QuarkNet 2017 Annual Report
Hawaii

During the period from September 2016 till August 2017 several QuarkNet activities took place in Hawaii.

On Sept 24, 2016, 23 students and 5 teachers participated at the annual Cosmic Ray Day Workshop held at Punahou School. The Cosmic Ray Day is an event for high school teachers and students. Lectures on Cosmic Rays and Solar Activity lead to activities using actual data from the Alpha Magnetic Spectometer (AMS-02) and Quarknet activities, about Solar Energetic Particles.
These particles, accelerated by the Sun, are measured by AMS-02, a particle detector on board the International Space Station (ISS).

Fig. 1 - Cosmic Ray Day Workshop held at Punahou School.

On Nov. 11, 2016, another Cosmic Ray workshop was held at the Maui College, for 18 students and 4 teachers. The Maui High School students and their teacher shared results of their summer research on cosmic rays and climate change.

Fig. 2 - Cosmic Ray Day Workshop held at Maui High School.

On April 1, 2017, a MasterClass was held at Punahou School for 20 students and 3 teachers. Master teacher Warren Huelsnitz invited NSF Ice Cube scientist to give a presentation on this research in Antarctica. A videoconference was held with students in Taiwan.

Fig. 3 - MasterClass was held at Punahou School.

Summer 2017 research and abstracts

During the 2017 summer, 6 students and 2 teachers, from Maui High School and Kamehameha Kapalama School in Honolulu, conducted particle physics research sponsored by QuarkNet. The Maui High students were mentored by James D Armstrong, solar physicist at Maui Institute for Astronomy. Veronica Bindi, associate physics professor and Michael Jones, physics professor emeritus, both at University of Hawaii Manoa, served as mentors for the Kamehameha Kapalama School students.

Abstracts:

1) Parameterization of Flux Graphs
Emi Ahlo - Kamehameha Schools Kapalama, Honolulu, HI
Using flux graphs, the reliability of a Student Cosmic Ray Detector can be identified. Analysis of numerous detectors with a variety of geometry and parameters have produced specific detector data characteristics that identify reliable detectors. The two most telling properties are a horizontal best fit line in the flux plots, and no more than 15% of a deviation from that line.

2) Altitude vs. Muon Lifetime
Kahiwakuikanaulu Hoe - Kamehameha Schools Kapalama
In order to analyze the relationship between muon decay time and elevation from sea level, muon detectors from around the world were reviewed for accuracy. The amount of flux and the consistency of the detector were the primary factors to monitor, and the lifetimes of each school along with its respective elevation were plotted to show a positive correlation between 40 m and 240 m of elevation, but higher altitudes had too few data points to draw a notable conclusion.

3) Cosmic Shower Parametrization and CME Hazard Prognosis
John Mailolo - Kamehameha Schools Kapalama
Cosmic showers are a natural event caused by radiation, which may produce negative and mutagenic effects within human populations. This study defines the parameterization to measure and detect increased levels of cosmic radiation, utilizing solar flare data first, then flux levels. In addition to parametrization, this methodology predicts a correlation with cosmic radiation on Earth, within one to three days. This parameterization also highlights the potential boundaries at which solar flares may pose a potential hazard, surpassing the Forbush effect, at solar flare magnitudes of M7 and higher.

4) Comparing EUV and LOS Magnetic Field Images to Determine if Coronal Holes are a Part of the Solar Cycle
Zain Jabbar - Maui High School
Everyday Earth is bombarded by charged particles from the sun, its solar wind. However, with current understanding of electromagnetism, charged particles slow down in a magnetic field and if the sun were a perfect bar magnet we would get

much fewer charged particles from the Sun than expected. This is due to coronal holes, areas on the Sun where the magnetic field lines protrude out radially from the surface, allowing charged particles to fly away and towards the Earth. Coronal Holes are visible using high frequency photography as in the high ultraviolet and X-Ray images. These areas are low in plasma density and are cooler due to the high energy particles released. It is well known that the eleven year Solar cycle has the Sun fluctuations in luminosity and with the number of sunspots, cool regions on the sun with strong magnetism. The goal of my project was to create a program and feed it data from NASA's AIA 193 Angstrom images and line of sight magnetic field images to count the number of pixels on the Sun covered by sunspots and by coronal holes and plot them to see if the two are linked within the same cycle. The results of this could help better understand the solar cycle and to better predict when the Earth is hit by dangerous solar wind, which can cause power outages and has shown to increase the number of heart attacks.

