CASE WESTERN RESERVE UNIVERSITY
COLLEGE OF ARTS AND SCIENCES

Astronomy Department Newsletter

JANUARY 2010

Scientists Astronomers believe that galaxies like our Milky Way are embedded in extended halos of dark matter whose gravity holds the galaxies together. Image courtesy NASA and the Hubble Heritage Team

CWRU hosts International Workshop "Dark Matter in the Milky Way"

In March 2009, the CWRU Astronomy and Physics departments teamed up to host an international workshop focused on dark matter in the Milky Way galaxy. Dark matter, the elusive material that is thought to make up 80% of the mass of the universe, remains undetected by direct experiments. Instead, all we know about the properties of dark matter is based on indirect astronomical evidence -- the rotation of galaxies, the motions of galaxy clusters, the formation of structure in the universe, and the properties of the microwave background.

Timed to coincide with a visit from Professor Carlos Frenk (Durham), one of the originators of the cold dark matter model, our workshop brought together a diverse group of astronomers and physicists working on the dark matter problem. Experimental physicists updated us on the latest results from dark matter detectors -- no confirmed detections yet, but the sensitivity of detectors continues to improve. Observational astronomers showed new results from the study of ultra faint dwarf galaxies orbiting the Milky Way, suggesting a common mass scale for the dark matter halos of these faint objects. We also heard updates from the Fermi Gamma Ray telescope, which continues to take data, in part searching for the faint signature of annihilating dark matter -- but again, no detections yet!

On the theory side, astronomers are using simulations to probe the detailed phase space structure of dark matter halos, while particle theorists continue to develop possible models to explain dark matter in the ever-narrowing range of parameter space. As the limits on mass and cross-section go down, driven both by improved detector sensitivities and ever-growing astrophysical constraints, the coming years should prove an exciting time for dark matter research. And of course, there's always the possibility that our understanding of gravity may need to be revised....

For more information on the workshop, see the Plain Dealer article at http://www.cleveland.com/science/index.ssf/2009/03/scientist_shine_light_on_dark.html

And many of the talks can be seen at http://astronomy.case.edu/DMworkshop.shtml

Inside this Issue:

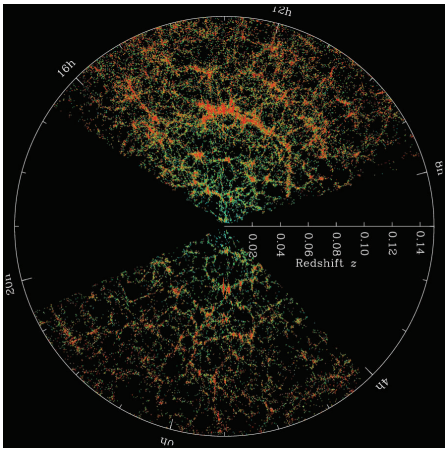
What they are up to; where have they gone . . .

Michelle Wilson is a CWRU ***senior astronomy major***. She spent last summer in the northern part of Holland, in Groningen, which is the home of one of the two major Dutch astronomical observatories. She worked with Prof Amina Helmi, who is one of the foremost researchers into "z=0 cosmology": the study of the "fossil record" left by the surviving oldest stars in the halo of the Milky Way, which gives important clues about the way our Galaxy, and other galaxies, were put together in the earliest epochs when stars began to form in the Universe. Michelle finished her research project and then spent 4 weeks broadening her horizons in other ways, visiting England, France and Germany.

In December, ***Steve Rodney (BS '03)*** defended his PhD thesis at the University of Hawaii's Institute for Astronomy. Steve worked on development of the Pan-STARRS-1 (PS1) telescope, and was involved in several of the early science results, including the first PS1 supernova detection. His thesis focused on light curves of thermonuclear supernovae, and, in January, Steve moved to Baltimore to take up a post-doctoral research position at Johns Hopkins University, working on the search for high redshift supernovae using the Hubble Space Telescope.

