Lesson Plan
Luis Alvarez: Dinosaurs, Pyramids, and Bubble Chambers

Photograph by Jerome Danburg, courtesy AIP Emilio Segrè Visual Archives, Danburg Collection

<table>
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<tr>
<th>Grade Level(s):</th>
<th>9-12</th>
<th>Subject(s): History, Particle Physics</th>
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<tr>
<td>In-Class Time:</td>
<td>60-90 min</td>
<td>Prep Time: 10-15 min</td>
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Materials

- Print outs of Seeing Particles Activity or Access to computers
- Discussion sheets (In Resources Section below)
- Videos/Links:
  - Pyramid Video: [http://www.dailymail.co.uk/sciencetech/article-5040093/Hidden-structure-inside-Great-Pyramid-Giza.html](http://www.dailymail.co.uk/sciencetech/article-5040093/Hidden-structure-inside-Great-Pyramid-Giza.html)
  - Seeing Particles Activity: [http://epweb2.ph.bham.ac.uk/user/watkins/seeweb/BubbleChamber.htm](http://epweb2.ph.bham.ac.uk/user/watkins/seeweb/BubbleChamber.htm)
  - What Really Killed the Dinosaurs: [https://www.youtube.com/watch?v=1iNcRJGzzxs](https://www.youtube.com/watch?v=1iNcRJGzzxs)

Objective

In this lesson plan, students will learn about the life of experimental physicist Luis W. Alvarez, as well as his contributions to particle physics. The activities in this guide are meant to highlight Alvarez’ contributions to physics, while the readings are meant to highlight Luiz’ other works in radar systems and extinction theories.

Introduction
Luis W. Alvarez was born in 1911 in San Francisco. He was a second-generation immigrant from Cuba, though due to the climate at the time towards immigrants and Cuba, he was not in touch with his Cuban heritage, and preferred to not be called Latino. His father was a physician.\[1\] He was encouraged by his high school teachers to attend the university of Chicago for college, and received his bachelors, masters and doctorate degree in physics there.\[1\] As a grad student he worked to build a cosmic ray telescope with Compton to measure the East-West effect of cosmic rays. They ended up finding that most cosmic rays were positive in charge and published their work. In 1936 he accepted a job to work the UC Berkley where he worked on an experimental team supported by a group of theorists lead by Oppenheimer. Alvarez’ worked on devices to observe the phenomenon K-electron capture with Fermi, however they never detected anything.\[2\] During this time Luis Alvarez was also the first to develop tritium (H3) on Earth, and measured its lifetime. He also measured the magnetic moment of the neutron while at Berkley. In 1940 Alvarez went to work at Radeon Laboratory with the United States Government to find applications if microwave radar.\[1\] During this time, he developed the first transponders for the military, as well as creating linear dipole array antennae, which where are used in precision bombing. Alvarez was also responsible for developing the technology for ground Control Airlifts. After this Alvarez was set to go back to work at Los Alamos National Lab, but was instead urged to work on the Manhattan project first. While helping the United States government on the Manhattan project Alvarez could create the first overhead detector for nuclear reactors, which would be able to tell the US government which countries had developed the technology for a nuclear bomb from simply flying a plane overhead. After the Nuclear Bombs exploded, Alvarez and a team of scientists flew over the clouds to measure the strength of the blast.\[1\] Finally retuning to Los Alamos as originally planned, Alvarez was the first to build a liquid Hydrogen Bubble Chamber, which he used to discover whole families of particles and their resonance states. In 1965 he was asked to develop technology that could be used to find unknown tombs in the Egyptians pyramids, and came out with Muon tomography.\[3\] In 1966 Alvarez took it upon himself to analyze the pictures from the Kennedy assigation and dispel conspiracy theories at the time. Alvarez even published a book on his methods to guide others in the future on how to deduct information from photographs \[3\]. In 1980, in collaboration with his son Walter Alvarez, the two came up with the theory that the dinosaurs mass extinction was caused by a massive comet collision, a theory Alvarez fought for until his death in 1988\[3\]. The theory was not universally accepted by Scientists until 2010.

