Observing Massive Gas Outflow from Supernovae Explosions around the Large Magellanic Cloud Galaxy

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Abstract

Within the Large Magellanic Cloud (LMC) galaxy, there are huge gaseous outflows that originated from violent supernovae explosions within this galaxy. Observing this outflow that is being kicked out from the LMC reveals that there is ionized gas present, which can be trace by using Ha emission. Using observations from the Wisconsin Ha Mapper (WHAM) in Chile, we are mapping out the Ha emission that is being kicked out of the LMC. In this project, I am removing the imprint of the Earth's atmosphere in order to isolate the gas cloud. This will be used to determine how much gas is being thrown out of the galaxy. The more gas the galaxy loses, the more it would not be able to make stars in the future.

Background

The Large Magellanic Cloud (LMC) is a satellite galaxy of the Milky Way. At a distance of about 163,000 light-years, the LMC is the third-closest galaxy to the Milky Way (Fig. 1). The LMC has a diameter of about 14,000 light-years and a mass of approximately 10 billion solar masses, making it roughly 1/100 as massive as the Milky Way. The LMC is rich in gas and dust and is undergoing vigorous stellar activity, which includes numerous supernovae explosions. These violent explosions occur at the end of a star's life. These catostrophic events cause the interior and surface of the star to be flung outwards at speeds up to 30,000 km/s, which creates a fast-moving shockwave as the gas plows through the surrounding medium. In the LMC galaxy, numerous neighboring supernovae explosions are going off, which causes huge amounts of gas to be pushed out of this galaxy and this is observed.

