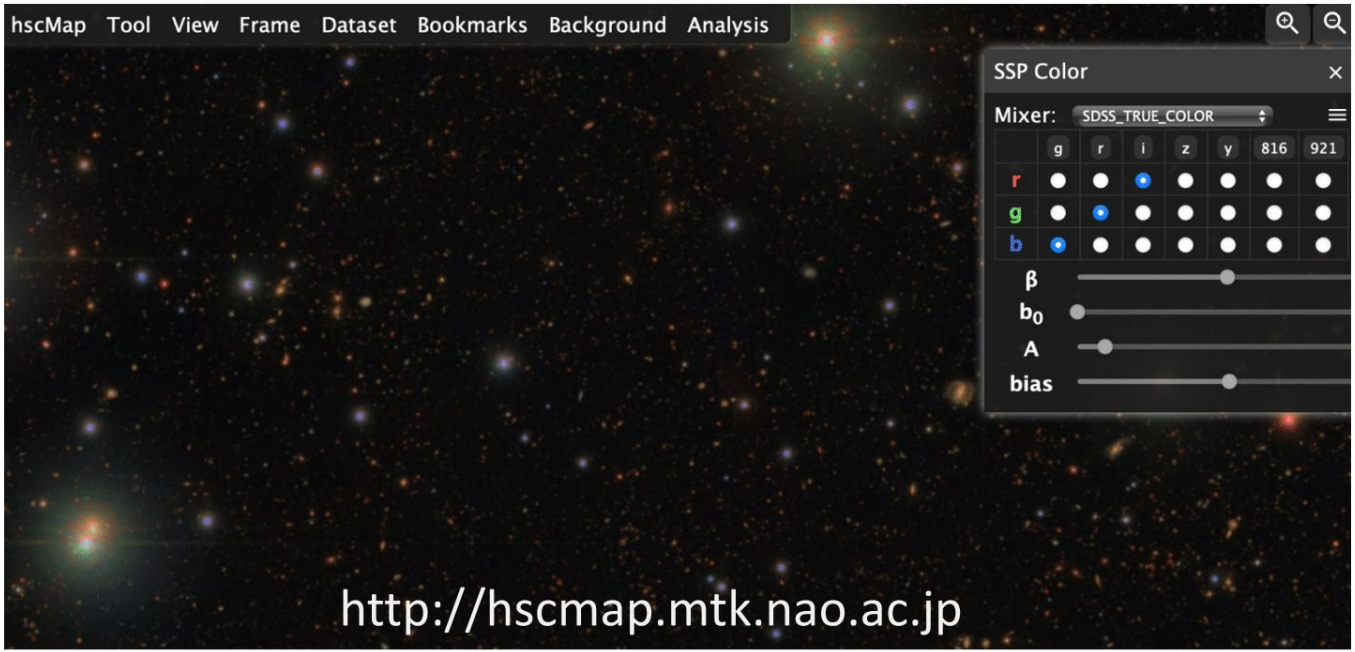
Three high school teachers bring the Subaru Telescope's big data to their classrooms

Kumiko Usuda-Sato (Subaru Telescope, NAOJ*, USA)
* National Astronomical Observatory of Japan
Tadashi Hara (Toyo University, Japan)
Tamiki Togashi (Saitama Prefectural Kasukabe High School, Japan)
Yuichiro Hiratsuka (Saitama Prefectural Yorii-Johoku High School, Japan)
Akihiko Tomita (Wakayama University, Japan)

- We bring the Subaru Telescope's high-quality astronomical images to classrooms at high schools.
- Three (3) earth science teachers (Hara, Togashi, Hiratsuka) and two (2) astronomers (Usuda-Sato, Tomita) have had monthly online meetings to develop and brush up on teaching materials.
- The teaching materials (worksheets for students and guidelines for educators) are available in Japanese online at: https://drive.google.com/drive/folders/1ENAsT7T3B3Dv9wVoCUmxJkoo2diOa3l3

The Subaru Telescope and “hscMap”

- The Subaru Telescope is an 8.2-meter optical-infrared telescope on Muanakea, Hawai`i.
- With its ultra-wide field-of-view camera “HSC,” the Subaru Telescope conducted an extensive survey called the Hyper Suprime-Cam Subaru Strategic Program (HSC-SSP).
- **The HSC-SSP big data is partially open to the public, and anyone can easily explore the vast cosmic images with hscMap.**



