

## Rutgers 2018 Annual QuarkNet Program Report

This is the 18<sup>th</sup> year for the Rutgers University QuarkNet Center. Personnel participating in the Center include lead teachers Daniel Kaplan and Frank Cappuccio along with Rutgers faculty members John Paul Chou, Yuri Gershtein, Eva Halkiadakis, Amit Lath and Steve Schnetzer, staff member Dave Maiullo and Rutgers students. All are actively involved in the summer teacher/student research program.



This year, we hosted our 11<sup>th</sup> QuarkNet-sponsored, summer research program for high school students. The goal of this program is to expose enthusiastic high school students to ongoing research in cosmology and particle physics, topics that are often sadly lacking in the high school curriculum. In addition to lectures and informal discussion sessions with Rutgers faculty, students get hands-on hardware experience building and taking data with cosmic ray detectors and using them to obtain high precision measurements of the muon lifetime and the speed of light. They also analyze actual CMS data to search for particles such as the Z and Higgs bosons and in the process learn about aspects of relativity such as 4-vectors and invariant mass. Alumni of the program value it highly and have sent letters and emails of support including to the Rutgers University President.

Each summer, we hold an evening public event during the two-week program that is attended by high school students along with their teachers, parents and the general public. This past summer the evening program was on the Tension in Cosmology resulting from the disagreement in measurements of the Hubble constant from different techniques. Experts from Rutgers and Princeton spoke on the physics of these measurements and the possible explanations and resolutions of the disagreement. This was followed by a lively Q&A session. [The two-hour event](#) is posted on YouTube.

Although the summer program has attracted outstanding students from top high school districts, we want to involve more students from economically disadvantaged districts. For the past two summers, a group of students from a local minority district have participated in the program. Although they were less prepared than students from the top high schools, they were just as enthusiastic and were able to learn the material just as well as the other students. We are strongly encouraged by this and plan to extend this outreach effort by recruiting students from additional disadvantaged districts for the coming summer.

In addition to the summer program, we held a one day Masterclass in March 2018 involving high school students and their teachers from nearby areas including several minority students from New Brunswick High School.

We also work closely with the New Jersey Chapter of the American Association of Physics Teachers. This year we held a one-day workshop attended by fifteen teachers. The focus of the workshop was on describing the content and activities of the summer program to them and assisting them in transferring the material to their classrooms.

Mentor: Steve Schnetzer

Rutgers University is one of the oldest QuarkNet centers having been established in 2000 the second year of the NSF funded QuarkNet program. Our center has trained over twenty high school physics teachers from throughout New Jersey in leading edge particle physics and have involved them in the construction, operation and classroom use of cosmic ray detector kits. For over ten years, we have run a highly successful two-week summer program for high school teachers and students.