Launch

One of the most important outcomes of student engagement in astronomy is the development of a mental model of the universe. Earth's Place in the Universe is one of the core ideas cited in the Next Generation Science Standards (NGSS). It is addressed at every grade level with increasing depth and detail. With time and experience this model becomes more sophisticated and accurate - but only if we are deliberate about the process.

Beyond the Sun, Moon, stars, and a few visible planets, students have very little experience with the objects that they must mentally arrange to create their model of the universe. It is for this reason that Launch-type activities in Voyages are grouped into sections. If students encounter an activity that investigates the Sloan instruments or database, their feet are firmly planted on Earth – Launch to the SDSS. Although the SDSS does not target solar system objects, we are working to provide some solar system level (Launch to the Solar System) activities to preserve the important element of increasing distance from Earth in students' emerging model.

As the objects of investigations increase in distance from Earth, they fall clearly into one of two categories: within our own Milky Way (intragalactic) or outside our home galaxy (extragalactic). Launch to the Milky Way activities focus on stars. Almost every star we can observe in the SDSS lies within the Milky Way. With only rare exceptions, bright spots in galaxy images are knots containing hundreds of thousands of stars. Galaxies, quasars, and the structure of the universe itself are topics contained within Launch to the Cosmos. Keeping students mindful of where their explorations take them is important and should be continually monitored by ground control.

Launch to the SDSS

Launch – What is SkyServer?

Summary

This Launch activity asks students to think critically about how data are stored and accessed by computers. Students are guided through a sequence that demonstrates how images are recorded, stored, retrieved, and displayed in SkyServer.

Key Vocabulary

- database
- RA and Dec
- CCD
- pixel
- exposure time

Key Concepts

A database is a way of storing, managing, and retrieving data on computer.

SDSS images are greatly magnified compared to what you can see with your naked eye.

A CCD is a device that is made up of a grid of elements called pixels that record the intensity of light that falls on them.

The CCD and the SDSS telescope act as a system that captures and records light.

Images and associated data that are seen in the SkyServer Navigate tool can be accessed through tools within SkyServer.

Comments

Within and beyond students' work in astronomy, the understanding of what a database is and how it is organized and accessed is an important and sometimes confusing concept. This Launch activity addresses this content while referencing interesting images at immense magnification. This begins the process of building an intuitive bridge from student experience to the SDSS data.

We suggest you carefully review this activity as there are multiple logical stopping places you may choose depending upon how you use the material.

Consider doing this activity in conjunction with Launch – Constellations to get students looking up at the sky before diving into the data.

Launch – My Special Place in the Database

<table>
<tr><td colspan="2">Summary
Students use tables and a special star finder to locate and investigate a unique place within the SDSS database that acts as a starting point for many different activities in Voyages. Students relate an area of the sky they are familiar with to how it appears in SkyServer, thus building a sense of the magnification and detail contained in the database.</td></tr>
<tr><td>Key Vocabulary

RA and Dec
star finder
database

Key Concepts

The SDSS does not have images over the entire dome of the sky.

SkyServer images reveal many stars and galaxies that we cannot see with our eyes.</td><td>Comments

With a database containing over 900 million objects, there are few investigations that are not better served by each student working with their own data. This activity starts with familiar bright stars and ends with students zoomed in on a nearby location. If you plan to do a number of activities from Voyages, students can develop an in-depth understanding of their own unique part of the sky.

This activity does not teach what a database is. See Launch – What is SkyServer? for content focused in that area.

Consider printing a copy of the start wheel included in this activity and teaching students how to use it in advance. Consider holding a star party. This will ground students' abstract explorations through personal experience.</td></tr>
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Launch to the Milky Way

Launch – Constellations

<table>
<tr><td colspan="2">Summary
This activity compares photos of the night sky with the SDSS sky coverage maps included in the website Astrometry.net to communicate a sense of the magnification and coverage of the survey.</td></tr>
<tr><td>Key Vocabulary

Constellation

Key Concepts

The SDSS coverage of the sky is not complete.

Constellations occupy large portions of the sky.

SDSS images magnify very small portions of the sky.</td><td>Comments

This activity can also be done by uploading a .jpg file of an SDSS image. The result is that Astrometry.net displays a series of graphics demonstrating clearly that the SDSS image covers a very small portion of the sky. If you are interested in seeing this activity included in Voyages, please contact voyages@sdss.org .</td></tr>
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Launch – Stellar Spectra

<table>
<tr><td colspan="2">Summary
In this Launch activity, students look for patterns in the continuum curves of stellar spectra. Student choose 10 – 20 spectra to sort based upon patterns they observe. Students may focus on the position of the peak of the curve, absorption lines, or use other information on the Science Archive Server to correlate to other data with continuum shapes.</td></tr>
<tr><td>Key Vocabulary

Key Concepts</td><td>Comments

This activity is very open-ended and relies on group interaction to round out the experience. This is not an ideal choice for independent study.

Allow for differing levels of interaction with the material. Some students may be able to incorporate observation of spectral line features while others may only focus on the position of the peak.

This activity could be used and a prelude to Launch – Stars as Blackbodies or Launch – Star Color.</td></tr>
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Launch – Star Color

Summary

This Launch activity begins with the naked-eye observation of star color to build an understanding of both the magnitude scale and color as quantitative measurements in astronomy. Students also start building an understanding of the information provided in conjunction with filters.

Key Vocabulary

- magnitude
- color
- filters

Key Concepts

The magnitude scale is inverse. The brighter the object, the smaller the magnitude measurement.

