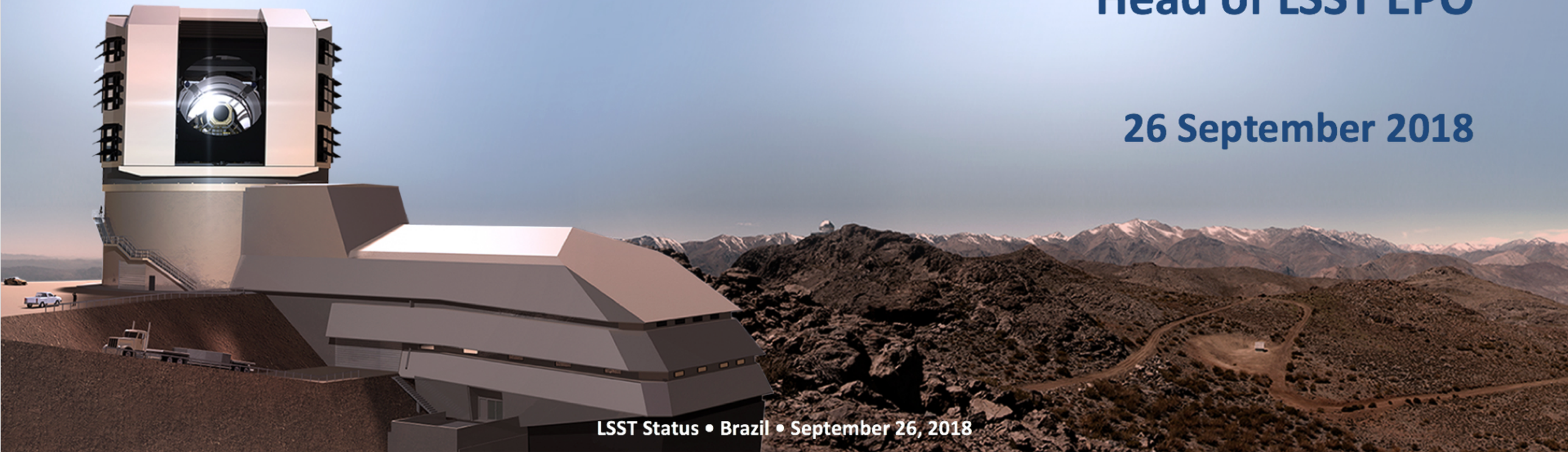
Education and Public Outreach (EPO)

Amanda Bauer
Head of LSST EPO

26 September 2018



EPO Mission

We provide worldwide access to, and context for, LSST data through accessible and engaging online experiences so anyone can explore the universe and be part of the discovery process.

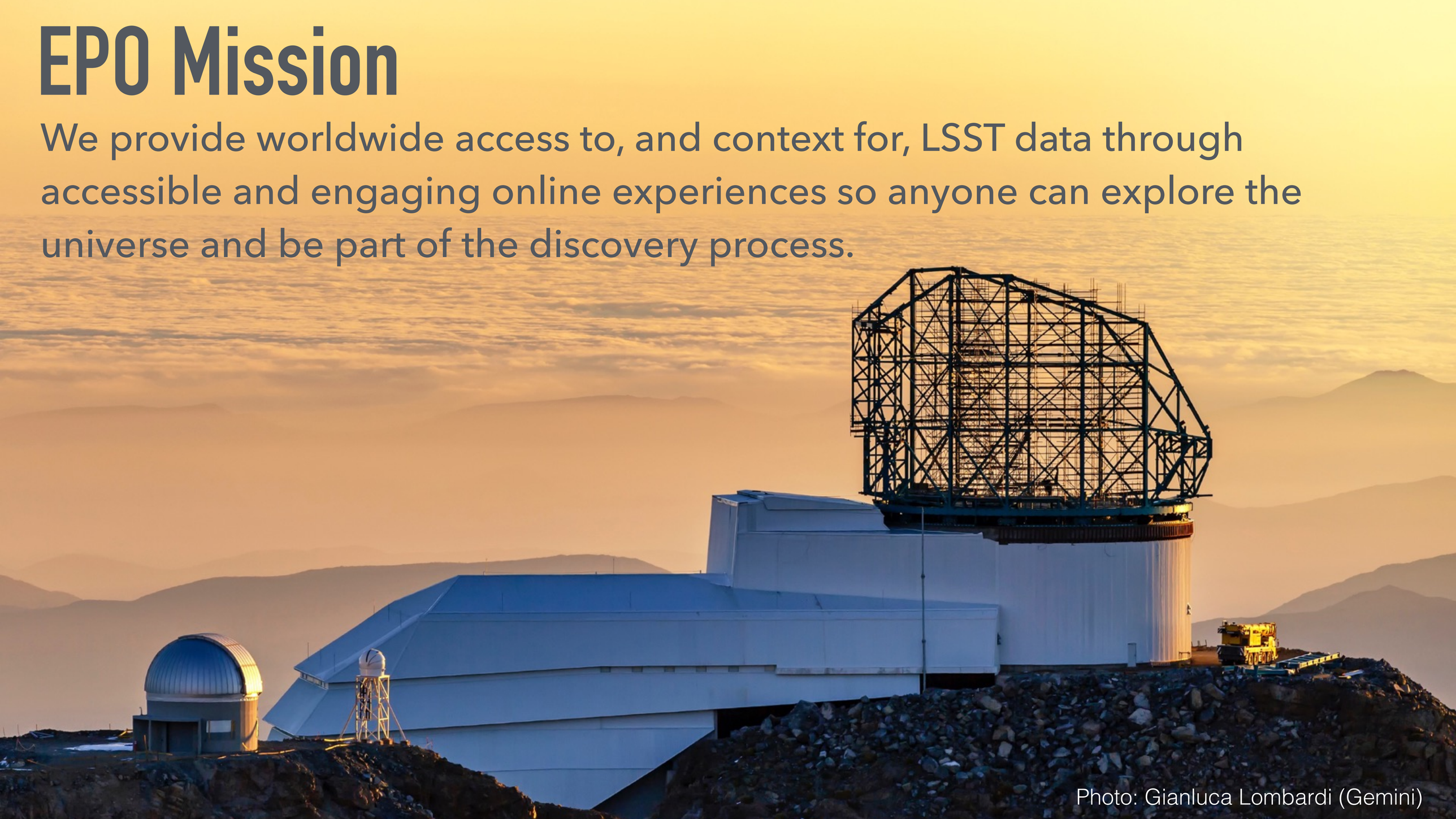


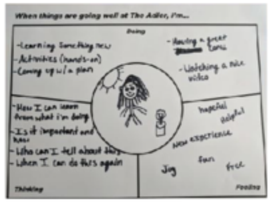
Photo: Gianluca Lombardi (Gemini)

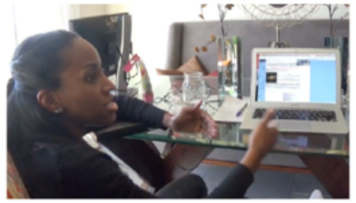
Audiences for LSST EPO

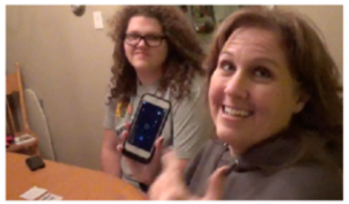
- Formal educators at advanced middle school, high school, college level
- Citizen science principal investigators
- Content developers at science centers and planetariums
- Science-interested teens and adults (“General Public”)

Research Sessions with Participants & Stakeholders

Activities in the Field







EPO Personas & Good Future Stories

EDUCATORS

Elena ASTRONOMY ELECTIVE

Data for Scholars

Easy to use and understand database that supports students in authentically conducting rigorous scientific inquiry.

