CASPER 2012 RET (Research Experience for Teachers) at Baylor University, Waco, Texas

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Abstract

The 2012 RET Program at Baylor University has been as advertised. It has been a diverse experience both in a functioning Dusty Plasma Lab, observations of the new IPG6-B Lab, curriculum development for the Physics Circus Project but also lectures on assorted cutting edge topics and discussions with fellow physics instructors ranging from programs of study to state and federal curriculum implementation. Exploration of particle chains, single particle reaction to Verdi laser pulses, the study of the electric field characteristic of a one half inch glass box in argon plasma, initial testing of the inductively heated plasma generator (IPG6-B), Verdi laser use, Gold dust tracking over time when in a laser fan of different frequencies and Baylor Physics Circus curriculum work from the 2010 performance have been topics explored during the institute.

Introduction

The Research Experience for Teachers at Baylor University affords an excellent opportunity to further educational background and to participate in a positive learning environment. Fellow instructors from various parts of the United States bring insights as to how and what curriculum plans are in place. Baylor researchers lead investigations that each member of the RET group can participate in.

Past experience in the Dusty Plasma division of the CASPER lab afforded background that was incorporated into lessons this past school year. Looking to again gain background knowledge and the possibility of returning to work in the # 2 GEC plasma cell group, #1 GEC plasma cell group or IPG6-B study of the moon's atmosphere was the motivation to reapply to this year's program.

1. The Research Segment of the Program

1.1 Choice of the Experimental Plasma Group.

The initial project discussion involved researching properties of Moon atmosphere and using the new IPG6-B unit to collect basic data. Due to construction issues, initial test runs and cataloging cell characteristics, this project was put off till the fall semester. Dr. Angela Douglas, a Dusty Plasma researcher at the CASPER lab, was in need of support work with processing data on the study of electric field characteristics of a one half inch glass box in argon plasma. This particular need and the possible chance to observe ongoing work using the new Vere laser helped make the initial work choice.

Lab supervisor, Jorge Carmona-Reyes, was also looking for support work with his study of the effects of laser light on gold dust and argon plasma characteristics in an adjustable rectangular glass box. The opportunity to work with the high speed camera, GEC cell #1, the micro controller and complete initial results with Image J software, was incentive to volunteer for this experience.

1.2 Participation during the institute

Discussions with Lab Director Jorge Carmona-Reyes and Dr. Angela Douglas were helpful to gain knowledge needed to set up and shut down the reference cell. . Dr. Douglas introduced the present knowledge and suspected electric field configurations that she expects are present a ½ inch class box in argon plasma. Her investigation is to verify the theory. The investigation of side and top view pictures of a single (melamine formaldehyde, 6 mf and 8.9 mf) particle pulsed by the Verdi laser were carried out a different powers and pressures (100mTorr to 70mTorr) The Verdi laser powers ranged from .01 watts to 3 watts. Each data set included 600 individual pictures and each one set had to be examined.

The second project involved observing the test runs or the new IPG6-B lab and observing the cataloging of the characteristics of the new cell. As this is a new project changes and adjustments to the equipment spread the observations over the weeks of the institute.

Discussions with Dr. J Kong about his study of helical formations of particle chains provided an interesting update to a previous year's study of particle chains and particle interaction. This study was not an option to be a part of as D. Kong was preparing for a conference in mid July.

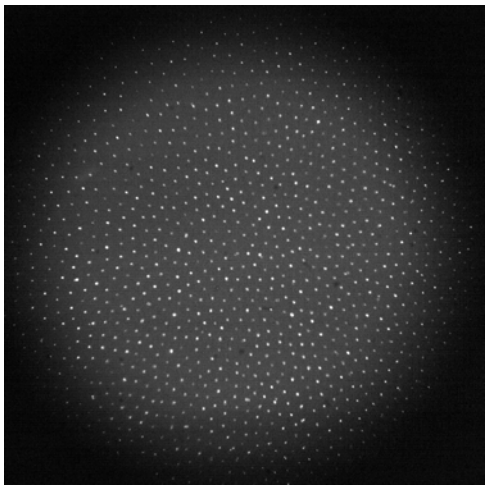
Data was collected under the direction of Lab Director, Jorge Carmona-Reyes for study of the shape of the electric field inside an adjustable rectangular glass box. This data was passed on to other experimenters in the lab for analysis.

