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Observation and multi-wavelength modeling of GRB 190829A and GRB 201015A by the MAGIC telescopes

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Starting from the first unequivocal detection of very high energy (VHE) emission from the luminous gamma-ray burst (GRB) GRB 190114C by the MAGIC telescopes, five detections of VHE emission from GRBs by ground-based instruments were reported as of today. Such new energetic components have become a new probe to explore GRB physics. GRB 201015A was a long GRB detected by the Swift/BAT and we started fast follow-up observations of GRB 201015A with the MAGIC telescopes about 30 seconds after its onset under good observing conditions. Subsequent optical observations measured the redshift of the host galaxy as 0.42 and found the associated type Ic-BL supernova. The total isotropic equivalent energy of the prompt emission is then estimated to be the order of 10^{50} erg, which is approximately 3 orders of magnitude below GRB 190114C. In this sense, GRB 201015A may have similar properties to GRB 190829A whose VHE emission was detected by the H.E.S.S. telescopes. GRB 190829A was also observed by the MAGIC telescopes 30 hours after its onset under good observing conditions. The MAGIC data analysis of GRB 201015A and GRB 190829A confirms the strong hint of detection from both GRBs, and the marginal signal from GRB 201015A implies a significant energy release in the TeV range, comparable with that of the prompt emission in the keV-MeV band. In order to unravel the origin of the possible VHE emission, we modeled the multi-wavelength data of both GRBs with off-axis one-component jet model, taking into account the prompt emission energetics of the two GRBs. The off-axis one-component model well reproduces the observed multi-wavelength light curve of GRB 190829A, whereas it was difficult to reproduce the multi-wavelength light curve of GRB 201015A due to optical peak around 200 seconds after its onset. Therefore, we used the on-axis one-component model instead to model the multi-wavelength light curve of GRB 201015A, and successfully reproduced the early-time optical and x-ray light curve. However, if the gamma-ray signal of GRB 201015A is real, the inferred VHE flux of GRB 201015A is about one order of magnitude larger than the SSC flux calculated from modeling. Our modeling suggests that both GRBs have a jet with small opening angle of about 1 degree. In this presentation, we report these observational results and theoretical interpretation of GRB 190829A and GRB 201015A.

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