

# Harlem Children's Zone: Astronomy Course Proposal

Nicholas Hunt-Walker

March 20, 2014

The overall objective in this proposal is to present a tour the contents of the night sky in 6-weeks, with the intention for Middle-schoolers with basic math experience (e.g. add, subtract, multiply, divide). The primary goals will be bringing space to ground-level, and making the practice of space science achievable for all. The format is a walk through the various size scales of our Universe. At each point we will study the details of objects at those scales and get a deeper feel for them. While we discuss each, I will introduce the physical concepts that bring us the knowledge of the night sky that we have today. What follows will be fairly directed, but everything is flexible depending upon resources at the Harlem Children's Zone, desires of the staff, and progress of the students.

Starting with the Moon, we discuss its dynamic history and growth into what we see today. We will cover the popular formation hypotheses and learn to reject all but one. We will cover the phases of the Moon and connect that to what we see in the night sky throughout each month, and talk about how the position of our Moon causes the solar eclipses that we see. Lastly we will discuss the age of the Moon, and how we know its age from radiocarbon dating. In order to strengthen the connection between what we learn about the phases of the Moon and what is seen I will have the students track the time of the Sun setting, the Moon rising, and the phase of the Moon twice per week. For a tangible demonstration of asteroids hitting the Moon and cratering its surface, we will use rocks to create craters in a soft, malleable material (e.g. soft clay).

Our next stop will be planets in and out of our Solar System. We will talk about how other planets acquire and influence their moons, then move on to how planets form in general. Our main concern with planets is how they allow for or discourage life. As such, we focus on all the necessary components that allow life as we know it, including how planets maintain their atmospheres. Our capstone for this phase will be the ongoing search for planets outside of our Solar System. Computer resources permitting, we will have students analyze a combination of actual and simulated data to try to detect planets of their own around Sun-like stars. If computers are not available, we can do a similar analysis on paper by plotting individual data points and performing rough measurements.

From there we have a natural transition to our own Sun. Our discussion will begin with its formation, and move on to how it sustains itself through nuclear fusion, how it provides for life on our planet, and also how it can end that life. We will encounter sunspots in the solar cycle and the enormous solar flares that our planet constantly defends against. I would like the students to get a feel for just how massive and powerful the Sun is, so as a demonstration we will calculate just how much energy is generated every second, and how much matter is consumed to produce that energy. This topic will end with actual data from the Solar Dynamics Observatory and Solar Heliospheric Observatory, chronicling how the Sun's activity changes over time through observing sunspots. Again, computational resources permitting, I can provide them with the appropriate data to do an individualized analysis, but a similar analysis can be done on paper.

Our Sun is only one of the hundreds of billions of stars within our galaxy. The way in which they are born is almost as exciting as the many and varied ways in which they live and evolve. Our lessons will begin with the creation of clusters of stars from giant molecular gas clouds, and follow these stars as they evolve over billions of years. We will also discuss their remnants after their evolution has ended. The demonstration for this section will use a program that I wrote for an astronomical statistics class during my graduate studies, where I simulate a cluster of stars and show the grand variety of objects in these clusters. Each star will be categorized and then followed as it evolves, producing the elements and molecules that we see today. If this type of demonstration is not feasible, then we can do a more tangible project where we build a 3D structure showing the positions and distances of the nearest set of stars. For this, each student can be responsible for 10 stars. They can learn about the position, color, brightness, and other properties to bring detail to their contribution. Then they can add their contribution to the class structure.

We see each star individually, but the ensemble of all of the stars in our sky is part of what constitutes our Galaxy. We will learn about the other components of the Milky Way (e.g. gas, dust, etc.), and discuss its overall structure (e.g. the galactic disk, central bulge, and extended halo). The students will then use what they've learned to point out similar structures in galaxies outside of our own. At the end, we will put all of this information together to come up with a picture of our own galaxy, comparing that to what we see in our own night sky (or what we would see if not for city lights). To further solidify the vastness of our galaxy, we can build a physical model of the different structures in our galaxy. Because the Milky Way is vast and populated with literally hundreds of billions of stars, it's not possible to produce a scale model showing the Sun's size in relation to the rest of the galaxy. However, we will work on a model that's partially to scale so that the students have a physical picture of the Milky Way.

The last stop on our journey will encompass our Universe as a whole. We will explore clusters of galaxies and how they fit into what is known as the Large-Scale Structure of our Universe. We will then learn how we know about the Universe's Large-Scale Structure through analyzing galaxies and supernovae. Finally, we will use actual data of distant galaxies to show that other galaxies are flying away from us, filling out our expanding Universe. We will end by discussing the ideas behind the Big Bang, and what remnants from that initial explosion we see today. We will demonstrate the expansion of our Universe with the classic demonstration of points expanding on the surface of a balloon.

It is my firm belief that learning happens best when there is work being done inside and outside of the classroom. As such, in addition to the lab demonstrations, I will send students home with a short question set about each week's topic, as well as encourage them to ask me questions about space, specifics of different space missions, or careers in astronomy and astrophysics. Lastly, because the beauty of the cosmos is what draws all eyes toward the night sky, I will have students search through the archives of Astronomy Picture of the Day (<http://apod.nasa.gov/apod/astropix.html>) each week and come up with an image that interests them, with an explanation of their interest. Depending on timing, budgeting, and class size, we may even be able to go on a field trip to the planetarium at the American Museum of Natural History, or do some star gazing at Columbia University if their Astronomy department's typical summer programs are running. Ideally, this class would take place three times per week, for an hour and a half each class with a break after 40 minutes. This would be long and often enough for students to learn a wide range of material, but also sparse enough for them to actually work on assignments and have free time. Through six weeks of these lessons and assignments, students will be sure to walk away with a deeper understanding of the contents of our night sky.