Tanya MS SCIENCE TITLE ONE

Immersive Learning

Direct, hands-on experiences that capture student attention and enable exploration and knowledge building.

GENERAL PUBLIC

Lecia FUTURE SCIENTIST

Serious Fun

Mobile-first interactive experiences, videos and articles to explore the universe beyond the scope of school.

Amelia ASTRONOMY ENTHUSIAST

Astrosnacks

Updates & informative experiences that fit a passion for astronomy into a hectic schedule.

CITIZEN SCIENCE

Candice RESEARCHER — PI

EPO Data for Science

Accessible LSST data to support science research objectives with citizen science activities

Margaret MODERATOR

Citizen Community

Ability to help people engaged in citizen science to connect with each other, grow their knowledge and do great science.

INFORMAL SCIENCE CENTERS

Sandra SMALL STAFF PLANETARIUM

Quality Collections

Real-time open access to LSST content library & updates, supporting both show creation and interactive presentations.

Camila SCIENCE CENTER — CHILE

Purposeful Multimedia

Content that intentionally supports the design of discovery-based, hands-on, interactive experiences.

Lionel LARGE STAFF PLANETARIUM

Immediate Access

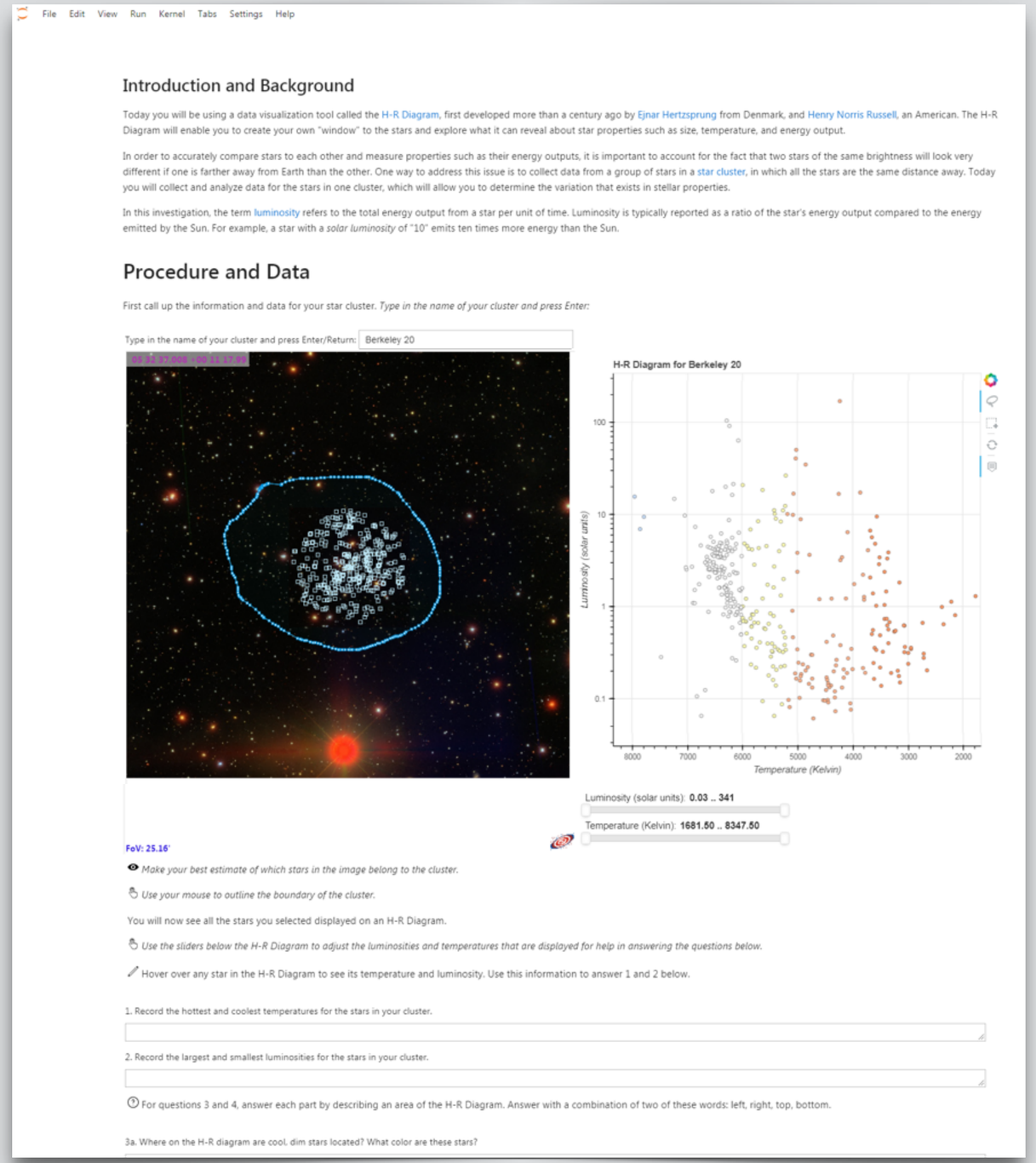
New LSST data, in raw and produced formats, seamlessly integrated into content creation & projection systems.

During Construction, EPO will build:

- Operations website and materials in English and Spanish
- Formal education program based on online notebooks
- Repository of multimedia resources
- Interactive Skyviewer
- Cloud-based EPO Data Center
- Capability to build citizen science projects
- Communications and Marketing Plans for Operations
- Strategy for measuring success

Formal Education

Online notebooks



- Accessible through a website
- No special software required
- No downloading data
- Embedded tools for data interaction
- Customizable

Coloring the universe

Introduction

Nearly everything astronomers know about the stars and galaxies in the Universe comes from the light we receive from these objects. Fortunately, that light contains a wealth of information. In this investigation, you will learn how astronomers use light and filters to learn about things such as distant galaxies, dusty nebulae and types of stars.

- How do filters pass light of specific energies and wavelengths,
- What types of filters are used in astronomical cameras?
- What can astronomers can learn by using these filters?
- How are color astronomy images made?

Types of Light

There are many types of electromagnetic radiation: radio waves, infrared, visible, ultraviolet (UV), X-rays, etc. Astronomers use all of these types of light to study objects in our universe. Each type of light has specific ranges of wavelengths and energies. The type of light we can see with our eyes is called "visible" light. Visible light consists of all of the colors of the rainbow, as shown below. You may have learned the acronym "Roy G. Biv" to remember the seven colors of the rainbow. The different colors correspond to different wavelengths and energies. Red light is the lowest energy of light we can see and has the longest wavelengths; violet is the highest energy of light we can see, and has the shortest wavelengths.