The color an object appears to the eye is reflected in the relative filter measurements for that object.

When comparing the color of two or more objects, one filter measurement alone cannot describe a color comparison between the targets.

Comments

If your students are new to the magnitude scale in astronomy, try jumping directly into this activity without discussing the scale in advance. For most students, uncovering the inverse nature of the scale for themselves can be more helpful than being told about it. Allow time for them to uncover the meaning at their own pace.

If a subset of your class is frustrated by this approach, you can determine the best time to provide some supportive clues. You could have cards at the ready with helpful hints or the link to Preflight – Magnitude.

Preflight – Filters may be a good follow-up to this activity.

This activity does not explore the mathematics associated with the color measurement.

Launch – Stars as Blackbodies

<table>
<tr><td colspan="2">Summary
The focus of this Launch activity is to guide students through the research process to investigate whether or not stars behave blackbodies. They must first observe or review blackbody curves in general and then create their own testable hypothesis that can be answered using SDSS data.</td></tr>
<tr><td>Key Vocabulary

blackbody
nanometer
wavelength
electromagnetic radiation
hypothesis

Key Concepts

Stars do emit radiation similar to ideal blackbodies.

The peak wavelength of a blackbody curve is related with the temperature of the object.

The peak wavelength of a spectrum moves toward shorter wavelengths as the temperature increases.

Total energy output increases with increased temperature.</td><td>Comments

This activity asks students to use the NoteBook tool that is part of SDSS data release 10 (DR10) and above. This requires that students create a log in to SkyServer. Be sure students are able to do this before starting. This activity can be done without logging in although it will be more of a challenge to create two sets of data for comparison.

This activity does not use or explain Wien's Law for calculating the temperature from the peak emission. You may choose to extend the activity to the area using the Science Archive Server (SAS). Instructions for accessing SAS are found at the end of this activity. If you would like to see Wien's Law covered in Voyages, let us know at voyage@sdss.org .</td></tr>
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Launch to the Cosmos

Launch – Redshift

<table>
<tr><td colspan="2">Summary

In Launch – Redshift students explore the measurement of redshift in relationship with SDSS spectrum graphs. Students develop an intuitive sense of the relationship between a spectrum graph, the visible light portions of the continuum, and absorption lines when redshift is present and when it is not.</td></tr>
<tr><td>Key Vocabulary

redshift
wavelength
electromagnetic radiation
spectrum
noise

Key Concepts

Redshift is measured by mathematically comparing the location of an observed absorption line to the location of that line when it is emitted from an object at rest relative to the observer.

The SDSS camera and filters measure the same portions of the electromagnetic spectrum regardless of the redshift of the object.</td><td>Comments

This activity focuses on how redshift is measured. See Preflight – Redshift for a discussion of what it is.

Redshift is a key concept in astronomy upon which much of what we know about the structure of the universe is based. Launch – Redshift is designed to make using redshift as a tool for deeper investigations easier.

Note: In the simulation at the end of this activity, the redshift equation is denoted in a slightly different way than in the text – observed wavelength is replace by emitted wavelength. Also, in the future, we hope to insert the SDSS filters into “filter details.” See Launch - Filters for an explanation of the range of SDSS filters.</td></tr>
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Launch – Galaxy Shapes

<table>
<tr><td colspan="2">Summary
This activity uses the Galaxy Zoo Navigator Tool to introduce students to galaxy morphology. Groups of students can work together to observe galaxies, explore one way that large amounts of data can be analyzed through citizen science projects, and think critically about how they would group galaxies.</td></tr>
<tr><td>Key Vocabulary

galaxy
spiral galaxy
elliptical galaxy
central bulge
irregular galaxy

Key Concepts

Galaxies can be grouped according to common characteristics.

We can learn about galaxy shapes when we observe how different people describe what they see.

Citizen science projects are designed to have large numbers of people contribute to answering scientific questions by having them answer questions about images and other data.</td><td>Comments

Well in advance of beginning this project, be certain your students will be able to access and use the Galaxy Zoo Navigator Tool. You will need a Zooniverse account to test your school system with the program. The resource guide Galaxy Zoo – Getting in and Getting Started outlines the steps to getting set up.</td></tr>
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Launch – Extragalactic Color Magnitude Diagrams

<table>
<tr><td colspan="2">Summary
This is a complex Launch-type activity that explores the nature and significance of a color magnitude diagram. It tests students' abilities to interpret what they observe and create a collection of galaxies with similar characteristics.</td></tr>
<tr><td>Key Vocabulary

color magnitude diagram
magnitude
absolute brightness
color
galaxy

Key Concepts

A color magnitude diagram is a graph that compares the relationship of color to absolute brightness for stars and galaxies.

A color magnitude diagram for thousands of galaxies shows an uneven distribution with high- and low-density areas.

Galaxies on the color magnitude diagram share characteristics that can be visually selected from the population of all galaxies.</td>
<td>Comments

Be sure your students are able to access Galaxy Zoo and Galaxy Zoo Talk from your school's computers. Use the steps outlined in Galaxy Zoo – Getting in and Getting Started.

Before beginning, students must have a firm grasp of the concept of color in astronomy. If you have the time for students to uncover the nature of the magnitude scale and color measurement for themselves, try Launch – Color.

The Zoo Tools that are used as part of this activity can be used to explore student questions. Don't hesitate to allow students to explore further. Expedition – Galaxies can help them set a course.</td></tr>
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