

## Z108a Star-formation rates of two GRB host galaxies at $z \sim 2$ and a [C II] deficit observed with ALMA

T. Hashimoto (NTHU), B. Hatsukade (NAOJ), T. Goto, S. J. Kim (NTHU), K. Ohta (Kyoto U.), T. Nagao (Ehime U.), A. K. H. Kong (NTHU), K. Nakanishi (NAOJ), and J. Mao (Yunnan Obs.)

Event rate of long Gamma-Ray Bursts (GRBs) is expected to be an useful tracer of the cosmic star-formation history. For this purpose, it is necessary to understand what kind of galaxies are traced by GRBs. Here we report rest-frame far-infrared (FIR) continuum detections of GRB 070521 and 080207 host galaxies at  $z \sim 2$  with ALMA band 8 and 9. The FIR photometries provide the reliable star-formation rates (SFRs), because FIR emission is free from dust extinction and possible radio contamination from long-lived afterglows of GRBs. The spectral energy distribution fittings indicate  $49.85_{-2.86}^{+72.33}$  and  $123.4_{-21.78}^{+25.19} M_{\odot} \text{ yr}^{-1}$  for the 070521 and 080207 hosts, respectively. The derived SFRs place them on the “main sequence” of normal star-forming galaxies at  $z \sim 2$ . The derived SFRs are significantly lower than that of radio observations. It is inferred that the observed radio fluxes in a previous study are contaminated by the afterglows. ALMA marginally detected [C II]  $158 \mu\text{m}$  emission line from the GRB 080207 host galaxy with  $S/N \sim 4$ . This is the first detection of [C II]  $158 \mu\text{m}$  of a GRB host at  $z > 2$ , and the second detection among known GRBs. The luminosity ratio of [C II]  $158 \mu\text{m}$  to FIR is  $7.5 \times 10^{-4}$ , which is one of the smallest values among galaxies at  $z \sim 1 - 2$  with the same FIR luminosity. The “[C II] deficit” could be a new physical property to characterise GRB hosts at  $z \sim 1 - 2$ . Possible parameters controlling the deficit include the metallicity, initial mass function, and gas density.