

Expeditions

The Next Generation Science Standards stress the need for students to be immersed in the *practices* of science and engineering. While it is important to learn about the abstract facets of these disciplines, it is equally important for students to learn how to practice concrete science and engineering skills from conception to experimentation (to possible implementation). Throughout Voyages, great attention and focus has been placed on these new standards so that activities provide students opportunities to observe, investigate, evaluate, and develop explanations and solutions; however, it is in the Expeditions section that activities incorporating these new standards have been more fully developed. Expeditions provides students the flexibility to practice science by formulating their own questions and by accessing data to pursue new and exciting hypotheses or conclusions.

In general, these projects require extended periods of time to complete as well as the use of outside programs like Excel. Prior experience working with outside tools such as Zoo Tools, Galaxy Zoo Talk, and spreadsheets is very helpful.

Because of the challenges involved with guiding students to complete research independently without the benefit of a “friendly neighborhood scientist” in the next room, the Expeditions section has yet to grow into the robust resource it is intended to be – a rich array of supported research opportunities using the vast SDSS database. Let’s use this to our advantage by creating tailor-made Expeditions for your classroom. Share your needs, interests, and challenges with us at Voyages so that we can chart the next course - *together*. And if your students find that they have learned something extraordinary while on their Expedition, let us know that as well. We may try to replicate it for future travels (and travelers) on our site.

Contact us at Voyages@sdss.org

Expedition to the Expanding Universe –

This Expedition is a three-part historical walk through the evidence supporting the theory that our universe is expanding. We take the first step in Moving Beyond the Milky Way which uses SDSS images to consider the evidence that (what we now know to be) galaxies are actually located well beyond the stars we see in the night sky. (If your students have already advanced beyond this level of understanding, you can easily move to the next step without loss of continuity.)

Following in the footsteps of Hubble and Humason, we next use large galaxy clusters to establish a relationship between redshift and distance using visual clues available from images of large galaxy clusters. Students use SDSS

images and data from the Abell clusters to do just that. The final leg of the journey is made when students move from a redshift-distance relationship to one that correlates redshift and absolute magnitude. Students run SQL queries to

Key Concepts	
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retrieve the needed information about the galaxies in each of the Abell clusters to create a color-magnitude diagram.

Part I – Beyond the Milky Way

Students sample the sky at various locations within the SDSS footprint to count the numbers of galaxies and stars, confirming that galaxies do not follow the same distribution patterns as stars. This important piece of information lays the groundwork for establishing the location of galaxies as outside (or extragalactic to) the Milky Way.

Part 2 - Distances to Galaxies

Students sort SDSS images of Abell clusters in order of their relative distance from Earth. The SkyServer Navigate tool is used to calculate the average redshift of the cluster. Students observe that relative distance is inadequate for revealing a relationship with redshift as this would require the even distribution of the clusters relative to one another in space. When students take into account the angular size of the galaxies within a cluster, a better fit is achieved.

Part 3 – Hubble Humason 1936 Redshift Magnitude Relationship

In this section, students use an SQL query to retrieve the data needed to construct a color-magnitude diagram from the Abell clusters.

Expedition to Galaxies

Because the options for exploration and investigation in the SDSS in the area of galaxies are so vast, Expedition to Galaxies starts by asking students to assess

their own skills, knowledge, and interests. The aim of this Expedition Inventory is to begin guiding students in the research process. Completing the inventory should focus attention on more specific areas of interest. The intent of this Expedition is to provide guided research experiences in several areas that result in students being able to achieve ever-greater levels of research independence.

Galaxy Color

CCD technology allows us to add color to our consideration of galaxy classification and suggest possible modifications to Hubble's tuning fork diagram. This activity teaches the construction of an SQL query to access large amounts of specific data from SkyServer in order to answer questions in astronomy. Students learn to construct queries with a clear view of the research process in mind from asking an answerable question and writing a hypothesis to defining variables, planning the research, and drawing conclusions with the use of statistics.

This Expedition is divided into two parts. The first part considers the implications of color on the Hubble classification system while teaching the basics of SQL. If your students choose to go on to *Design and Conduct Your Own Investigation*, they will construct their own individual questions related to galaxy color, formulate a hypothesis based upon their knowledge of the subject, define the data needed to test their hypothesis, retrieve the needed data, analyze those data, and draw conclusions. The result is a complete independent research experience for students.