Highlights of the 2014/2015 Academic Year

Crowd Funded Research: We started this year with a fundraising campaign for MilkyWay@home, and raised $48,193.40 to keep MilkyWay@home operating through 2015! This is a really fantastic accomplishment, and we owe a debt of gratitude to those of you who made it possible to keep the research pipeline running. As promised, I am providing an accounting of where those funds were actually spent at this link: 2014 Accounting. Accomplishments are noted in this newsletter and on our social media sites and web pages.

Unfortunately, the funding situation is even worse this year. Prof. Newberg has lost all of her federal research funding, and is running an even more desperate campaign to continue running MilkyWay@home and analyze data from the Chinese LAMOST survey. MilkyWay@home is a half PetaFLOPS computing resource powered by 25,000 people around the world who donate their unused computer cycles. It has been under development for a decade. It is teaching us about the distribution of stars in the Milky Way’s stellar halo, and soon will be used to measure the distribution of dark matter in the Milky Way. Newberg is the head of the LAMOST Stellar Halo Substructure key project, and leads a group of nine US astronomers who have been granted data rights to this national key project of China through their contributions to the survey design and science infrastructure. The LAMOST survey has taken spectra of six million Milky Way stars and will run for two more years to collect several million more stellar spectra.

To learn more about our current fundraising campaign, click the links on the left column.

International Accolades: This year Prof. Newberg shared the 2015 Breakthrough Prize in Fundamental Physics, as a member of the Supernova Cosmology Project, for the discovery that the Universe is accelerating (dark energy). This is a $3,000,000 prize that was shared among the fifty members of two international teams who made this important discovery in 1999. Newberg has donated her share ($32,787) to her research group, to fund her graduate students.

Also this past year, Newberg was named one of the Highly Cited Researchers (Most Influential Scientific Minds) 2014 by Thompson Reuters. This list includes about 1% of the most highly cited researchers in Space Science.
Wave-like Patterns in the Milky Way disk:
Newberg made international news for the discovery that the Milky Way disk of stars is not flat but is instead corrugated. From our position in the Galaxy, if we look away from the Milky Way's center the position of the stellar disk appears to oscillate up and down! This result means that the disk of stars extends much farther than previously thought, and also explains why there appear to be rings of stars farther out than the end of the disk. As we look out, it looks like the number of stars in the (presumed flat) disk drops off quickly, and then farther out where the disk ripples back up it looks like a detached ring of stars appears. We now understand that the galaxy didn't end; the disk is just going in and out of our view.

More than 50,000 people watched a 20 minute YouTube video to find out more. We have also posted a 50 minute lecture for astronomers and a one minute video for kids.

Upgrades to MilkyWay@home: Jake Weiss and Sidd Shelton had a very busy summer upgrading our two MilkyWay@home applications: separation (which finds the density distribution of stars in the Milky Way halo) and n-body (which may one day find the density distribution of dark matter in the Milky Way halo but which currently measures the amount of dark matter in the original dwarf galaxy that was pulled out by the Milky Way's gravity into a long stream of stars). See the Science page for more information.

We have just recently shown that our new MilkyWay@home algorithm (called "modified fit" for arcane reasons) is able to correctly determine the density distribution in a set of test data that we created to make sure the algorithm works. This improved algorithm includes a more accurate representation of the distribution of brightnesses of the turnoff stars that we use to trace stellar density. We now plan to run the algorithm on real data from the Sloan Digital Sky Survey to map the distribution of stars in the Milky Way’s stellar halo. Technical details can be found in the blog.

We discovered that our n-body method for generating dwarf galaxies was flawed, causing the simulated galaxies we were throwing into the Milky Way (to be pulled out into tidal streams in the simulation) to be unstable. Sidd completely re-wrote the code to simulate the galaxies and rigorously tested it. With the new code we have again shown that MilkyWay@home can find the mass of the dark matter in the original dwarf galaxy we put into a simulation, just by looking at the distribution of stars that are strewn out across the sky at the end of the simulation. Now we need to figure out how robust this result is to not knowing exactly the shape of the Milky Way and the path the dwarf galaxy was traveling through the Milky Way. If this works, it will be incredibly important! See the developer blog for technical details.

The stream of stars from the simulation of a dwarf galaxy falling into the Milky Way. The stream gets longer with time. It is also longer if the dwarf galaxy started out larger or less massive. MilkyWay@home sorts it out!
Is the dark matter made of axions? Pierre Sikivie is a well-respected particle physics theorist. He believes that if the dark matter is made up of a theoretical particle called an axion, that the dark matter distribution would include rings in the plane of the Milky Way’s disk. We set out to understand whether this was reasonable, given what we know about the structure of the Milky Way – and found that it is! Julie Dumas put together the pieces of the axion model, and showed that it looked very similar to common dark matter distributions that are used to model the Milky Way. It was consistent with the distribution of stars in known tidal streams. However, we were not able to find evidence for or against the presence of dark matter rings. There is always more to learn!

Student Accolades: Julie Dumas became the first African American to receive a PhD in physics from Rensselaer, and only the 90th black woman to receive a physics PhD, ever. Jake Weiss received his BS and is now a graduate student, still working on MilkyWay@home. He is also a Space Grant fellow! Graduate student Paul Amy received a Presidential Fellowship. Graduate student Charles Martin was the Wild Card winner in FameLab USA: Exploring Earth and Beyond for the NY regional competition; the award was for his excellent presentation skills. Matthew Newby left us to take a teaching position at Temple University, and Jeff Thompson left to teach at Southern Vermont College. Undergraduate students Adam Susser (grad student at Case Western), Jake Bauer (grad student at Cambridge), Roland Judd (Goldman Sachs) all graduated. We welcome Keighley Rockcliffe, Brianne Foster, and Clayton Rayment to the group.

Other research results: See the published papers listed to the left (most are publicly available on arXiv) for more results!

Get more news on facebook: Visit our facebook page to get more news and information. There you will find pictures of all of us at various conferences, links to YouTube videos including new astronomy videos for kids, images of our participation in a Rosa Barba art installation at Rensselaer, and announcements of a small fraction of the outreach activities we have all participated in.