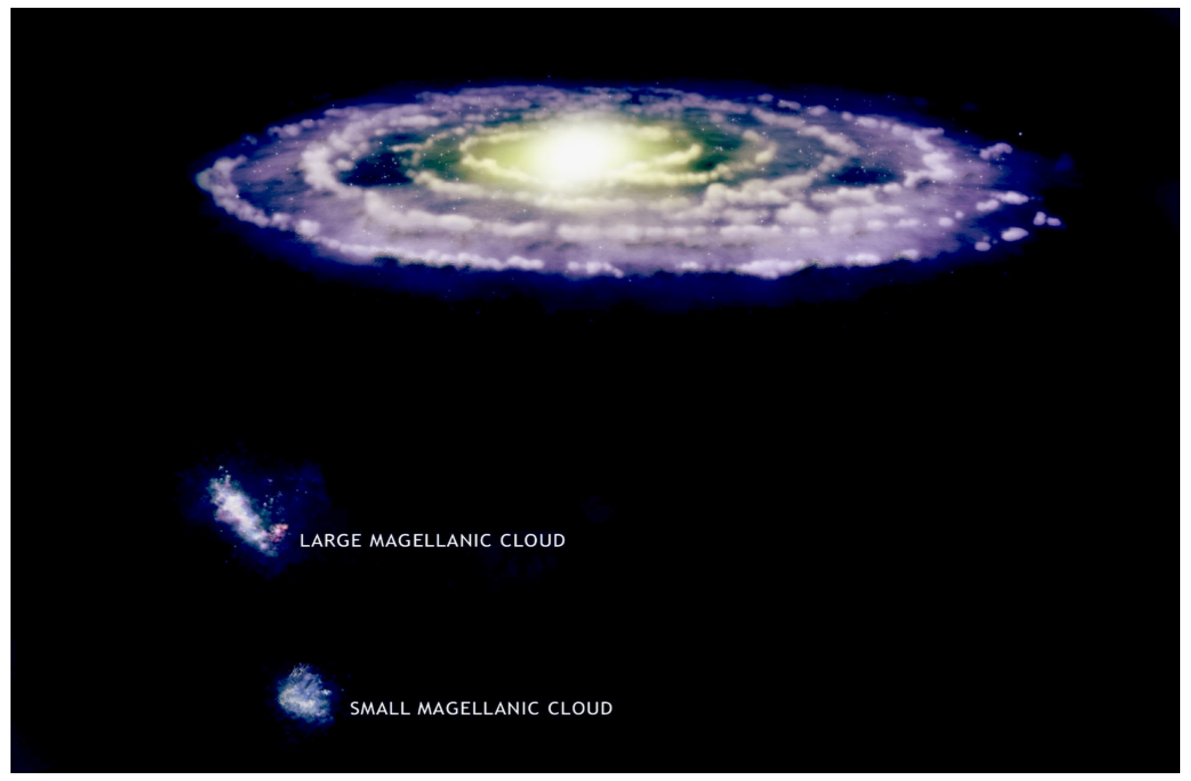

Fig. 1 Map of the Milky Way galaxy with the LMC galaxy

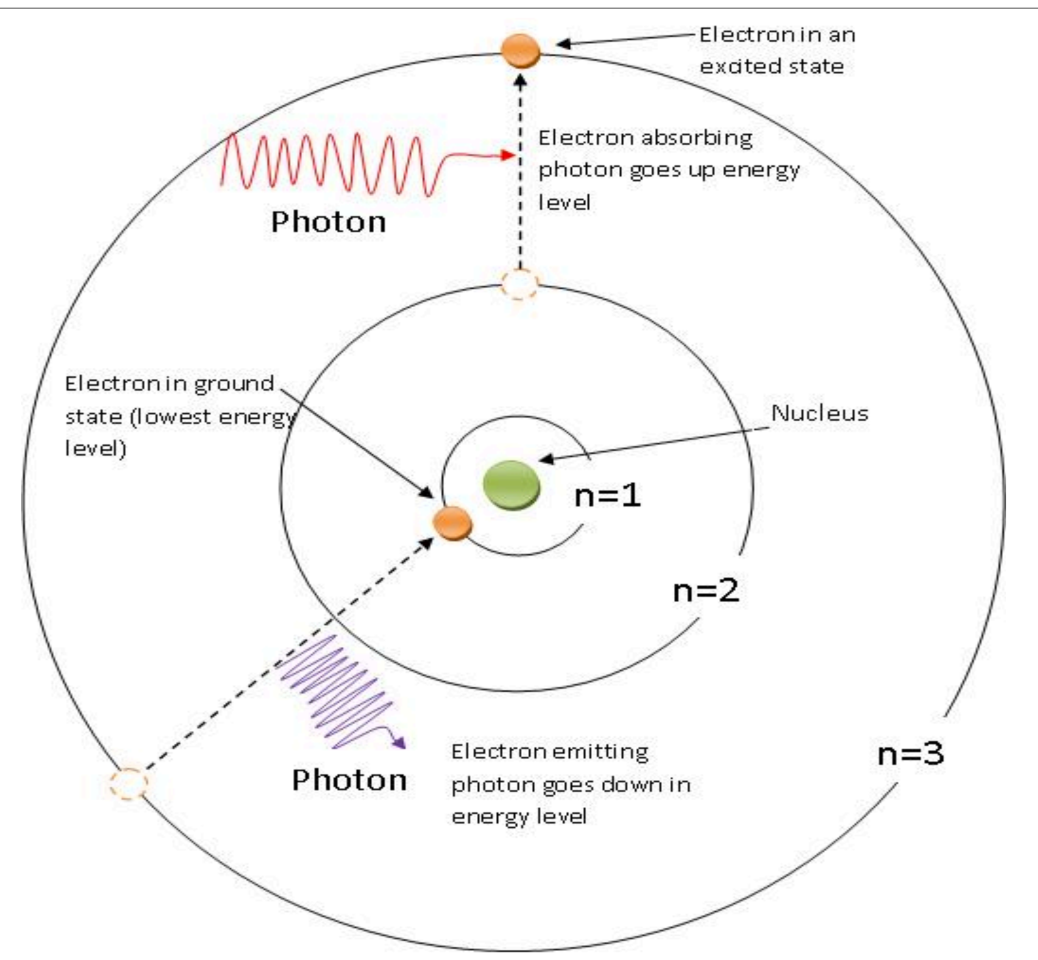

Fig. 3 When sunlight hits OH molecules, they can absorb sunlight, exciting an electron to a higher energy state. When the electrons fall to a lower energy level, they emit bright emission. This overlaps with the light we are observing from the gas clouds traveling in space. This atmospheric line must be removed before we can explain astronomical objects. In Fig.2, The OH line is present and this is to be remove.

Observation and Data Procedure

Observing this gaseous outflow that is being kicked out from the LMC reveals that there is ionized gas present, which can be trace by using Ha emission. Using observations from the Wisconsin Hα Mapper (WHAM) in Chile, we are mapping out the Hα emission that is being kicked out of the LMC. This mapping out of the Hα emission data is already available to us, so there was no need to make new observations. We observed two faint regions in the LMC galaxy for several days throughout the year to get the velocity range of each region. The data from the WHAM telescope is given as a spectra that gives several information about it. The spectra on the bottom (Fig. 2) is an example of a spectra from the WHAM on a particular day. From this there are several peaks in the spectra. Some of these are from the Earth's atmospheric emission and some of them are from the stars in the faint region of the LMC.