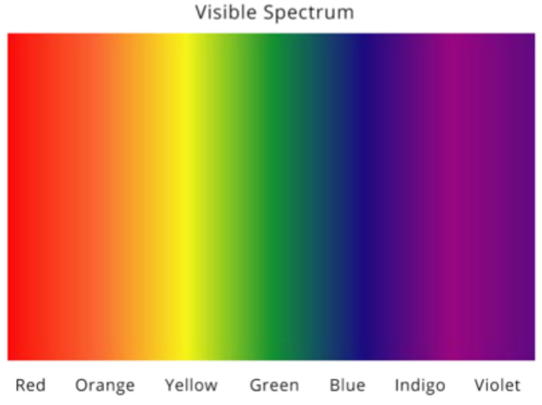


Figure1 (static): Source: http://www.daltonism.org.uk/2018/01/rainbows/

How Filters Work

Digital cameras cannot see color. They can only measure the amount of light that falls on the photosensor. To build a color image, we use filters when we take pictures of an object. A filter is designed to allow only certain wavelengths (or colors) of light to pass through it. All other wavelengths (or colors) are blocked. The image below on the left (Figure 2) shows an example of how an orange filter allows some wavelengths of light to pass through while blocking others. There are filters like this inside a digital camera (e.g., the one on a smartphone.) Tiny red, green, and blue filters are placed over the pixels of the photosensor as shown in the picture below (Figure 2) on the right. When you take a picture, your camera measures light simultaneously through all three kinds of filters.

To better understand how filters work, try out the filter tool below:

○ Red ○ Orange ○ Yellow ○ Green ◉ Blue ○ Indigo ○ Violet

1. What does the prism do to the white light?

   Choose the red filter.
2. What does the filter do to the red light? What does it do to the other colors of light?

   Now choose the blue filter.
3. What does the filter do to the blue light? What does it do to the other colors of light?

Constructing an Image with Three Filters

Looking at a rainbow you might think that we need to use (at least) seven filters to produce a color image. But you actually only need three. This is because our eyes contain sensors called "cones" that are designed to detect red, green, and blue light. Much like the electronics in a camera, the cones in our eyes only see in black and white, but our brain knows how to turn the relative amounts of red, green, and blue light measured by the cones into a color image. This is known as the "three-color process." Remarkably, our eyes can see over a million different colors with this method. Now let's explore how the three-color process works.

Below is a color image made from red, green and blue filters.

Each of the three images of filtered light start out as black and white images.

A color (red, green, or blue) is assigned to each image, and then the three images are combined.

Figure 3: Comparison of the light passed by filters.

4. In which of the three filters is the red shirt the brightest?
5. In which of the three filters is the green shirt the brightest?
6. How does the red shirt appear in the green filter? Why is that?

Color The Universe

Learn how to make astronomy images.

u Select

g Select

r Select

i Select

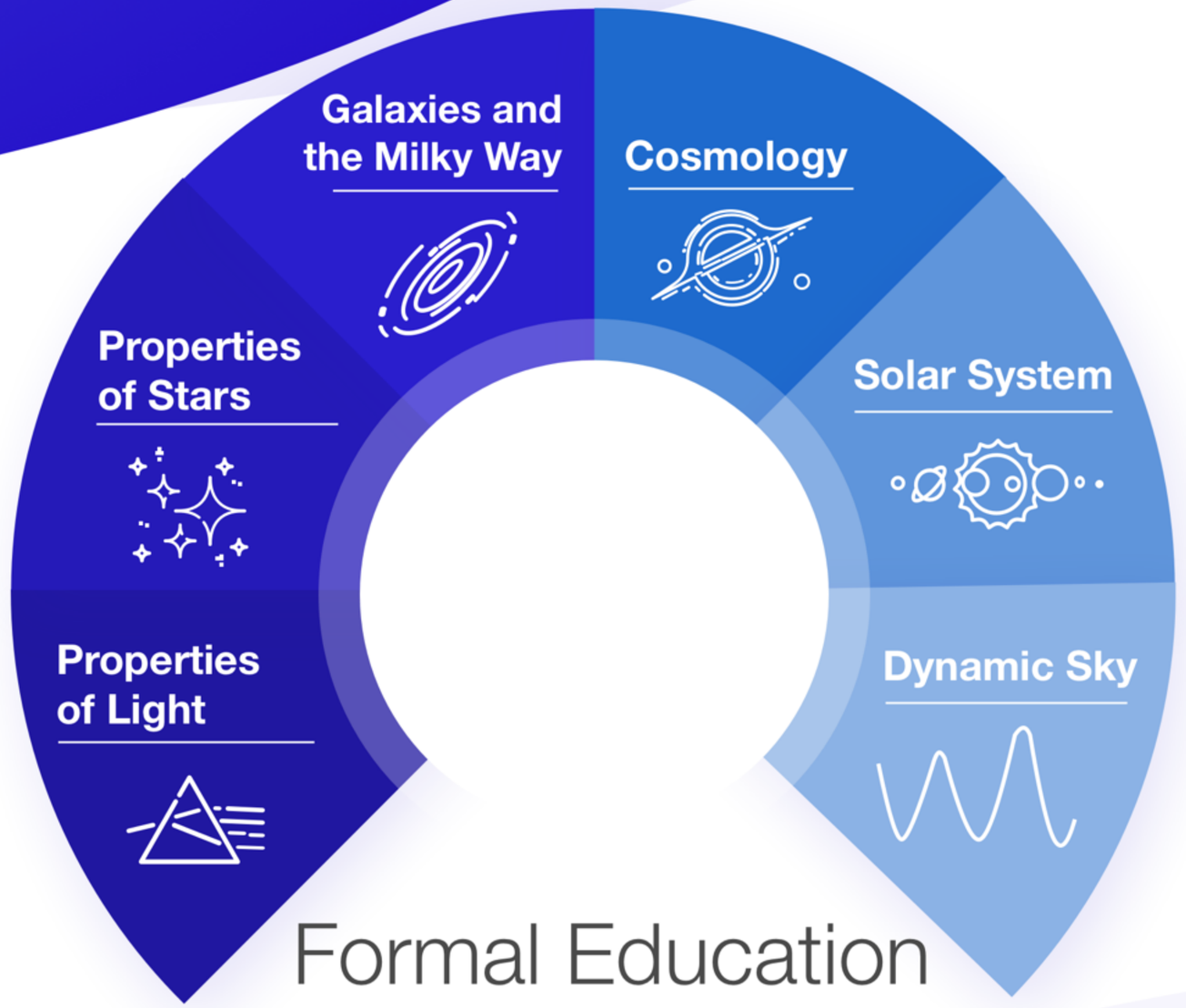
z Select

y Select

Reset Print

\+ -

M33



Formal Education Themes

Contents of a Foundational Investigation

Notebooks

- Student notebooks with interactive widgets to evaluate data and document what they have learned.
- Teacher notebook with real-time class management tools, such as “monitor student progress” or “combine class data sets”.

