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Astronomy's New Messengers: A traveling exhibit on gravitational-wave physics

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Abstract. The Laser Interferometer Gravitational-wave Observatory exhibit *Astronomy's New Messengers: Listening to the Universe with Gravitational Waves* is traveling to colleges, universities, museums and other public institutions throughout the United States. *Astronomy's New Messengers* primarily communicates with an adolescent and young adult audience, potentially inspiring them into the field of science. Acknowledging that this audience is traditionally a difficult one to attract, the exhibit publicly announces itself in a charismatic fashion to reach its principal goals of broadening the community of people interested in science and encouraging interest in science among young people.

As a frontier physics effort, a core mission of the Laser Interferometer Gravitational-wave Observatory (LIGO) [1] Scientific Collaboration is to inspire interest in astronomy and fundamental science among students and to educate the broader community. In this context, *Astronomy's New Messengers: Listening to the Universe with Gravitational Waves* is an innovative outreach project whose aim is to inform young students and the general public of the physics of gravitational waves and the science of the LIGO detectors.

Funded by the National Science Foundation through grant NSF-0852870 from the Informal Science Education program, the EPSCOR program, and the Office of Multidisciplinary Activities, and managed by the LIGO Scientific Collaboration, *Astronomy's New Messengers* consists of an approximately 200 sq. ft. touring exhibit which will be displayed at colleges, universities, museums, and other public institutions through the nation. *Astronomy's New Messengers* includes possibilities for age-appropriate self exploration and a messaging that allows visitors to first discover their own excitement in the subject, and then delve deeper into its complexity. The exhibit's introductory area presents a general overview of the LIGO detectors and its science, while inviting visitors to step inside, explore and find out more. Text panels and a large LCD screen with a looping high-quality video produced by Milde Marketing [2] for the International Year of Astronomy [3] cornerstone project "100 Hours of Astronomy" deliver key informational points.

The main area of *Astronomy's New Messengers* explains how gravitational waves are generated by cataclysmic events in the distant universe, how LIGO "listens" for these events, and

Figure 1. Young students at the University Museum, Oxford MS, watching the Einstein's Messengers video and playing the black hole hunter game. The interferometer kiosk is in the background. (Photos by Elizabeth Herren.)

demonstrates how scientists decode their signals. Three hands-on components engage visitors in discovering how LIGO operates and understanding some of the foundations of gravitational wave astronomy: a working and interactive laser interferometer, a grid-patterned rubber sheet which illustrates the curvature of space-time, and the black hole hunter game [4] kiosk. A second LCD screen with looping video compiled of clips from the NSF movie *Einstein's Messengers* [5] and several panels with photographs and diagrams further encourage visitors' interest in LIGO and the deep universe.

The interferometer model, constructed by the Ann Arbor Hands-On Museum [6] in collaboration with the Michigan LIGO group, intuitively shows visitors how an interferometer operates. A fringe pattern is projected on a screen, illustrating the concept of light interference and the effect of environmental noise. By tapping the interferometer case, visitors can disturb the fringe pattern. A photodiode at the output port of the interferometer measures the fringe variation and speakers produce a sound for an ultimate multi-sensory experience. Each key element of the interferometer is called-out and explained on a LCD screen.

The concepts of space-time and of gravity as space-time curvature are illustrated with the rubber sheet interactive. Visitors can set a heavy steel ball on a grid-patterned sheet, which becomes stretched around the ball. Rolling a second, smaller ball into the depression formed around the larger one, visitors can visually understand how space-time warps around massive objects and affects the motion of bodies in space.

The purpose of the black hole hunter game, developed by Cardiff University, is to give visitors an opportunity to do (in a figurative sense) what LIGO scientists do, i.e. look for gravitational signals in noisy streams of data. Simulated gravitational waves are translated into sound clips. Through a GUI interface on a computer screen, visitors try to detect recorded sounds of black hole events buried in different static noise clips.

Crucial to the design, integration and implementation of these elements was the collaboration between the LIGO Education and Public Outreach group and professional exhibit designers. *Astronomy's New Messengers* was designed by Lee H. Skolnick Architecture + Design Partnership [7], a multi-disciplinary firm of architects, designers, and educators providing award-winning architecture and exhibit design services.

Astronomy's New Messengers premiered at the Street Fair of the World Science Festival [8] in New York City in June 2009. After a month-long stay at the Adler Planetarium in Chicago, the traveling LIGO exhibit will be on display in a network of museums, science museums, public

libraries and academic institutions across a cluster of southern states from August 2009 to February 2010.

In 2010, an extended version of this exhibit will appear in a New York City venue that is accessible to a large and diverse cross section of the general public. This second phase of the project envisages the design and construction of a large-scale, interactive exhibit, which will draw upon elements of the touring exhibit (and upon lessons learned from the former's evaluation). The large-scale exhibit will blend LIGO science with high-concept artwork through incorporation of an interpretive 3-D lighting display. This large-scale exhibit is scheduled to debut at a prominent public location at the 2010 World Science Festival in New York City, alongside a signature event on the theme of gravitational-wave astronomy and featuring high-profile keynote speakers and artists. After the 2010 Festival, the exhibit will be transferred to a permanent home in a public institution or science museum.

The large-scale exhibit will incorporate elements from the touring exhibit, but on a grander scale – e.g. using larger flatscreen displays and poster boards and including a larger table-top interactive interferometer. A key additional element of the large-scale exhibit will be the blending of the table-top interferometer with a major, high-concept work of art in the form of an interactive three-dimension lighting display designed and realized by Leni Schwendinger Light Projects [9], a NYC-based art studio which specializes in creating lighting environments for architectural and public spaces all over the world. To highlight and illustrate the grand scale of gravitational-wave astrophysical sources, the output of the interferometer will be linked directly to a large-scale three-dimensional artwork suspended from the ceiling, symbolizing the Universe above the Earth. Changes in the interferometer's fringes will be translated and displayed on a spatial field of strands of diodes, creating a dazzling show of light and sound in real time, with each and every visitor who disturbs the interferometer contributing to the patterns of light, color and sound of the "sky" above them, representing the everlasting link between Earth and the Universe.

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