5) Hydroponic System Simulation of UVC Effects on Plant Growth for Mars

OneJae Lee – Maui High School

Mars is currently being researched for future expeditions and even colonization efforts. National Aeronautics and Space Administration (NASA) is currently looking into the viability of food production and ways of maximizing efficiency food production on Mars for long expeditions. An important fact to remember when dealing with farming crops on Mars is the environment. Mars has a very thin atmosphere, about 100 times thinner than that of Earth Mars also lacks a global magnetic field. Due to this, more harmful radiation like ionizing radiation, galactic cosmic rays and high-energy ultraviolet rays contact the surface of Mars. Recent data shows that the surface radiation from galactic cosmic rays is equivalent to 0.67 millisieverts per day These high-energy rays are known to cause DNA damage, tissue damage, and even death in living organisms. The higher exposure to high-energy rays on Mars brings up a question of whether or not the light present on Mars is suitable for plant growth. If growth rate, final mass and also qualitative data between a control hydroponics system only being exposed to normal visible light to an experimental hydroponics system exposed to both normal visible light as well as high energy radiation were compared, then the effects of the high-energy radiation present on Mars on plants could be approximated. Although it would be very difficult to replicate galactic cosmic rays in a laboratory setting due to it being impossible to create a supernova in such settings, it is possible to test other types of high energy radiation. One type of radiation that is found in higher amounts on Mars compared to Earth is ultraviolet-C (UVC). Non-ionizing ultraviolet radiation is divided into three categories based on wavelength, with UVC being the shortest wavelength range out of all three of the categories. Although UVC is non-ionizing, it still has a relatively high energy level due to it being the junction between ionizing and non-ionizing radiation and is actually used as a mutagenic agent in plant due to DNA having a strong absorption maximum at the wavelength UVC is present in; this combined with the fact that UVC photons are of high energy makes creating high amounts of DNA damage, similar to those caused by ionizing radiation, easily done quickly. A UVC level of 3 W/m2 is the assumed irradiance on Mars based on the results of a study done by A. C. Schuerger of University of Florida. The result of

this experiment could be used to question whether or not the light present on Mars could reasonably be used for plant growth without further processing. Methods of processing that could be utilized are filters or possibly using a solar panel to harness energy to use a much safer LED light system.

RESULTS of 2016 Cosmic Ray Workshop Evaluation, Sept 24

Student Grade Level 3 - 9th gr, 10 - 11th gr, 9 - 12th gr
Science Courses taken/are taking – (extensive background, except for 9th graders)
Physics - Conceptual, IB, Physics 1 & 2, Honors, AP
Biology, Chemistry, Environmental Science, AP Biology,

Please circle the numbers according to the scales given.
SA-strongly agree, A-agree, U-unsure, D-disagree, SD-strongly disagree

Attitudinal Survey	**SA**	**A**	**U**	**D**	**SD**
1. I felt comfortable with others at this workshop ….……	5 (13)	4 (7)	3 (2)	2	1
2. I liked the balance between lectures and activities ……..….	5 (10)	4 (11)	3 (1)	2	1
3. I needed more instructions in order to do the activities …….	5 (2)	4 (3)	3 (5)	2 (10)	1
4. Learning about cosmic radiation is important for everyone …	5 (8)	4 (9)	3 (5)	2	1
5. I am more aware that everything is interconnected in nature.	5 (13)	4 (5)	3 (2)	2 (2)	1
6. I am fascinated with humans living elsewhere…….	5 (13)	4 (5)	3 (4)	2	1
7. I want to learn more about radiation and cosmic rays…….	5 (14)	4 (5)	3 (3)	2	1
8. I would come to future workshops on these topics …….……..	5 (14)	4 (6)	3 (2)	2	1
9. I would recommend this workshop to my friends ….……..……	5 (13)	4 (9)	3	2	1

Lectures/Activities	**Excellent**	**Very Good**	**Good**	**Ave**	**Fair**
1. TED Cosmic Rays Video – V. Bindi……..……	5 (13)	4 (8)	3	2	1
2. Sun's Activity and Radiation – V. Bindi……	5 (14)	4 (8)	3	2	1
3. Solar Modulation Activity – W. Huelsnitz……6(2)	5 (9)	4 (9)	3 (2)	2	1
4. Solar Flares & CME's – K. Whitman…..……..	5 (12)	4 (7)	3	2	1
5. Lunch with Physicists…….……	5 (15)	4 (4)	3	2	1
6. Solar Energetic Particles – K. Whitman…….	5 (13)	4 (6)	3 (2)	2	1
7. Moon and Mars Village – V. Bindi…..…….….	5 (16)	4 (1)	3 (1)	2	1

Please complete the following on the back of this page: (Even one sentence is adequate.)