Teacher Guide

- Learning outcomes
- Prerequisites
- Level and time
- NGSS / Curriculum Nacional standards
- Teacher notes
- Common student misconceptions and questions (with answers)
- Introductory and assessment videos
- Options for adjusting challenge levels
- Background
- Extension investigations
- Ideas for further study

Assessment

- Alignment matrix to US and Chilean standards.
- Additional questions for assessment
- NGSS (Next Generation Science Standards) assessment rubric

Each year, 144 million people visit planetariums worldwide - 27 million in the US alone

(Source: Loch Ness Productions)

Photo Credit: M. Park/Inigo Films/LSST/AURA/NSF

Challenges for content creators at planetariums:

- Knowing where to search for content
- Finding curated content
- No in-house data science experience
- No data format standards
- Having limited options due to software vendor, inability to share between groups
- Lacking internet connection

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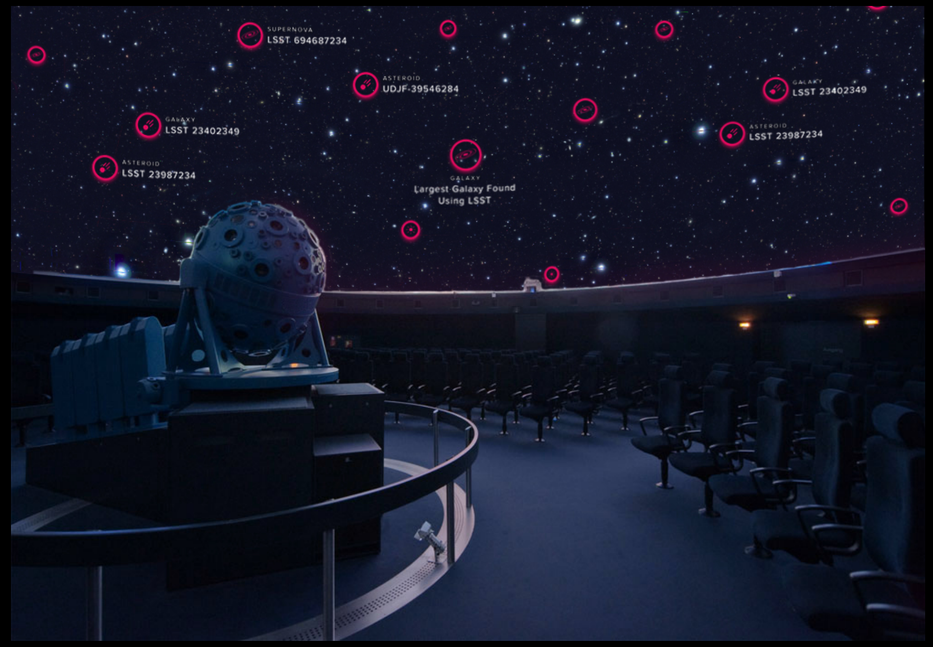
LSST EPO deliverables:



Library of digital multimedia assets

Fulldome sky view with LSST Alert stream overlay

Media specific for Chilean audiences

3D multimedia

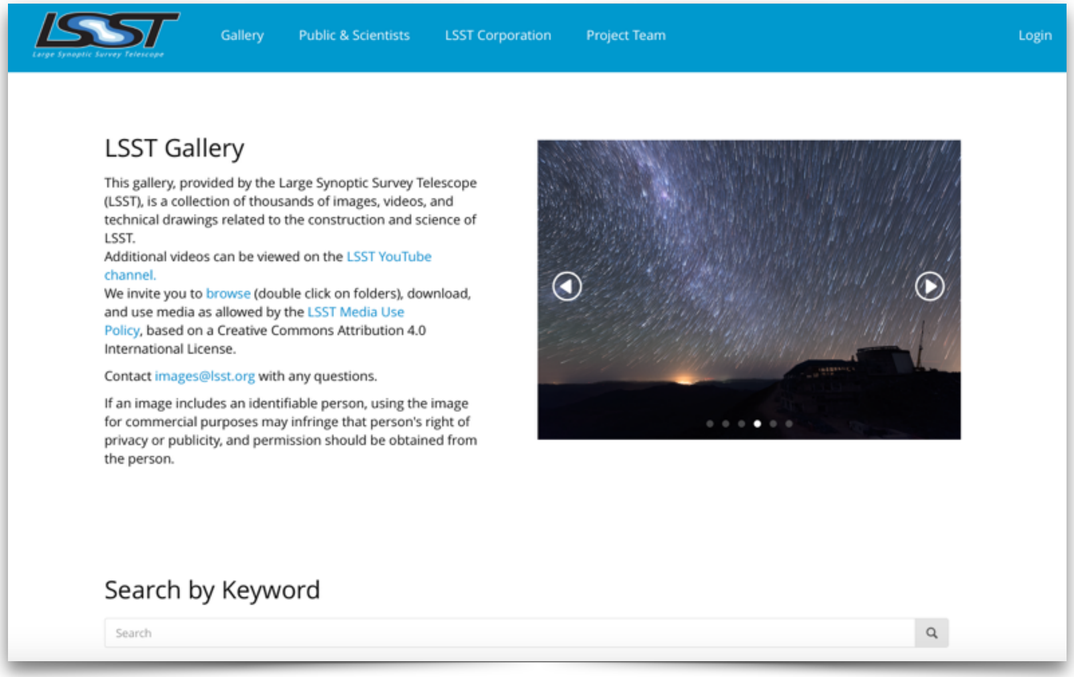
DATA2DOME

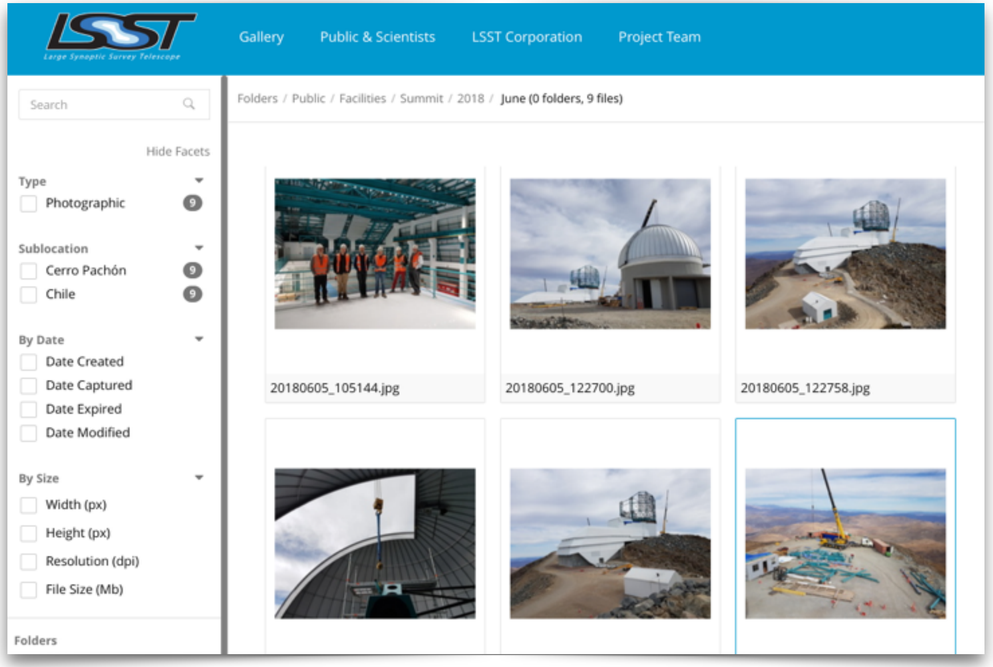
A Standard for Dome Content Distribution

BRINGING TOGETHER ASTRONOMY DATA PROVIDERS, SCIENCE CENTER PROFESSIONALS, AND SOFTWARE VENDORS TO ADVANCE THE STATE OF THE ART IN BIG DATA VISUALIZATION

Multimedia Gallery

LSST EPO will produce video clips, images, and 3D models to be used throughout the Operations website. Assets will also be provided in formats that support emerging industry standards (IMERSA Dome Master, AVM, Data2Dome) to enable content creators at informal science centers to freely incorporate them as they deem best.



