Two γ-Ray Bursts from Dusty Regions with Little Molecular Gas

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Long-duration gamma-ray bursts (GRBs) are thought to be associated with the explosions of massive stars. Because GRBs are bright enough to be observable in the cosmological distances, they are expected to be a new tool to scrutinize the obscure details of the distant Universe. Although multi-wavelength observations of GRB host galaxies have been conducted, the environment where GRBs occur is still unclear due to the lack of spatially-resolved observations of molecular gas and dust. Previous searches for CO in GRB host galaxies did not detect any emission [1,2,3,4]. Molecules have been detected as absorption in the spectra of GRB afterglows [5], but absorption lines probe the interstellar medium only along the line of sight, so it is not clear whether the molecular gas represents the general properties of the regions where the GRBs occur.

We conducted observations of the CO emission line and 1.2-mm continuum towards two GRB hosts (GRB 020819B at $z = 0.41$ and GRB 051022 at $z = 0.81$) using the Atacama Large Millimeter/submillimeter Array (ALMA). The CO emission line is clearly detected at the nuclear region of the GRB 020819B host and the GRB 051022 host (Figure 1). This is the first case for detecting spatially resolved molecular gas emission in GRB hosts [6]. The 1.2-mm continuum emission is also detected in both GRB hosts. The spatially resolved continuum map of the GRB 020819B host shows that the emission is significantly detected only at the GRB site.

We found that the spatial distributions of molecular gas and dust are clearly different in the GRB 020819B host. The ratio of molecular gas mass to dust mass at the GRB site is significantly lower than that of the nuclear region, indicating that the GRB occurred under particular circumstances within the host. The molecular gas-to-dust ratio at the GRB site is also lower than those of the Milky Way and nearby star-forming galaxies [7], suggesting that the star-forming environment where GRBs occur is different from those in local galaxies. The possible reasons for the deficit of molecular gas in the GRB site are that much of the dense gas has been dissipated by a strong interstellar UV radiation field, which is expected in regions with intense star formation. The lack of molecular gas in optical spectra of GRB afterglows has been reported [8] and a possible explanation is the dissociation of molecules by ambient UV radiation with 10–100 times the Galactic mean value from the star-forming regions [8,9].

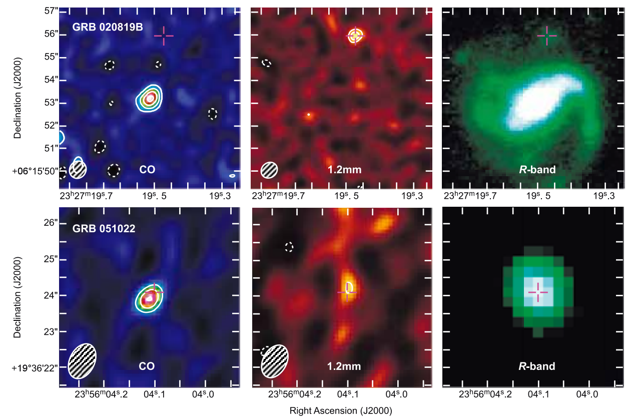

Figure 1: Velocity-integrated CO maps (left), 1.2-mm continuum maps (middle) obtained with ALMA, and optical *R*-band images (right) of the GRB 020819B host (top) and the GRB 051022 host (bottom). The magenta cross represents the position of radio afterglow. ALMA beam is shown at the bottom left. Original figure from [6].

References

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