



---

# Immersing Southeastern Louisiana Middle School Students in Physics at the LIGO Livingston Science Education Center

Amber L. Stuver

LIGO Livingston Observatory



LIGO-G0901015-v1





# Overview

- LIGO and the Science Education Center (SEC)
  - » Collaboration
  - » Mission and Structure
- Student Programs
  - » Introduction
  - » Science at Work
  - » Inquiry-Based Activities
- Teacher Professional Development
- Educational Research
- SEC Next Phase
- LIGO Hanford Education





# LIGO

- NSF large facility seeking to directly detect gravitational waves (GW) originating from massive, energetic events in the universe.
- Two facilities:

Hanford, WA



Livingston, LA



- Along with detection, education is one of LIGO's central goals.



# LIGO Science Education Center (SEC)

- First class outreach program complements LIGO as an NSF large facility
- Built on a partnership with the Exploratorium, SUBR, LaSIP and La GEAR UP
- Informal learning environment housing 50 hands-on exhibits focusing on LIGO science, all but ~10 made by the Exploratorium
- Exposes students, teachers and the public to LIGO concepts *and scientists* while being a platform for educational research





# Mission and Structure

Leverage the scale, technology and science backdrop of the Observatories to create rich visitor experiences:



- » Student field trips integrate hands-on standards-based activities with explorations of LIGO science and technology.
- » Teacher professional development programs emphasize science inquiry along with key LIGO science concepts.
- » Programs for the general public address a variety of interests and ages.
- » Outreach programs are built on partnerships.

LIGO-G0901015-v1





# Student Programs

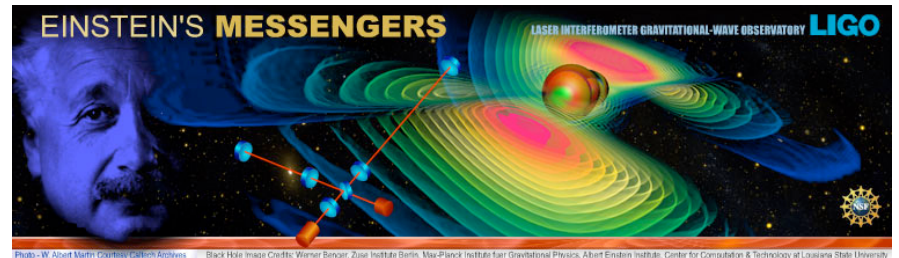
---

- When students visit the SEC, they get the opportunity to explore the science of waves and gravity through inquiry-based activities and exhibits as well as **see science at work**.
  - » All activities and experiences are tailored to address points in the LA Grade Level Expectations and the LA Comprehensive Curriculum.
- Programs are targeted to middle school students.
  - » Programs are also offered to elementary, secondary and post-secondary students.
  - » Monthly “Science Saturdays” are open house style programs for the general public.
- This academic year (through end of Feb.): 3875 students + 76 accompanying adults.



# Student Introduction to LIGO

- Pre-visit materials are mailed to teachers prior to the field trip.
  - » Includes a ~20 min. documentary, *Einstein's Messengers*, to introduce students to the science of LIGO.
- When students arrive on site, they are briefly introduced to LIGO, GWs and concepts dealing with scale and scientific notation.
  - » Scale makes connections on how far away typical GW sources are and how small GWs are upon arrival at Earth.
- Students are also introduced to docents (more later).
  - » Docents are STEM or education majors, trained in LIGO concepts and often from groups under-represented in STEM fields.





# Science at Work



- Pre-Control Room Tour

- » Students are introduced to vacuum properties to make the connection with LIGO's large scale ultra-high vacuum and shown a full scale mirror suspension to make the connection to the actual mirrors that will be seen through IR cameras in the control room.

- Control Room Tour

- » Students then visit the LIGO control room where staff are currently working; they are either led by SEC staff or a LIGO scientist.
- » The need for a control room is explained, the staff positions that man the control room are explained and a live video tour of the site is given.
- » Students are free to ask questions on anything they see in the control room, on how to become a scientist/engineer/etc., what life is like for staff, etc.





# Inquiry Based Activities

---

- Classroom Activities

- » Hands-on, staff member facilitated inquiry activities are available
- » Most focus on light and wave properties (e.g. interference, refraction, etc.) with a few on gravity (e.g. gravity blanket)

- Exhibit Hall Exploration

- » About 45 minutes is allotted for free exploration of the hands-on exhibits housed in the SEC.
- » Students are given 4 “rules” for their experience: **interact** with the exhibits, **learn** something, **share** something, and *have fun*.
- » A short exhibit demo is performed by a staff member not only to teach a targeted concept, but to show students that there are multiple ways to use the exhibits.





# Teacher Professional Development

---

- Two types of focus are provided in PD programs: “*snacks*” and *inquiry*.
  - » “*Snacks*” programs provide teachers with information and materials to construct small scale classroom demonstrations that are inexpensive, made with common items and mirror an exhibit at the SEC.
  - » *Inquiry* programs provide experience focused on the facilitation of inquiry based activities in their classrooms.
- Three MSP programs are funded by LaSIP and are organized by university or school systems.
  - » All LIGO science PD programs have La GEAR UP schools participating.



