Fermi-LAT study of two gamma-ray binaries, HESS J0632+057 and AGL J2241+4454

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GeV gamma-ray emission from two gamma-ray binary candidates, HESS J0632+057 and AGL J2241+4454, which were recently reported by H.E.S.S. and AGILE, respectively, have been searched for using the Fermi-LAT archival dataset. Spatial and temporal distribution of gamma-ray events are studied, but there was no evidence for GeV gamma-ray signal from either sources.

1. INTRODUCTION

X-ray binaries are rather common Galactic X-ray objects and about 300 sources are catalogued. Recently several objects have been reported to emit gamma-rays of GeV and/or TeV energies which are modulated in their orbital periods, and a new category of gamma-ray binaries is emerging ([Mirabel] 2012), but their emission mechanism is not understood well. It is clear that we need more observations and samples for the detailed study of their nature.

In this study, gamma-ray emissions from HESS J0632+057, for which 321-day period has been found recently, and AGL J2241+4454, which could be identified with a Be star binary with 60-day period, have been searched for using the Fermi-LAT data in the GeV energy range.

2. HESS J0632+057

This object was found as a TeV point source by H.E.S.S. in the Monoceros SNR/Rosetta Nebula region ([Aharonian et al.] 2009). It coincides with a massive star MWC148/XMMU J063259.3+054801 (d ∼ 1.5 kpc) which is variable on hour timescales, and is suspected to be a binary system ([Hinton et al.] 2009). Then, 321 ± 5 day period was found in the XMMU source ([Bongiorno et al.] 2011). TeV follow-up observations for 6 years have revealed that gamma-ray fluxes are modulated at this period ([Maier et al.] 2011, [Aleksic et al.] 2012) (see Fig. 1). However, this object is not listed in the Second Fermi-LAT catalog ([Nolan et al.] 2012).

We analyzed LAT gamma-ray data above 200 MeV for 3.5 years using the Fermi Science Tools (version v9r27p1) with P7SOURCE_V6 response function. The resulting skymap is shown in Fig. 2. The likelihood analysis yielded no significant signal, and we found no evidence for gamma-ray emission. We obtained an upper limit of 1.0 × 10⁻⁸ cm⁻² s⁻¹ (90% C.L.) for 1-year data (3.5 year-data is under analysis). The spectral energy distribution is shown in Fig. 3 with radio and X-ray data ([Skilton et al.] 2009) where the GeV limit is very close to model expectations assuming inverse Compton emission (solid: $E^{-2.0}$ electron injection with $E_{min} = 1$ GeV, dashed: $E^{-1.9}$ / 1 GeV, dotted: $E^{-2.0}$ / 2 GeV).

Orbital modulation of GeV gamma-ray emission has been investigated assuming the 321 day period. We could not find any significant phase bins, and Fig. 4 shows the upper-limit light curve.
3. AGL J2241+4454

AGILE reported the discovery of this object for a short period (2010-07-25/26) with a flux of \(1.5 \times 10^{-6} \text{cm}^{-2}\text{s}^{-1}\) above 100 MeV (Lucarelli et al. [2010]). However, Fermi-LAT observations could not confirm this detection and set an upper limit of \(1.0 \times 10^{-7} \text{cm}^{-2}\text{s}^{-1}\) (95% C.L.) above 100 MeV (FermiSky blog [2012]). It could be identified as a Be star HD 215227 (MWC 656) showing an orbital period of 60.37 ± 0.04 days (Williams et al. [2010]).

We analyzed LAT gamma-ray data above 100 MeV using the Fermi Science Tools as in the previous section. The resulting skymap is shown in Fig.5 (2010-07-25/26) and Fig. 6 (3.5 years). We found no evidence for gamma-ray emission and obtained upper limits of \(7.2 \times 10^{-8} \text{cm}^{-2}\text{s}^{-1}\) and \(9.4 \times 10^{-10} \text{cm}^{-2}\text{s}^{-1}\) (90% C.L.) for the two-day data and 3.5-year data, respectively.

Orbital modulation of GeV gamma-ray emission has been investigated assuming the 60.37 day period. We could not find any significant phase bins, and Fig. 7 shows the upper-limit light curve.
4. SUMMARY

We have searched for GeV gamma-ray emission from HESS J0632+057 and AGL J2241+4454 using the Fermi-LAT data. No significant signal was found from either objects and long-term and orbital-phase-resolved upper limits have been set on gamma-ray fluxes which set restriction on their high-energy activities.

Acknowledgments

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