Nick Indriolo (BS '05) writes: I am currently at the University of Illinois working for Ben McCall, and our lab specializes in astrochemistry, and observational and laboratory studies of the spectra of molecules of astrophysical interest. My primary focus has been an observational search for the molecular ion H3+ in diffuse interstellar clouds. Because the chemistry behind the formation and destruction of H3+ is rather simple, we can use H3+ column densities to estimate the interstellar ionization rate of molecular hydrogen due to cosmic rays. Our initial findings suggest that the ionization rate is an order of magnitude larger than previously thought, and we are currently searching for correlations between H3+ abundance and several other variables (e.g. number density, temperature, location in the Galaxy). The general theme of my thesis project is to better understand the relationships between H3+, other molecules, and the physical conditions in the ISM. Also, I hope to put tighter constraints on the cosmic-ray ionization rate, as well as shed light on what may be causing the higher-than-expected ionization rate.

Dr. Zehavi Awarded NSF Grant to Study Galaxy Clustering



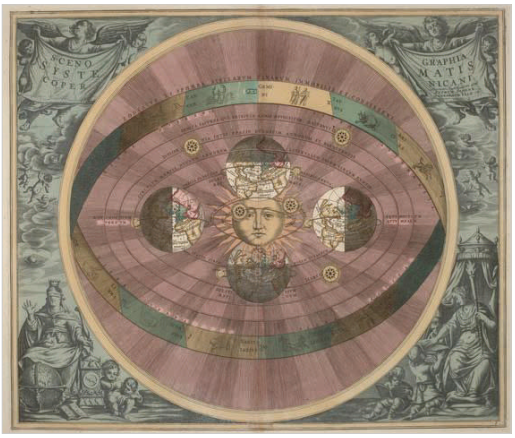
The National Science Foundation has awarded Dr. Idit Zehavi a three year grant to study galaxy clustering and inferences relating to galaxy formation and evolution. The spatial clustering of galaxies encodes important information about how galaxies form and evolve. Zehavi and collaborator Zheng Zheng (Yale) are working at the interface of theory and observations to study these topics using data from the recently- completed Sloan Digital Sky Survey (SDSS).

This plot shows the spatial distribution of galaxies in a slice from the SDSS. Each point represents a galaxy, color coded by its intrinsic color. Zehavi and collaborators study this distinct clustering pattern and its dependence on different galaxy properties. Interpreting these measurements can shed light on the relation between galaxies and dark matter and provide insight on the complex picture of galaxy formation. Comparing and connecting clustering measures from surveys at different epochs, through the growth of dark matter halos, will also enable a detailed study of galaxy evolution.

Steven Janowiecki Provides New Views of the Burrell Schmidt

Steven Janowiecki (BS '08, now at Indiana U) writes: While on an observing run at the Schmidt in late March 2009, I had some free time waiting for the Moon to set. The deep Virgo imaging project has such strict sky condition limits that any moon is too much. Instead of just letting the telescope sit idle, I started taking pictures of it, inside and out. After attaching my camera to the dome and video-taping a few rotations, I got more serious and strapped my camera to a metal scaffold just east of the dome. After opening the camera's shutter for a 3 minute timed exposure, I hurried back in to the dome. Once inside, I rotated the dome slit entirely around while shining my flashlight on the inside of the dome and the telescope. This allowed the camera (with its open shutter) to "see through" the dome and photograph the telescope, in a cutaway view. My first few attempts at this type of image were unsuccessful because of the shutter timing or dome illumination, but I eventually got it to work (in a total of 8 different images). By positioning the telescope on top of the polar axis, the whole tube (and finders) were visible in the images. I stood in an unusual place alongside the pier so I could also be visible in the image, while still holding the telescope control paddle to rotate the dome. During the three minute camera exposure, the stars (notably Orion over the dome) trailed as a result of the Earth's rotation. The thin crescent moon also appears very brightly in this long exposure. Finally, you can even see my flashlight trail, as I walked back in to the dome after starting the camera's exposure. Observing on the Schmidt is always a lot of fun, especially when there's extra time for telescope glamour shots.