More info about hscMap: http://prc.nao.ac.jp/citizen-science/hscv/index_e.html

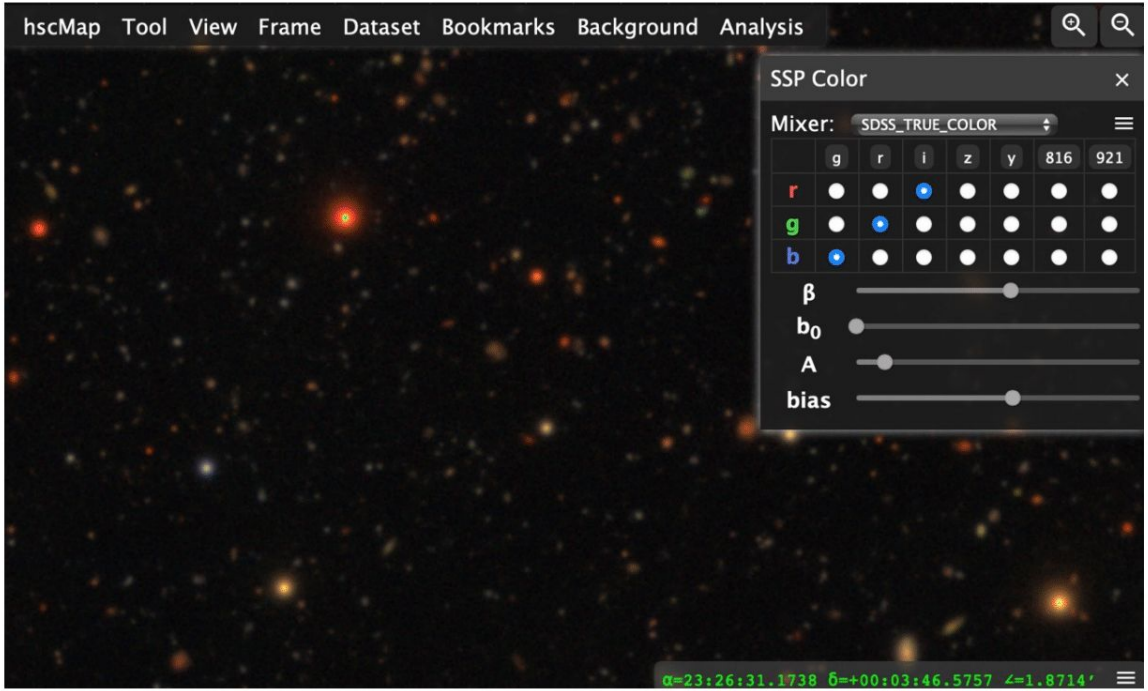
List of teaching resources

Title	Duration	Level	Calculation	Themes	Created by
H0 - hscMap operation	10 - 15 min	easy	-	How to operate hscMap	Hara
A1 - Hubble Classification	10 - 20 min	moderate	-	Diversity and interaction of galaxies	Hara
A2 - Distant galaxies Page 4	15 - 20 min	moderate	-	Apparent size, brightness, and color (Hubble-Lemaitre law)	Hara
A3 - Fuzzy objects in the Universe Page 5	40 min	easy	-	Different kinds of celestial bodies	Hiratsuka
C1 - Angular distance of a galaxy	20 - 30 min	difficult	required*	Estimation of the size of a galaxy and galaxy cluster	Hara
C2 - Size of a galaxy cluster	20 - 30 min	difficult	required*	Estimation of the ditance of a galaxy cluster	Hara
C3 - Number of galaxies in the Universe Page 5	40 min	difficult	required*	Estimation of the number of galaxies in the entire Universe	Togashi

* Using a simple trigonometric function.

Educators can tailor their teaching content by combining some of them according to the class time and students' level.
They must start from H0 to let students get used to the hscMap operation.

Resource A2: Qualitative recognition of the Hubble–Lemaître Law



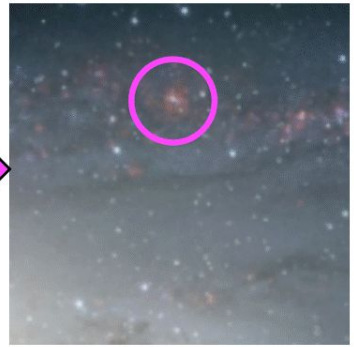
This **color template** can eliminate the color difference between monitors and allow students to observe the color of galaxies confidently.

- Students go deeper into hscMap and recognize the characteristics of small-looking galaxies, such as brightness and color.
- Students discuss the relationship between the color + brightness of small-looking galaxies and the expansion of the Universe.

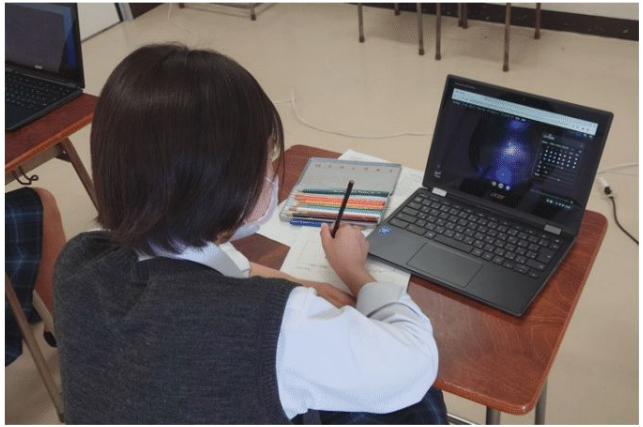
Hara

Teaching resource A3: Connecting star-forming regions (HII regions) inside and outside of the Milky Way Galaxy

Orion Nebula



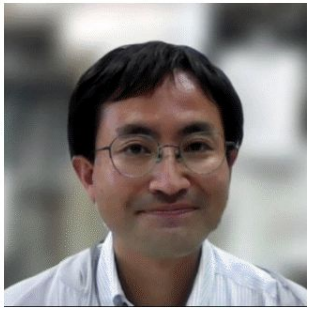
Andromeda Galaxy



Hiratsuka

Teaching resource C3: Estimation of the number galaxies in the Universe

In a group, students count the number of galaxies in specific areas and then extrapolate the (averaged) number to the entire Universe.



Togashi