# Docents



- In cooperation with Southern University - Baton Rouge, undergraduate students in STEM and education majors are trained and serve as docents explaining exhibits to visitors.
- Docents are trained on the SUBR campus in their local “Inquiry Laboratory” (complete with 6 exhibits) as well as on-site at the SEC.
- Docents represent a step in the pathway to being a scientist and serve as role models to students from underrepresented groups in the STEM fields.
- 3 cohorts of ~15 students each have completed training.





# Educational Research

---

- Student Perceptions of Science and Scientists
  - » Investigating students' attitudes toward science, the people who do science, its utility, its process and personal interest before & after visiting LIGO.
- Parent-Child Interactions
  - » Parents employed various strategies to explain exhibits to children
  - » Those with better attitudes towards science visited more exhibits
- Student Exhibit Interaction Pre- & Post- Facilitated Inquiry Activity
  - » Compare the behaviors of kids who went to the exhibit hall either before or after engaging in an inquiry-based activity in the classroom
  - » Children who did the inquiry activity first demonstrated more inquiry behaviors (e.g., asking questions, making observations, etc.)
- This work is done in cooperation with a Tulane psychology faculty member, Dr. Lisa Szechter.



# SEC Next Phase

---

- NSF funded the 5 year plan of a *continuum of engagement*.
- Longitudinal: Repeat Engagement
  - » Whole grades of small school districts of both high and low performance
  - » The same students visit the LIGO SEC every year between 5<sup>th</sup>-9<sup>th</sup> grade (except 7<sup>th</sup>)
  - » Will study how interactions with exhibits change pre- & post-classroom inquiry activity and how students' attitudes towards science change through this progression
  - » Funding buses to transport students



## SEC Next Phase (cont'd)

---

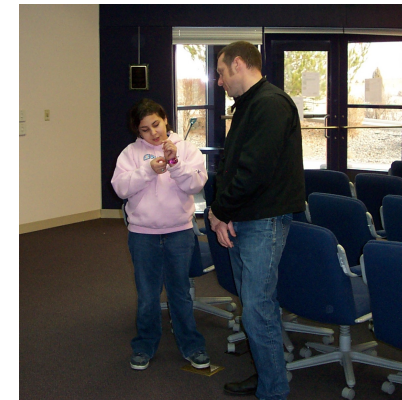
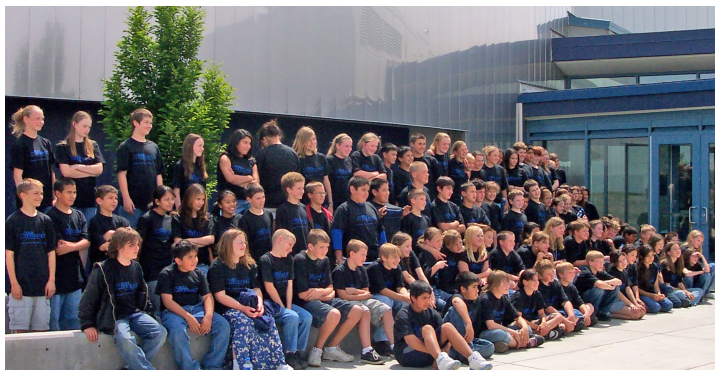
- **Broad Impact: 9<sup>th</sup> Grade Academy**
  - » Teacher PD offered to entire school system's 9<sup>th</sup> grade teachers annually
  - » Student field trips for an entire school's 9<sup>th</sup> grade class (rotates within system)
  - » Goal: provides repeated teacher exposure to different experiences in multiple contexts to enhance student learning
  - » Funding substitute teacher costs



# LIGO Hanford Student Outreach



- GEAR UP and Yakima Valley/Tri-Cities MESA bring hundreds of middle school students to the LIGO Hanford each year.
- The majority of these students are from homes where English is not the first language.
- A field trip to LIGO is the first look at a professional science facility for many of the region's middle school students.
- These field trips amplify the "*Prepare Yourself for College*" message of the partners by offering real-time examples of college education at use in the world of work.
  - » Math is a particular point of emphasis.





# LIGO Hanford Teacher PD

- Teacher PD focuses on the improvement of inquiry-based instruction across grades 3-8.
- The MSP grant is administrated by Educational Service District 123 and partners with WSU Tri-Cities, Columbia Basin College, LIGO, and the Pasco and Othello School Districts.
- The program:
  - » A two-week 60-hour summer academy for ~30 teachers at LIGO, with facilitation provided by the team of partners
  - » Followed by quarterly three-hour follow-up workshops during the school year.







# Summary

---

- Inquiry-based experiences dominate the LIGO's outreach efforts.
- To reach middle school students, LIGO combines field trips for students, role models for students, and training for teachers.
- LIGO provides the opportunity to see science *and scientists* in action – math and science are not just taught in school, but are really used!
- Educational research provides a measure of outcomes and disseminates this to the professional community.
- Changing the way that middle school students see the world and their own potential may be the most significant outcome that these visits achieve.



# LIGO Outreach

---

- LIGO Livingston
  - » William Katzman – SEC Program Leader
  - » Kathy Holt – SEC Staff
  - » Tien Huynh-Dinh – SEC Staff
  - » Joe Giaime – LIGO Livingston Observatory Head
- LIGO Hanford
  - » Dale Ingram – Outreach Leader
  - » Erin Steinert – Outreach Staff
  - » Fred Rabb – LIGO Hanford Observatory Head