**Instructions**

**Engage: 10-15 Minutes**

To get the students thinking about the wide range of thing Alvarez has done throughout his career we will be starting with something that at first will seem vastly different than what most kids imagine a particle physicist to do. We will be learning about the pyramids!

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What is the teacher doing?
Introduce the video, and settle the kids down to watch it. Answer questions as they arise and explain more of the muography afterwards. Explain that this technique was developed back in 1965 by Luis Alvarez, and segue in lecture portion.

What are the students doing?
Watching the video and asking questions, taking notes and answering questions on the discussion sheet provided.

Explore: 10 Minutes
Students will now get a grander scheme of what Louis Alvarez did in his life through a short lecture type format of his most notable accomplishments and benchmarks. (Link in Required readings)

What is the teacher doing?
Giving a lecture and answering questions as they come from the slides and slide notes given in the resources section. Put a special emphasis on the bubble chamber work Alvarez did as a segue to the next section.

What are the students doing?
Taking notes on the discussion sheets, and asking the teacher questions. Learning about the different things radar can do and a brief introduction to particle physics.

Explain: 30 Minutes
Now the students will explore some of the tracks that different interactions leave in a bubble chamber. This includes differing particles as well as what interactions look like.

What is the teacher doing?
Showing the students pictures of Bubble chamber art and explaining to them activity. Answering questions as they come.

What are the students doing?
Students will be learning what Alvarez did to discover so many particles and tell the difference between interactions. They will go through different pictures of Bubble Chamber Interactions and selecting which of the possible options they think corresponds to the reaction given. Working in groups is suggested to spark debate/discussion.

Elaborate: 15 Minutes
Finally, the Students will wrap up by learning about the Alvarez Hypothesis of Dinosaur Extinction and how that has changed over the years. This is to really emphasize the breadth of Alvarez’ work.

What is the teacher doing?
Setting up the Video by Hank green which discusses the Alvarez’ Hypothesis and its evolution over time.

What are the students doing?
Watching the video and answering the last parts of their discussion sheets.

Evaluate:
Here the teacher will evaluate how the students did by going over their discussion sheets and checking for completeness and understanding.
Discussion Questions

Discussion Questions can be found as a Handout with a corresponding Answer Key in the Supplemental Materials to this lesson plan.

1. What kind of Detectors did the Scientists use to discover the Hidden chamber in the Egyptian Pyramid? How much do these particles weigh compared to the electron? Are they harmful?
   a. Muon. 200x more. No
2. How are the particles used in the detectors created?
   a. When the atmosphere interacts with Cosmic rays
3. Where was Luis Alvarez Born? Where was his family from?
   a. San Francisco, Cuba
4. Where did Alvarez go to school?
   a. University of Chicago
5. Name one of the things Alvarez developed in his time working with the US Government
   a. Transponders
   b. Linear Dipole array antenna for precision bombing
   c. Ground Control Airlift System
   d. Detector to find Nuclear Reactors
6. What was Alvarez’ Involvement in the Manhattan Project?
   a. Measured the power of the blast
7. Alvarez is most famously known for building the first what?
   a. Bubble chamber
8. After his Nobel prize winning work Alvarez worked on 3 other major projects. What where they?
   a. Pyramid Radar with Muon Tomography
   b. Analysis of the Kennedy Photos
   c. Alvarez Dinosaur extinction theory
9. What was the metal used to create the Alvarez theory?
   a. Iridium
10. How did Luis Alvarez die?
a. From throat cancer in 1988

Further Reading and Additional Resources

- Alvarez, by Luis Alvarez, an autobiography
  o Luis Alvarez’ Auto Biography about his life and career in physics and Aviation.
- Discovering Alvarez by W Peter Trower
  o A memorial piece made after Alvarez’ death, a collection of essays from his students and peers describing him as a person and what it was like to work with him

Extensions

- Related AIP Teachers’ Guides on Women and Minorities in Physical Sciences:
  o SACNAS

Common Core Standards


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**Subject Writing**

| CCSS.ELA-LITERACY.WHST.11-12.7 | Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation |

### Next Generation Science Standards


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