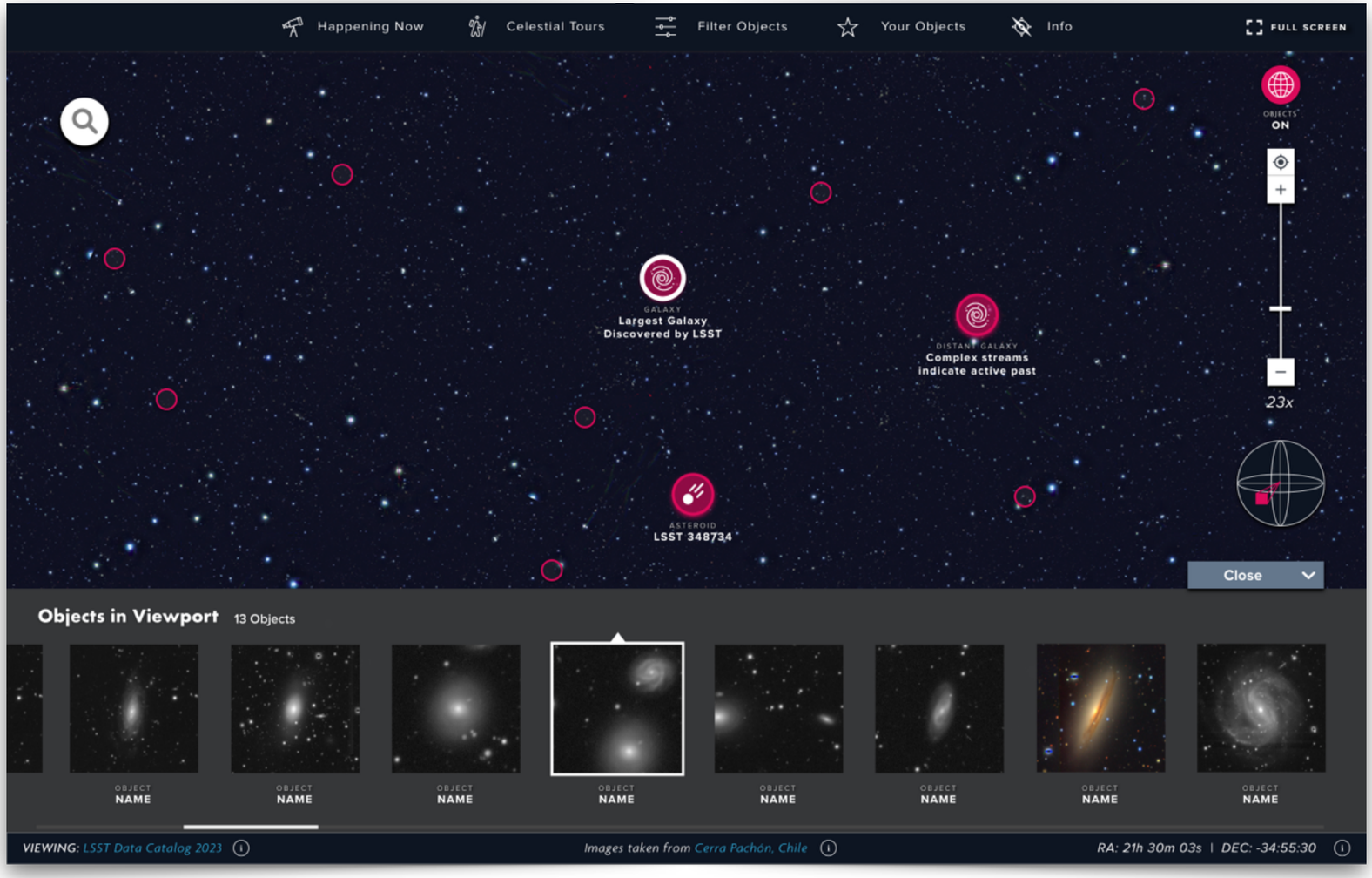


https://gallery.lsst.org

Skyviewer

Photo Credit: LSST Project/NSF/AURA

The viewport highlights objects within the current skyviewer to suggest options for user



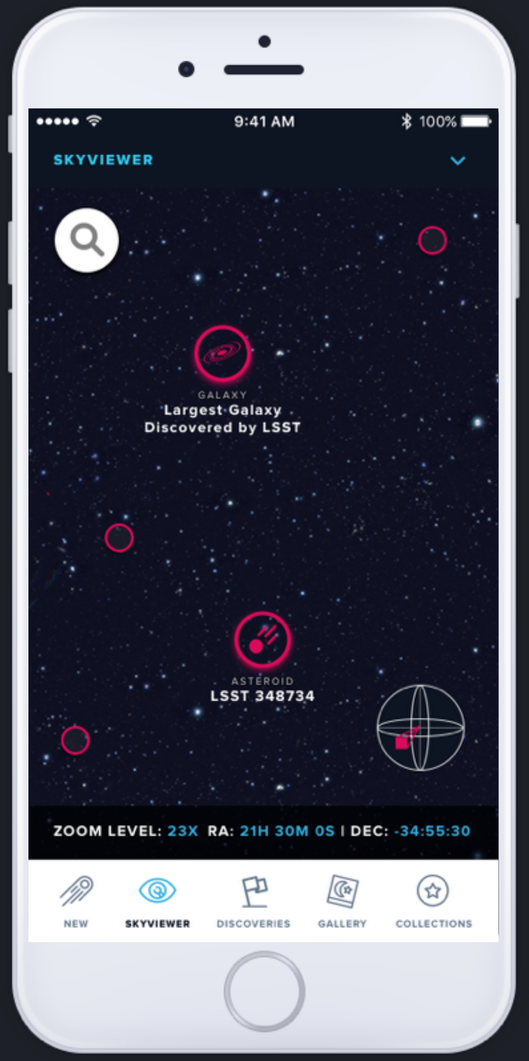
- Curated objects highlighted
- Links to recommended features