The final project during the institute was also to be directed of Jorge Carmon-Reyes. This project is an attempt to verify previous effects of laser light on gold dust particles. The high speed camera (500 frames per second, 2 seconds of data, every 8 minutes over a 2 hour span) took top view pictures of gold dust clouds. Two different types of lasers were used. The data was cleaned of background light; particles tracked using Image J software, saved into a spread sheet where particle speeds could be calculated.

1.3 Computer Picture Sample

The following picture is a sample from the experiment of a single particle illuminated by a Verdi laser pulse and the gold dust –laser experiment.

Gold particle cloud with background light



1.4 Results

Dr. Douglas showed the RET team the theoretical electric field characteristics of the one half inch glass box in argon plasma and used those results to first drop particles into the box, change a cloud of particles to vertical chains and finally drop all but one of the particles out of the chain leaving a single particle. The laser pulse was applied to move the particle and pictures were taken to document the motion back to equilibrium. Dr. Douglas was ending her employ as an experimenter at CASPER the next to last week of the institute and was leaving the collected data for use later.

Jorge Carmona-Reyes' investigation into time dependence of gold dust (9.2 micron) in laser light has shown motion away from the source in previous test runs when working at powers below three watts after thirty minutes. There seems to be some relationship between the use of leaving a viewing laser fan or Verdi laser directed on the cloud when it is left turned on for a period of time. Mixture of gold dust and mf show that the materials mix when the laser is turned off and then will separate the instant the laser fan is turned on. An explanation of the initial separation, the power settings when the separation occurs, if the laser fan is causing the separation, why the separation seems instantaneous after the initial separation, are all questions that have been ask and will need further investigation. Our experiment did not show the dynamic change when there is only gold dust in the cloud.

Questions have been raised about the quality of the initial gold dust batch presenting validity questions about the first experiments. Microscopic pictures of the gold dust before and after initial test runs show a break down in the gold coating. More test with this new batch of gold particles will either confirm or dismiss this possibility.

2. Curriculum work for topics from the 2010 Physics Circus

2.1 Initial plan

The RET group was ask to look at the Texas and National Educational standards that applied to the five subject areas covered in the 2010 edition of the Circus. Our directions were to find three different levels of difficulty in each of the areas and list topics and samples of those topics. Supervisor Jorge Carmona-Reyes talked in terms of a future online game format and Institute director Dr. Hyde talked in terms of eventually having a marketable online instruction tool.

2.2 Implementation

Dr. Steve Rapp researched both the Texas and National standards for each section. The five sections were split up among the four participants with Steve Rapp taking two of the sections. Each participant decided on the three levels of difficulty and then discussed their ideas with the other participants. The discussion also included how to find a consistent usable format for presentation at the end of the institute.

2.3 Results

After discussions on levels of difficulty there were disagreements that were not resolved. My impression why this happened is that the four RETs come from very different economic areas and locations within the United States. Our assumptions of what is considered basic to advance differed greatly. As a result the final presentation papers will not reflect total agreement on each of the five sections.

The assumption that the finished product would be used by just students was not shared by other members of the group. My part was prepared as if each question or topic would be independently researched if needed. The format of the final papers are quiet different because of the different assumptions

My section was the electricity section of the circus. (Section 5). The first level introduced basic terms, Ohm's Law, current flow, basic elements and combinations of elements. The second level contained simple circuits, loop law, junction law, electric field, capacitors and capacitor circuits. And finally, the third level contained simple circuits with switches, magnetic fields, Alternating Current fundamentals, RC circuits, and inductors.