Course Highlight: Astronomical Arguments



As part of CWRU's SAGES general education curriculum, Professor Chris Mihos has developed a new course exploring scientific controversies, using examples from astronomy and cosmology. The course is taught seminar-style, with a heavy emphasis on student-led discussions. The course starts with a discussion of the scientific process -- both as an ideal and as a practical reality -- and readings from philosophers of science such as Thomas Kuhn and Karl Popper. With the benefit of scientific hindsight, we then address some historical controversies such as the Copernican Revolution, the size of the Galaxy, and the distance to the "spiral nebulae." From there, we move on to modern examples of astronomical debates, covering a range of topics including dark matter vs modified gravity; Pluto: planet or not?; did Mars ever have oceans?; and more. In each case, we examine the scientific basis of the controversy as well as the roles played by cultural and human biases. The course has proved immensely popular and helps students understand not just the universe we live in, but also scientific process that we use to study it.

Chair's Space

Welcome to the 2010 edition of the CWRU Department of Astronomy Newsletter. It seems like the only constant around here is change. After three years of dedicated service as department chair, Heather Morrison has happily returned to her life as a regular faculty member, turning the reins over to me for a while. Please join me in thanking Heather for her efforts, as we look to build on her successes and move the department in new and exciting directions.

Our research opportunities continue to grow. The Burrell Schmidt is still going strong, of course; we use it to study faint starlight around galaxies and galaxy clusters -- the archaeological signatures of past dynamical interactions. We are also actively participating in the new Sloan Digital Sky Survey III project, with particular emphasis on the BOSS and Segue 2 surveys. The BOSS survey aims to study the clustering of galaxies out to z=0.6, measuring the imprint of the acoustic oscillations in the early universe on the distribution of galaxies in space. Segue 2 looks to map the Milky Way's halo in ever-increasing precision, studying the kinematics and chemical abundances of stars out to 100 kpc distant.

Case students continue to be a vital part of our mission. We have been working hard to grow our graduate program, and our undergraduates are very active in our research. You can read about many of their activities in the pages of this newsletter. Our undergraduate majors continue their successes after leaving CWRU; over the past several years these students have gone on to do graduate work at a variety of universities, such as Wisconsin, Illinois, Indiana, Colorado, and Michigan, to name just a few.

You, our friends and alumni, play a critical role in many of these activities, through both your support and your participation. We thank you very much for this help, and we hope you enjoy reading about some of the happenings in the department. Feel free to drop us a line -- we'd be happy to hear from you with any news, suggestions, or stories you'd like to share!

Chris Mihos

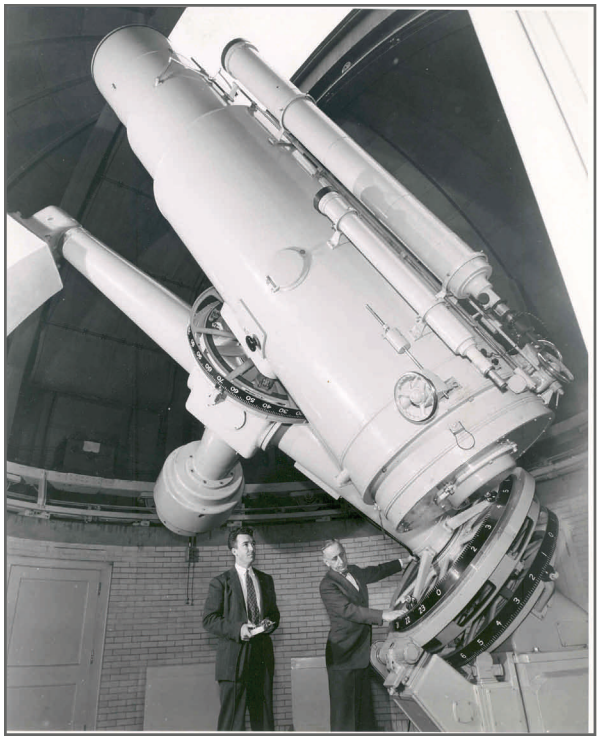
Carl K. Seyfert Prize Fellowship for Undergraduate Research