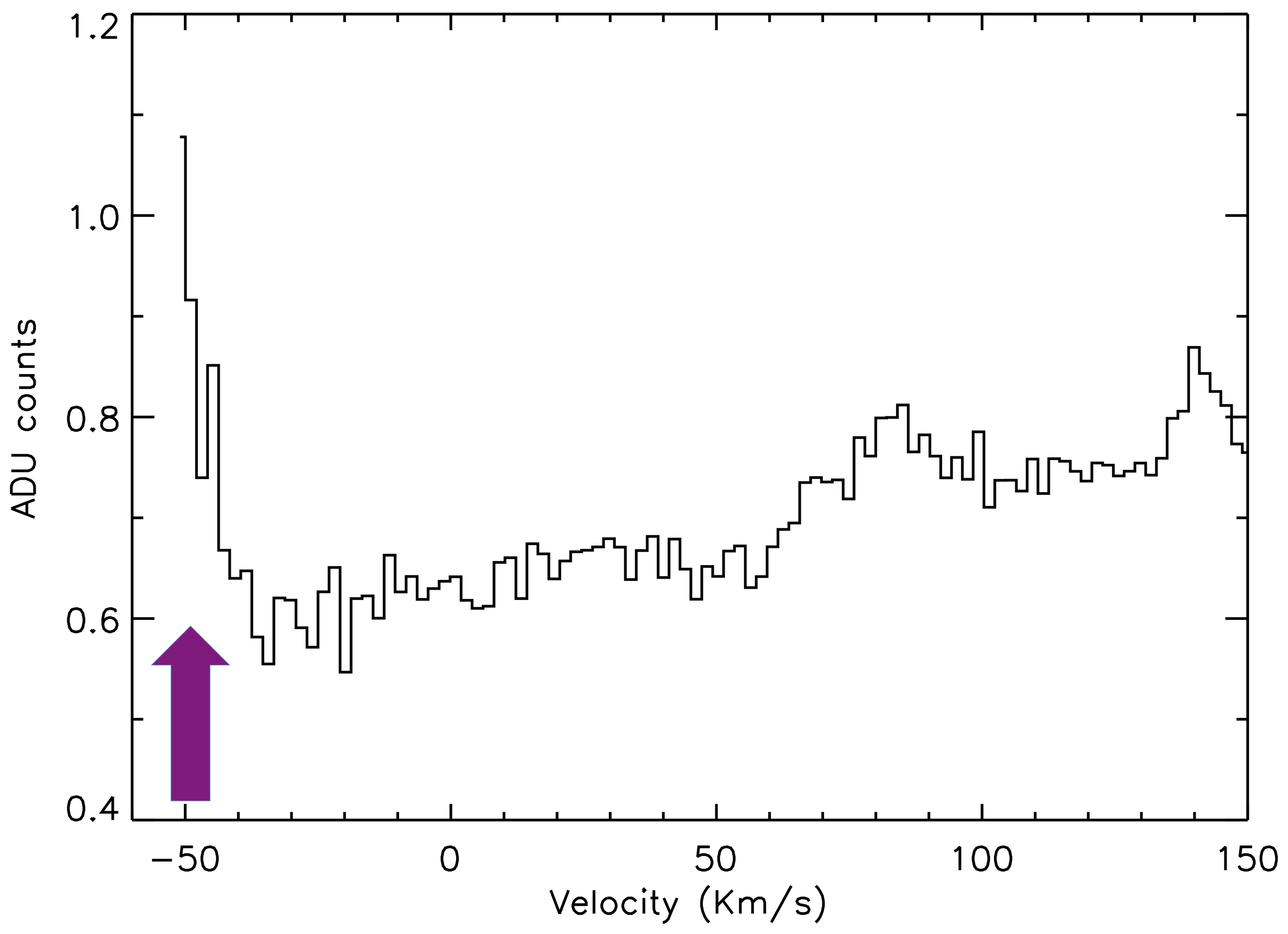

Fig. 2 The OH line is known to have velocity at exactly -272.44 km/s in the geocentric frame, which is the velocity frame with respect to Earth. Here is a sample spectra from the WHAM with the arrow pointing to the OH line needed to be remove.

Reduction

To remove Earth's atmospheric emission, I first subtract off the Gaussian fit of the strong OH line from the spectra (Fig. 2). Then, I stack up all of the spectra and see when of them is not lined up perfectly or some of their peaks us unusably huge. By removing some of these spectra, I finally get a neatly stack of spectra. From this, I average out the whole stack to get one averaged spectra in order to create an atmospheric template so that it can determined how much gas is being thrown out of the LMC galaxy (Fig. 4). By fitting several Gaussians into the averaged spectra, we get an atmospheric template of Earth.

