the advent of X-ray micro-calorimetry will likely open another new window on the the physics of the intracluster medium. I will review the expected performance of these new tools and discuss the potential advances they may produce in our understanding of clusters masses and of the kinematics and energy transport processes in the cluster plasma.	BAUTZ, Mark