Case astronomy's second Seyfert Fellowship was awarded to ***Samuel Johnson Stoever***, an undergraduate student at Cornell University. Sam worked with Prof. Heather Morrison on the origins of the Milky Way's disk. They used the unique imaging available from the Sloan Digital Sky Survey (SDSS), of which the department is now a full member. Using the colors of stars just evolving off the main sequence, they were able to constrain the ages of stars in both the inner and outer parts of the disk: important historical information never before available. Sam's talent with computer languages benefited the project, which Prof. Morrison is now continuing with SDSS astronomers in the US and Germany.

The Fellowship supports one undergraduate student each summer to come to Cleveland and work on cutting-edge astronomical research with CWRU faculty members. The Seyfert Fellowship is awarded based on a national competition each spring.

The Fellowship's namesake, Dr. Carl Seyfert (1911-1960), was a Cleveland-born astronomer who worked on a variety of subjects, including stellar and galactic astronomy, and astronomical instrumentation. Dr. Seyfert was also a member of the Warner and Swasey Observatory at Case Western Reserve University from 1942-1946, where he used the Burrell Schmidt wide-field telescope to study the luminosity function of stars in the Milky Way.

The Seyfert Fellowship has been made possible by a generous contribution from CWRU Astronomy alumnus Dr. Anthony J. Wasilewski, whose doctoral thesis was based in part on Seyfert's pioneering work on active galaxies.



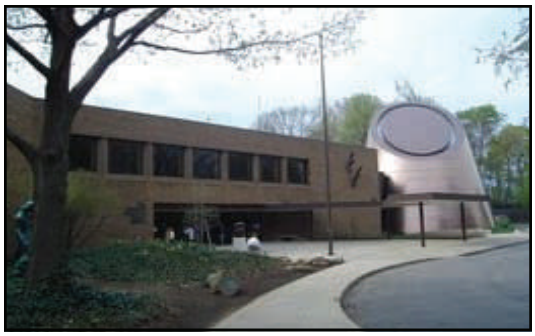
Carl Seyfert and Jason Nassau at the Burrell Schmidt telescope

Frontiers of Astronomy Lectures

Since the 1920's the Department of Astronomy has sponsored a public lecture series entitled Frontiers of Astronomy. These public talks are presented at the Cleveland Museum of Natural History with the Cleveland Astronomical Society and the Cleveland Museum of Natural History as cosponsors and with the support of the Arthur S. Holden, Sr. Endowment. These lectures are well attended with the 2008-09 series of five lectures drawing more than 1200 total attendees.

Dr. Eric Herbst (The Ohio State University) presented: “Chemistry Meets Astronomy: The Role of Molecules in Understanding Stellar and Planetary Formation”, Dr. Alan Marscher (Boston University) presented: “Jets from Black Holes in Quasars”, Dr. Sally Oey (University of Michigan) presented: “Powering the Universe with Massive Stars”, Dr. Carlos Frenk (Durham University-England) presented: “The Great Cosmic Gamble: Making Galaxies from Nothing”, Dr. Mario Livio (Space Telescope Science Institute-Baltimore) presented: “Is God a Mathematician?”