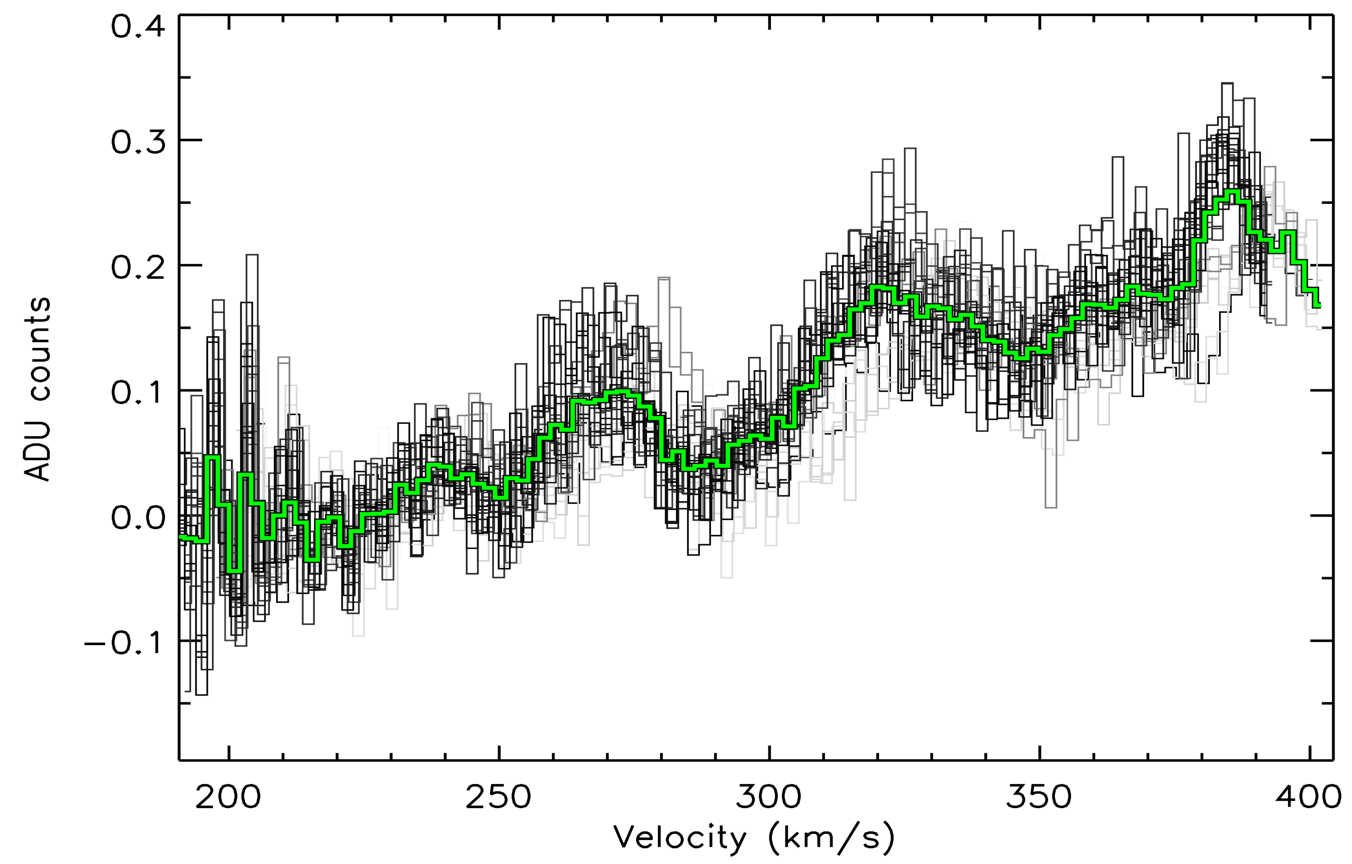

Fig. 4 Here is the spectrum with several spectra stacked on top of each other in a plot with velocity vs. ADC counts. In the green is the average spectra used for fitting and finding the atmospheric template

Future Work

What I will do next is fitting the atmospheric template with several Gaussian. From this information, it will give us the width, mean velocity position and the area of each Gaussian.

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Within the Large Magellanic Cloud (LMC) galaxy, there are gas coming out of the LMC galaxy. Looking at this outflow of gas coming from the LMC reveals that there is ionized gas present. Using data that is already present from a telescope looking at this gas outflow, we are measuring the gas that is being pushed out of the LMC. In this project, I am removing the Earth's atmospheric emission from this data due to that the Earth's atmosphere heavily affects the gas coming in. By removing the Earth's atmospheric emission, the data then will be used to determine how much gas is being thrown out of the galaxy. If the galaxy loses a lot of gas, then it can not be able to make stars in the future.