Molecular Gas in the Host Galaxies of Long-duration Gamma-ray Bursts

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Long-duration gamma-ray bursts (GRBs) have been shown to be associated with the explosions of massive and short-lived stars, and are expected to trace galaxies with ongoing star formation. Although multi-wavelengths observations of GRB host galaxies have been conducted to understand the environment where GRB occur, these studies lack the understanding of molecular gas properties, which is the fuel of star formation. While molecular hydrogen has been detected in absorption in the spectra of GRB afterglows, the detected column density probes only one sight line in front of the GRB. In order to measure the gas content in host galaxies, lines need to be detected in emission.

We conducted CO observations toward 10 GRB hosts at z=0.1-2.5 by using Atacama Large Millimeter/submillimeter Array (ALMA). This is the first CO survey for GRB hosts, providing the largest sample with CO observations. The targets have been studied at multi-wavelengths, allowing us to compare their physical quantities (such as SFR, stellar mass, star formation efficiency, and gas consumption timescale) with other galaxy populations. We successfully detected CO emission in 7 GRB hosts (including two tentative detections), and triples the sample size of GRB hosts with CO detection. The molecular gas mass of the hosts ranges 10^8 - 1^11 Msun by assuming a Galactic CO-to-H2 conversion factor. We found that the hosts with CO detection at z=1-2 have a star-formation efficiency similar to normal star-forming galaxies at the redshifts. This is in contrast to the previous results, where GRB hosts at z < 1 show higher star-formation efficiency compared to local star-forming galaxies. The molecular gas mass fraction is also comparable to z~1-2 normal star-forming galaxies.
The similarity between the GRB hosts and normal star-forming galaxies at z~1-2 suggests that GRB occur in normal environments at the redshift range.