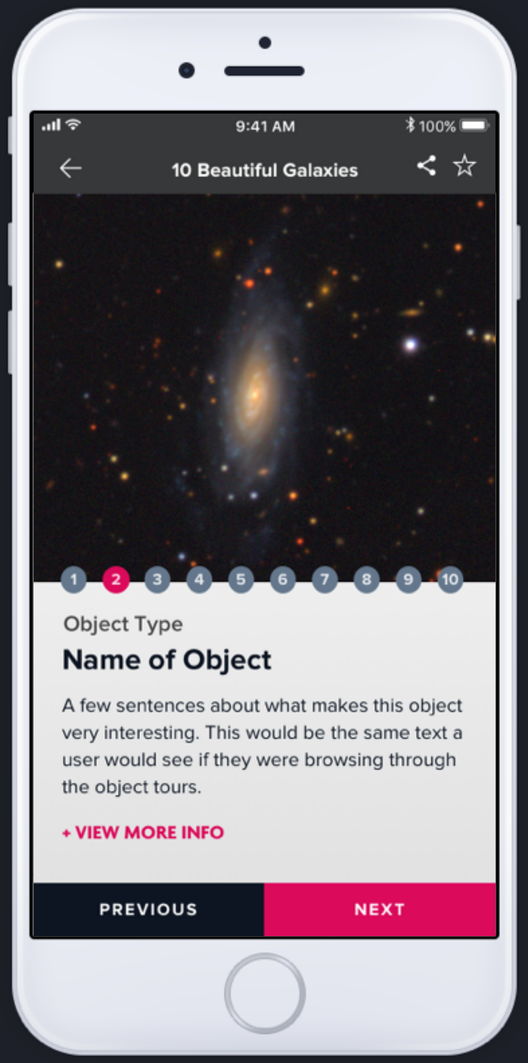
Skyviewer as a Self-Guided Educational Tool

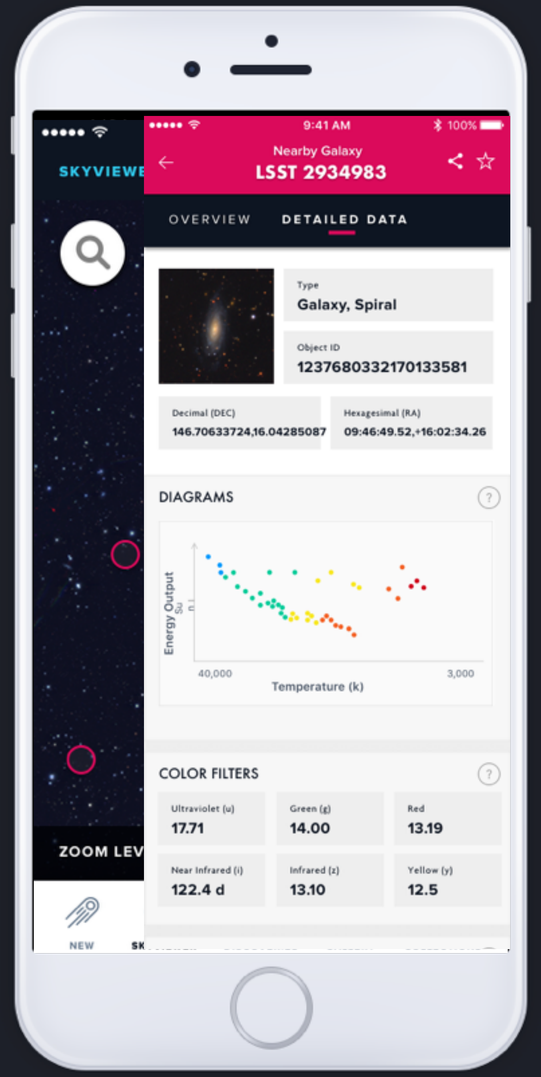
"I saw a lot of information about something that is so intangible"

"An exploratory site where you get to just delve into what the telescope sees"

The website will be mobile friendly and features will be shareable.





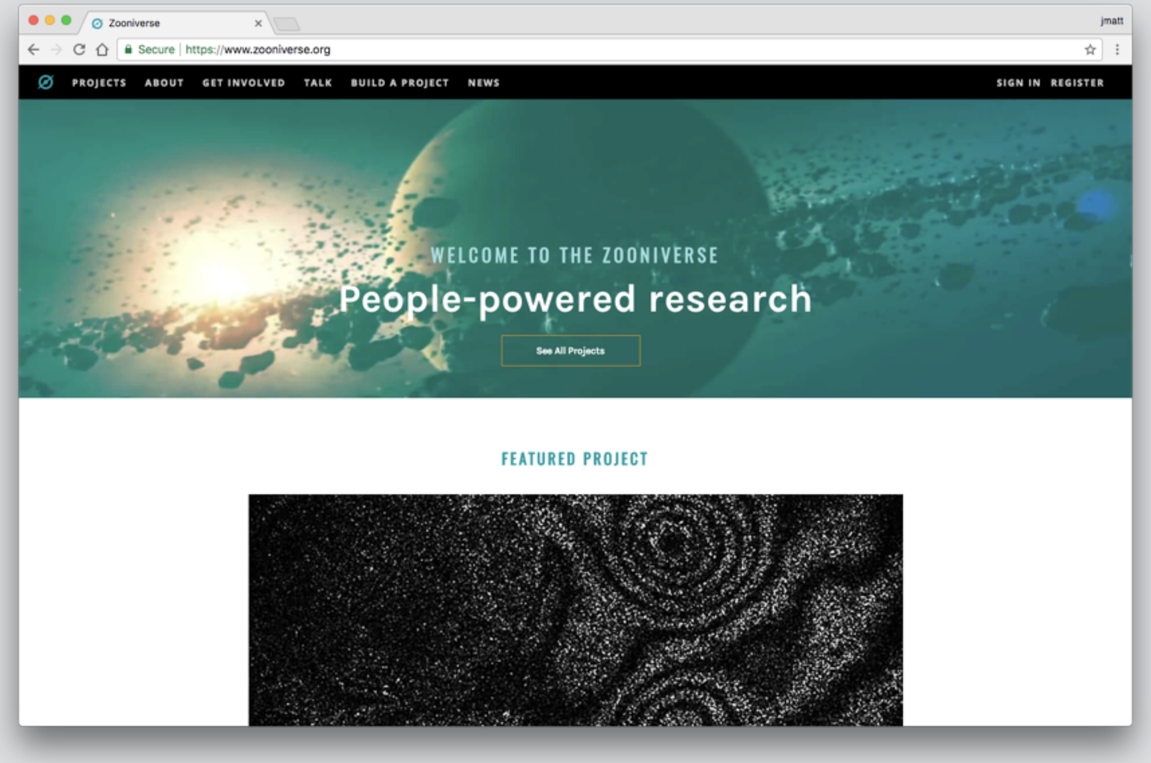


Citizen Science

Photo Credit: LSST Project/NSF/AURA

Citizen Science

People-Powered Research



Public volunteers help make science happen by contributing to real research projects