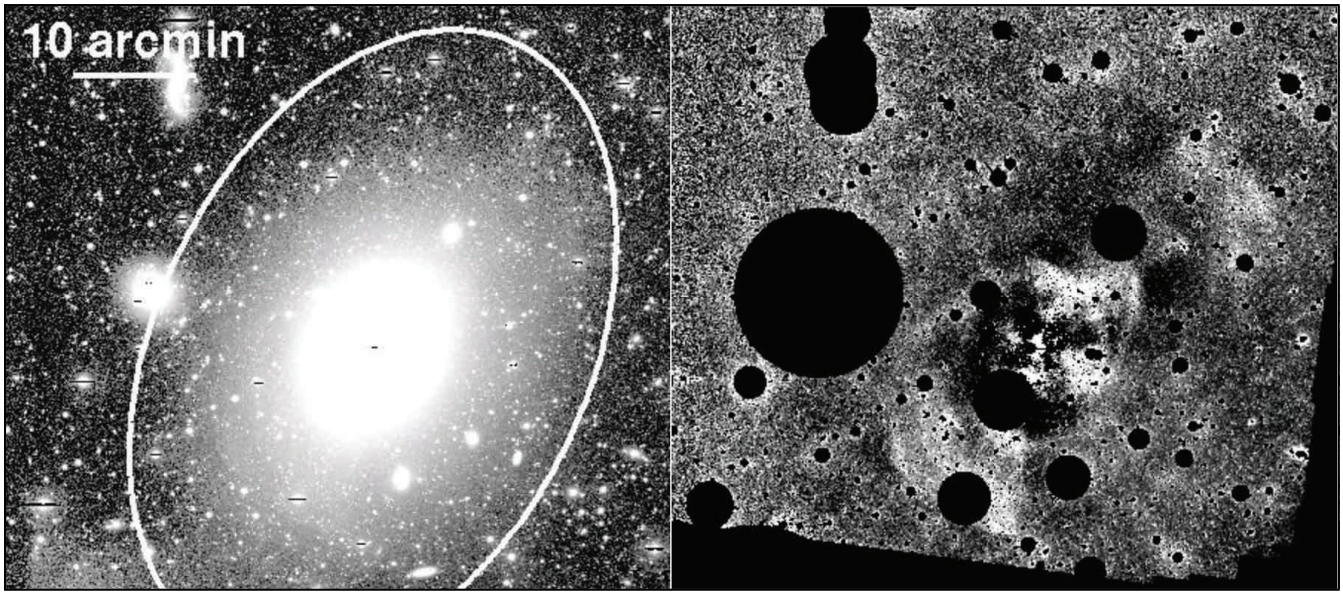
The 2009-10 lecture series continues with Prof. Neta Bahcall (Oct 15); Prof. Robin Ciardullo (Nov 12); Prof. Julio Navarro (Dec 10); Prof. Avi Loeb (Mar 18); Prof. Juna Kollmeier (Apr 15). If you are in the Cleveland area, please consider attending these free public lectures. Check out our website: http://astronomy.case.edu for more information.



Deep Imaging of the Virgo Cluster

Chris Mihos and collaborators continue their survey of diffuse light in the Virgo Cluster with the upgraded Burrell Schmidt telescope. At the January AAS meeting, Mihos reported on the discovery of diffuse star streams around several Virgo ellipticals, a signature of past infall of satellite galaxies. Graduate student Craig Rudick gave a dissertation talk reporting on measurements of the color of Virgo's intracluster starlight. This work, along with the story of Paul Harding's upgrades to the Schmidt, was featured in a recent Cleveland Plain Dealer article, which can be seen at **http://www.cleveland.com/science/index.ssf/2010/01/using_a_69-year-old_telescope.html**

The Virgo elliptical M49 (left), showing a complex system of stellar shells after subtraction of the smooth galaxy light (right).



CASE WESTERN RESERVE UNIVERSITY
COLLEGE OF ARTS AND SCIENCES

Warner & Swasey Observatory
Department of Astronomy
10900 Euclid Avenue
Cleveland, OH 44106-7215

Phone: 216-368-3728
Fax: 216-368-5406
http://astronomy.case.edu

Burrell Schmidt, Kitt Peak Observatory

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