I want _____

I learned _____

I wish _____

I hope _____

RESPONSES by grade levels.

9th graders

I want
1. To know do a little more research on this topic. (Really interested and would like to learn more.)
2. To come to these workshops more and learn more.
3. To pursue astrophysics, even more so after participating in this lecture.

I learned
1. More about cosmic rays and solar activity. Especially CME's, SEPs and why it's difficult to put people in space (other than oxygen, etc.)
2. A lot about solar rays and galactic rays. About how we can go to Mars someday. I liked learning about the sun and its radiation.
3. That there are many astronomy and physics-oriented careers.

I wish
1. That there were more events like this that I could go to.
2. To come again.
3. To participate in any future events and see the team again.

I hope
1. That, if they had a quantum physics workshop, I would go and be inspired to get a job in that field.
2. There are more workshops like these.
3. To obtain this desired career, now guided by this perpetually insightful and thought-provoking knowledge.

11th Graders (no comments from 1)

I want
4. To learn more about solar system and beyond.
5. To learn more about physics concepts like these.
6. To learn more about life in Mars.
7. To learn more about solar system.
8. To learn about cosmic radiation.
9. To learn more about cosmic rays and how they affect our planet.
10. To research more about our solar system.
11. To learn more about how the universe works.
12. More hands on activities.

I learned

4. About cosmic rays and solar flares
5. Much more about cosmic rays and the sun than I had from anyone else.
6. A lot about cosmic rays since I didn't really know about it.
7. about cosmic rays.
8. about the solars.
9. About cosmic rays and how there are different cycles in the sun & SEP.
10. About cosmic radiation.
11. About cosmic rays and the potential hazards for us on earth and astronauts.
12. What causes solar flares

I wish

4. I understood the last page of Activity 2 a little better.
5. I could have convinced other people I know to have attended this workshop.
6. To get to know more of the other students.
7. I could have talked to more physicists.
8. To come to more workshops.
9. To come and learn more about SEPs and cosmic rays.
10. We accomplish going to Mars.
11. The people on Mars One the best of luck.
12. I had a better understanding of the topics.

I hope

4. This event occurs again. ☺
5. I can attend future workshops like these.
6. Another event like this happens again.
7. We go to Mars.
8. For astronauts to go to Mars.
9. To come again in the future.
10. To come back here.
11. To have a career in physics.
12. To learn more about cosmic rays.

12th Graders (1 incomplete)

I want

13. To learn more about our universe and how the smallest particles affect the biggest, more massive objects in our universe.
14. To learn more about space!
15. To become an astrophysicist even more so now.
16. To have more workshops like this (w/ activity, not just the particle phys workshop like spring.)
17. To go to space.
18. Humans to go to Mars.
19. To travel to another planet and be able to live on a colony there.
20. To learn more about biomimicry.

I learned

13. About cosmic and solar rays can affect humans.
14. A lot about cosmic rays as I hadn't ever heard of them before!
15. A lot.
16. About cosmic rays and how they affect us here and potential Mars/Moon missions.
17. That space is dangerous place.
18. About the dangers of space.
19. That galactic cosmic rays affect astronauts.
20. SO MUCH about what it would take to get to Mars and how physics is involved in this process.

I wish

13. We had the opportunity to do more calculations on our own for the workshop activities.
14. That we had longer to talk at lunch with the people!
15. That I didn't come late.
16. To connect importance of cosmics rays with other sciences (bio, chem?) and maybe other fields (psych, econ?)
17. Humans don't go extinct before they get to space.
18. That I go to space.
19. To be able to go into space.
20. I had taken a physics course before graduation.

I hope

13. The physicists who taught and helped us succeed with their research and help us understand our universe works.
14. That there are more workshops like this in the future.
15. These types of events continue to happen.
16. To see humans on the Moon/Mars in my lifetime.
17. We will become an intergalactic species.
18. That humans go to Mars.
19. That I live long enough to see the Mars missions.
20. I take a physics course in college.