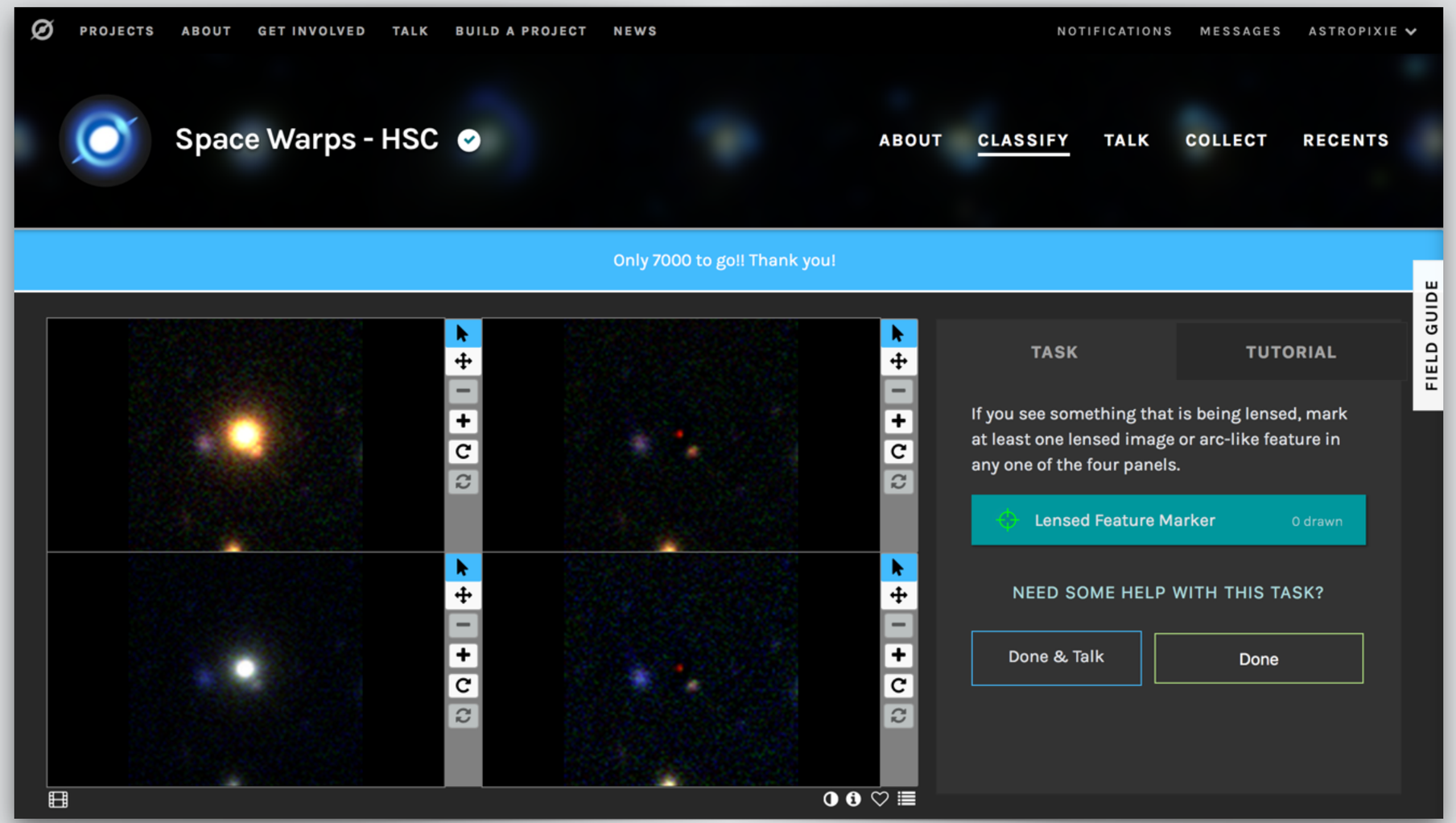
Citizen science can be a research tool enabling more science with LSST

LSST EPO will enable researchers to initiate Citizen science projects using any LSST data

Citizen Science

LSST EPO has partnered with *Zooniverse* to maximize flexibility in the types of projects that can be created by LSST citizen science principal investigators.

SpaceWarps.org exists now using HSC (LSST-like) data



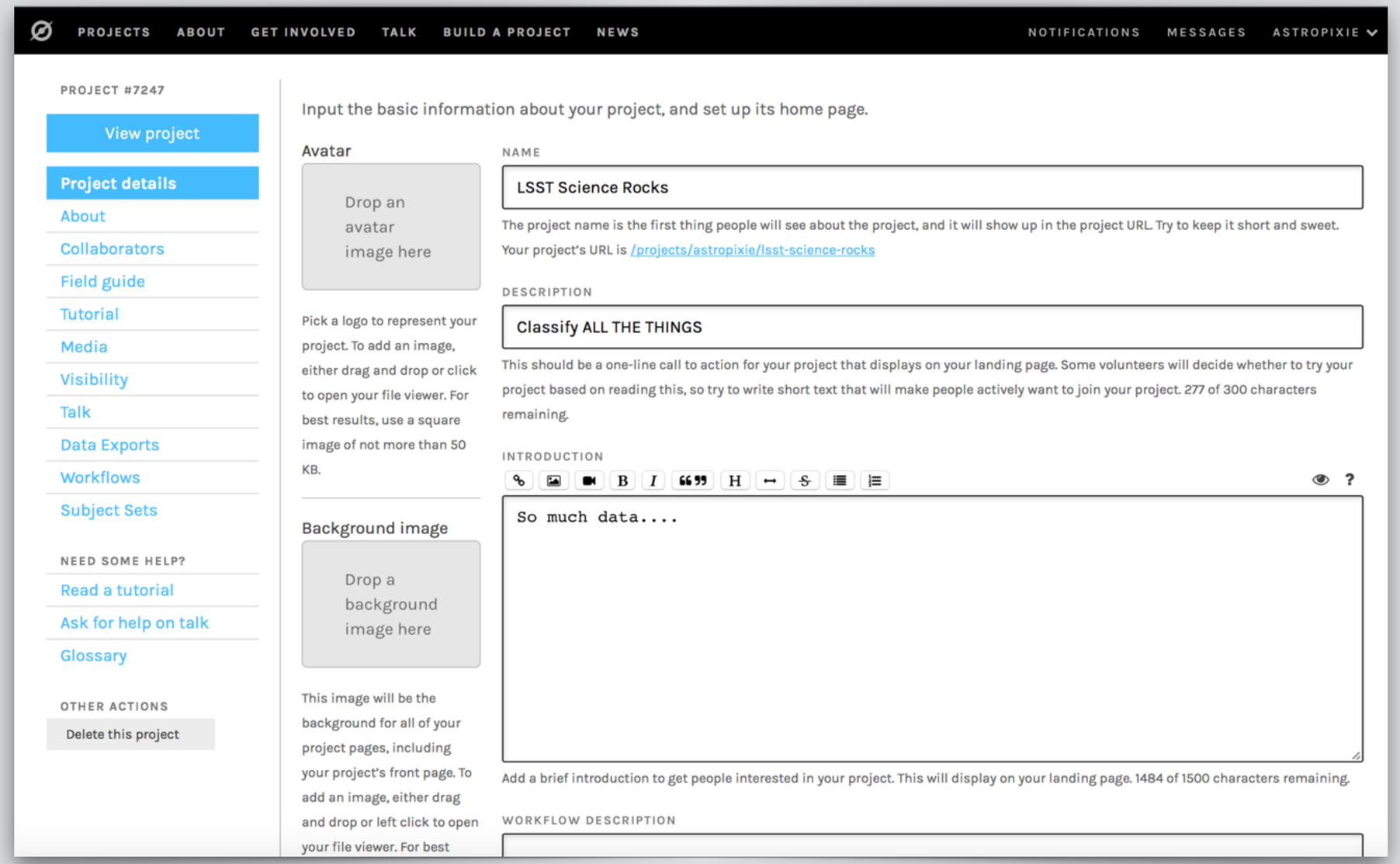
Lead by Aprajita Verma (Oxford)

Citizen Science

Any researcher can build a citizen science project with LSST data

YOU: can let us know what projects you might like to build so we are prepared.

