Galactic Secrets: Decoding the LMC's Gas and Elemental Fingerprints

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Background

The Large Magellanic Cloud (LMC), a nearby galaxy, is shaped by gas outflows driven by explosions of massive stars. These events eject gas and heavy elements, enriching the environment and influencing future star and planet formation. We use observations from the Hubble Space Telescope to analyze light from background stars that passes through the LMC's gas clouds. These clouds absorb specific wavelengths, creating absorption features and revealing gas properties. We investigate how stellar feedback shapes galaxies and contributes to the cycle of matter in the universe.

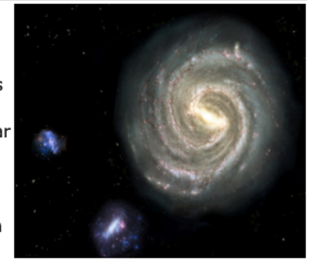

Figure 1: Milky Way with the Large and Small Magellanic Clouds. Image Credit:Nina McCurdy/ Nick Risinger/ NASA

Data & Observations

★ We use archival ultraviolet observations from the Hubble Space Telescope's (HST) ULLYSES program, a large legacy survey designed to provide high-quality spectra of massive stars in nearby galaxies. ULLYSES enables detailed studies of stellar winds, feedback, and the interstellar medium across different environments.

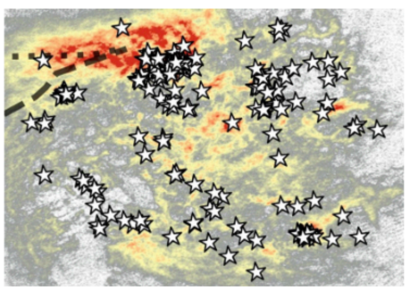

Figure 2: We analyze 180 sightlines. As light from each star travels it passes through varying regions of gas in the LMC.

★ Our analysis compares spectra obtained with the Cosmic Origins Spectrograph (COS) and the Space Telescope Imaging Spectrograph (STIS), which provide high-resolution measurements of absorption features in the LMC.

★ The HST ULLYSES program utilizes COS and STIS instruments to cover different wavelength ranges and brightness levels. The COS instrument is optimized for fainter stars due to its high ultraviolet sensitivity, while the STIS is better for brighter stars. Together these instruments give us a better view of stellar wind signatures and interstellar absorption features.

What is a Spectrum?

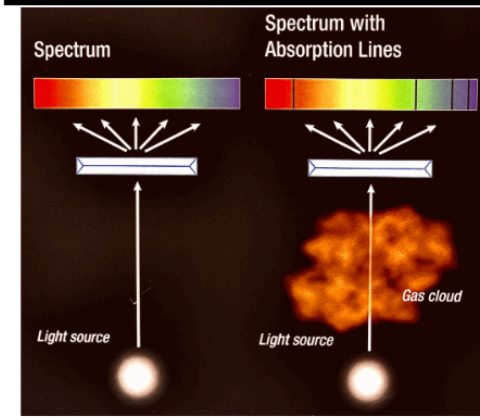

Figure 3: Light captured from source and then dispersed into spectroscopy. Image Credit:The Perot Museum of Nature and Science

When light from a star is observed, it forms a continuous band of colors called a spectrum. When starlight passes through a gas cloud, certain wavelengths are absorbed by the gas. This creates dark lines in the spectrum, known as absorption lines. Each element absorbs light at specific wavelengths, so these lines act like fingerprints that tell us what elements are present and thus the physical conditions of the gas.

★ We favor STIS over COS and FUSE due to how much better the resolution comes out between the 3.

★ COS and FUSE have more clutter in them which makes it harder to pick out things like the Milky Way, Gas Clouds and LMC

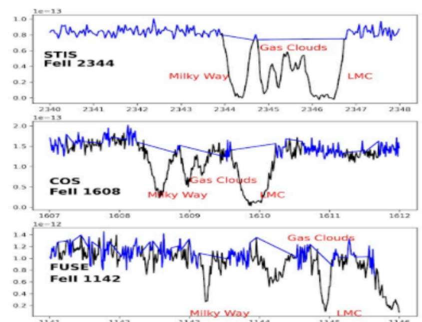

Figure 3 : We utilize 3 separate instruments to resolve wavelengths at different velocities.

Our neighboring galaxy, the Large Magellanic Cloud (LMC), is shaped by powerful explosions from massive stars. These explosions push gas and heavy elements outward, enriching the galaxy and helping create the material for new stars and planets. Using observations from the Hubble Space Telescope, we study light from distant background stars that passes through gas in the LMC. By analyzing missing pieces of light, we can determine the gas's physical properties and better understand how star formation influences galaxies.

Acknowledgements:

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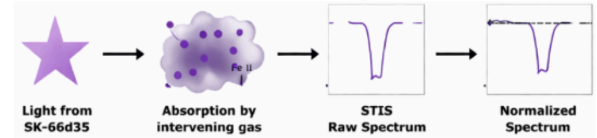
Normalization Process



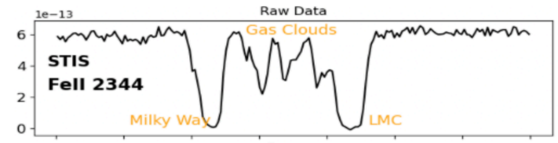
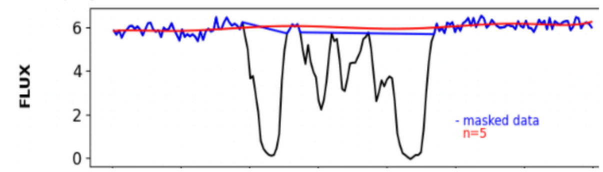
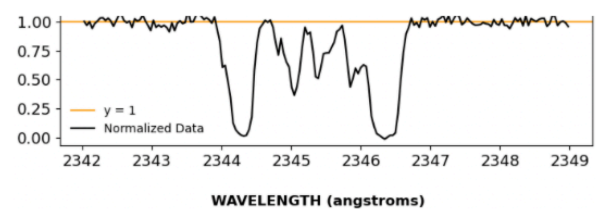


Figure 4: Fe II (2344 Å) absorbers toward a star in the LMC.

Step 1: We exclude the sightlines absorption features. Then fit a polynomial to the remaining background signal to model the star's underlying continuum.



Step 2: We divide the flux by the continuum fit, which sets the baseline to 1. This makes absorption features across spectra from various instruments gratings easier to analyze.



Conclusion

★ By analyzing 180 sightlines through the LMC, we use ultraviolet absorption features to characterize the properties of outflowing gas

★ These findings contribute to a broader understanding of how galaxies evolve and recycle material to create new stars and planets

★ We develop a deeper understanding of galactic environments and connect our existence to the explosive deaths of distant stars

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