3. Lectures, Discussion Sessions and Field trip.

3. 1 *Lecture sessions*

Each Wednesday members of the summer institute gathered at the Pat Neff Building for a luncheon and lecture based on the expertise of invited Baylor staff members. Talks included CERN and LHC updates on the Higgs announcement, business tips for science and engineering majors, professional presentation topics and topics about the cosmos. The institute leaders presented talks on how to write a scientific paper and the format of a presentation.

3.2 "Physics Circus" meetings

Each Monday morning the teachers in the program were scheduled to meet for discussions and presentations of their work with supervisor Jorge Carmona-Reyes. This schedule was changed to Friday mornings so Dr. Hyde, institute director, would be included.. "Physics Circus", a Baylor University outreach program in cooperation with the Waco Public schools presents science programs for students and teachers with follow up studies of student progress through graduation. The program follows one group of students from sixth grade through graduation.

3.3 Field trip to SpaceX Engine Testing and Development facility

A field trip to the SpaceX rocket engine testing and development facility site in McGregor, Texas was offered to both REU and RETS members of the institute. The outing was a one day excursion with tours of the control bunker and testing areas along with a lecture by one of the facility engineers. Emphasized was the fact that college grads in physics, chemistry and engineering were welcomed to apply for employment. Also noted was the average age of an employee on this base was around thirty years old. The group was on site when one of the engines was test fired.

File picture of SpaceX facility

4. Conclusion

More programs of this type need to be offered and more participants need to take part to renew classroom enthusiasm for science and increase instructor background knowledge. This type of program can not only be an inspiration to participant's students to pursue careers in science but also a means to educate the general public to the need for funding future science research.

Valuable experience has been gained of how a working lab operates. The opportunity to see the interactions of the personnel, communication between the lab technicians and experimental investigators, team work of carrying out experiments has been an enlightening experience.

Many insights were gained into how the CASPER outreach program, Physics Circus, is managed and future planning to continue the program. Online possibilities could be in the future to reach a wider audience than just the local Waco district and targeted grade level.

Acknowledgements

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My Internet Resources for Plasma

Sandia National Labs
http://www.sandia.gov/bus-ops/partnerships/tech-access/facilities/pmtf.html
Plasma Physics and Controlled fusion
http://www.iop.org/EJ/journal/PPCF
Plasma on the Internet
http://plasma-gate.weizmann.ac.il/PlasmaI.html
Coalition for Plasma Science
http://www.plasmacoalition.org/
A Teacher's Guide to Plasma Science on the Web
http://www.plasmacoalition.org/edu.htm
Free Software for Atomic and Plasma Physics
http://plasma-gate.weizmann.ac.il/FSfAPP.html
Plasma Physics Reports
http://scitation.aip.org/ppr/?jsessionid=2543571091194670271
Coulomb Crystals in Plasma Processing Reactors
http://uigelz.ece.uiuc.edu/Projects/DTS/dts.html
Space Science Education resource directory
http://teachspacescience.org/cgi-bin/search.plex?mode=new&newgr=9,10,11,12
RPI Plasma Dynamics Laboratory
http://hibp.ecse.rpi.edu/
Plasma Dictionary
http://plasmadictionary.llnl.gov/
Laser Diagnostics of Plasma
http://wwwrsphysse.anu.edu.au/prl/laser_diag.html
Dusty Plasma Physics… Imperial College London
http://www.pp.ph.ic.ac.uk/dustpage/
The internet Plasma Physics Education Experience
http://ippex.pppl.gov/
Theoretical Principles of Plasma Physics and Atomic Physics… very high end
http://www.plasmaphysics.org.uk/
Plasmas – the Fourth State of Matter…nice source of pictures and intro materials
http://fusedweb.pppl.gov/CPEP/Chart_Pages/5.Plasma4StateMatter.html
Auburn University Plasma Science Laboratory --- nice source for DC plasma study
http://narn.physics.auburn.edu/
Dust Coagulation in Plasma Environment
http://www.icpdp2011.de/program/default.html
One Dimensional Vertical Dust Strings in a Glass Box (abstract)
http://pre.aps.org/abstract/PRE/v84/i1/e016411