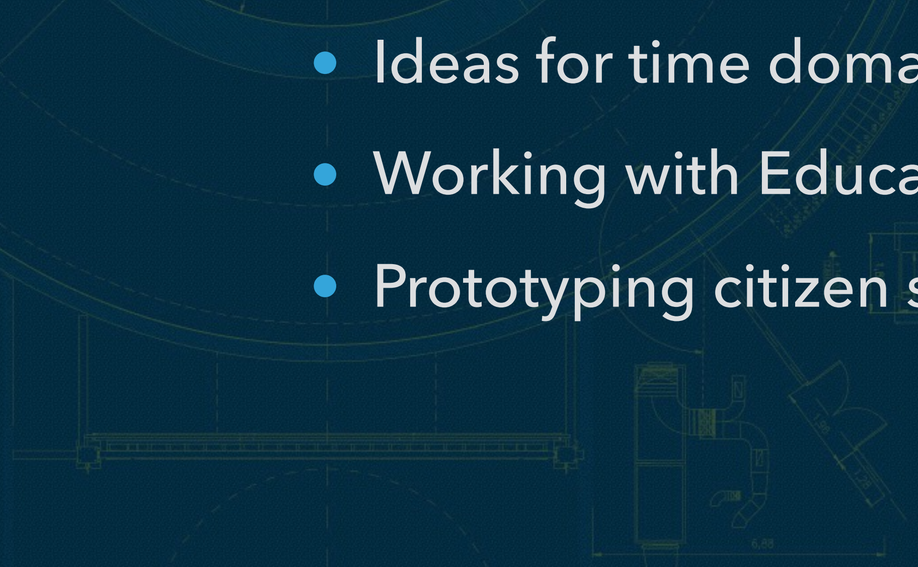
English and Spanish



Engaging with the LSST Science Community

Opportunities for EPO and LSST Science Community members to work together!

- Writing articles about your favorite science topic
- Implementing pre-cursor data into EPO Data Center
- Contributing object selection algorithms
- Developing interactive visualizations
- Ideas for time domain astronomy for the public
- Working with Education Team on Professional Development
- Prototyping citizen science projects



Viva Chile!

Spanish language

LSST EPO offers something unique to Chile - online educational activities allow us to reach people anywhere in the country (and the world!)

EPO will provide all materials in both English and Spanish

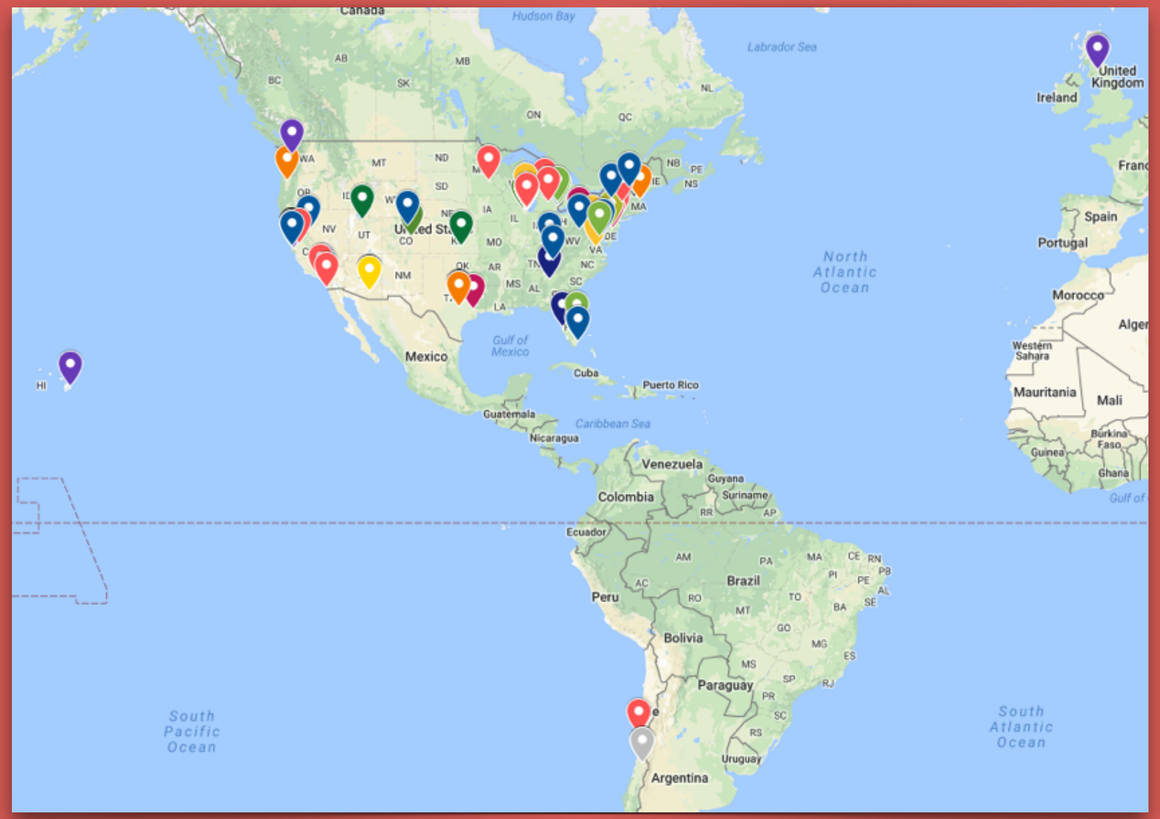
Diversity, Inclusion, Accessibility

We are engaging with diverse learners and those traditionally underrepresented in STEM to ensure deliverables remain relevant, accessible, interesting, and engaging to broad audiences.

User Testing

So far 168 people from 27 US states, Chile, and the UK have shared feedback and insights on EPO program plans and prototype deliverables.

EPO recruited for diverse individuals and viewpoints to take part in evaluation and prototype testing sessions.



Key Objectives of LSST EPO

- Provide non-specialists access to LSST data through online tools and interfaces
- Facilitate citizen science projects that use LSST data
- Further STEM education and training by engaging with educators to integrate real LSST data into classrooms and introductory astronomy courses
- Develop multimedia resources for content developers at informal science centers
- Build relationships with institutions and organizations serving under-represented groups and proactively engage with diverse audiences
- Engage with the Chilean community by providing EPO products in Spanish
- Remain agile and relevant during the full lifetime of Operations by adjusting to technology trends and educational priorities
- Provide evidence-based evaluation of the LSST EPO program and publicly report findings

As we ramp up to Operations, Communications joins EPO

EPO Construction Schedule - Yearly Focus

2019	Formal Education		
2020	Skyviewer	Branding	Communications Strategy
2021	Notebooks with code	Video production	Ramp up Marketing
2022	Incorporate LSST Commissioning Data	Professional Development	Prepare for start of Operations!

EPO will deliver:

- Operations website and materials in English and Spanish
- Formal education program based on online notebooks
- Repository of multimedia resources
- Interactive Skyviewer
- Cloud-based EPO Data Center
- Capability to build citizen science projects
- Communications and Marketing Plans for Operations
- Strategy for measuring success

Amanda Bauer, Head of LSST EPO

abauer@lsst.org