XMM-Newton Observations of the Dark Accelerator MGRO J1908+06

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Abstract

MGRO J1908+06 is one of the brightest TeV gamma-ray sources in the Galactic disk. It was originally discovered with Milagro and later confirmed with H.E.S.S. and VERITAS as an extended TeV source. A nearby GeV gamma-ray pulsar, PSR J1907+06, was recently discovered with the Fermi LAT suggesting that MGRO J1908+06 is an asymmetric pulsar wind nebula. While counterparts to the pulsar have been found at X-ray and radio wavelengths, no emission other than TeV gamma rays has so far been detected from MGRO J1908+06. The pulsar wind nebula appears to have an extremely low X-ray to TeV gamma-ray flux ratio. We have obtained XMM-Newton data for the region near MGRO J1908+06 and present the results of our search for extended X-ray emission from the pulsar wind nebula.

Introduction

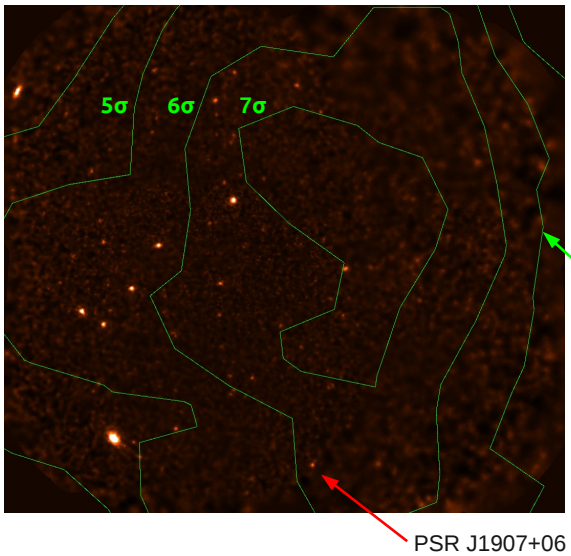
MGRO J1908+06 belongs to a small group of "Dark Accelerators", objects capable of accelerating particles to TeV energies, yet not visible at X-ray, optical, or radio wavelengths. It was detected with Milagro, H.E.S.S., and VERITAS as an extended TeV source with a radius of ~0.3° (Aharonian et al. 2009, A&A 499, 723). The source is very bright in TeV gamma rays with a flux of about 20% that of the Crab nebula. The presence of a nearby gamma-ray pulsar, PSR J1907+06 , recently discovered with *Fermi*, suggests that the TeV source is a pulsar wind nebula (Abdo et al. 2010, ApJ 711, 64). It is currently not known why MGRO J1908+06 is very bright in TeV gamma rays, yet extremely faint at other wavelengths. We have obtained XMM-Newton data from the deepest X-ray observations of MGRO J1908+06 to date in order to search for extended X-ray emission.

XMM-Newton Data

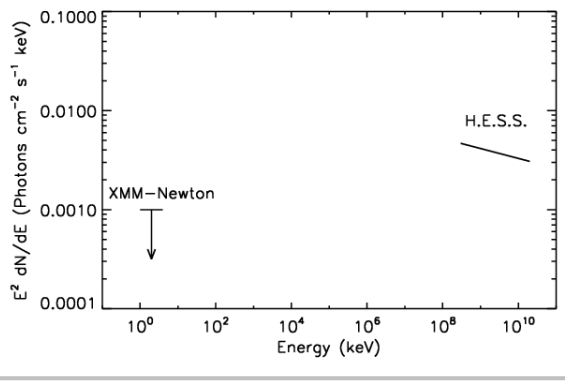
MGRO J1908+06 was observed with XMM-Newton in four separate exposures arranged in a mosaic to cover a field 0.75° across. The exposure times ranged from 7 to 17 ks. We analyzed the data with the Extended Source Analysis Software (ESAS) to subtract the instrumental backgrounds. We then combined the data from the four exposures and extracted images and spectra.

X-ray Image

Shown below is an X-ray image of the combined MOS and PN data from the four exposures. The image is 0.75° across and has been adaptively smoothed and background subtracted. The contours show a significance map of the TeV gamma-ray emission detected with H.E.S.S. (de Oña Wilhelmi et al. 2008, AIP Conf. Proc. 1085, 273). No extended X-ray emission is apparent in the image. The gamma-ray pulsar PSR J1907+06 is detected as a faint X-ray source.

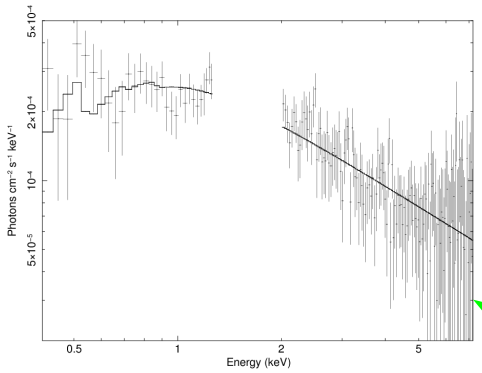


X-ray to TeV Spectrum of MGRO J1908+06

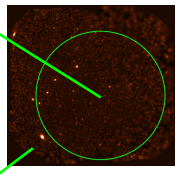


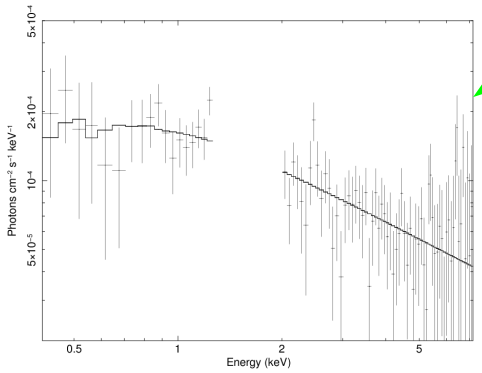
X-ray Spectrum

We extracted an X-ray spectrum of a circular region with a radius of 0.3° centered on the TeV source. For comparison, we also extracted a spectrum of the available EPIC data outside the circular region. Both spectra were fitted with an absorbed power-law model. The spectra show a significant excess of X-ray emission over the instrumental background. The spectral shape indicates that this excess is likely of astronomical origin and not due to additional instrumental background from soft protons. However, the two spectra do not show a significant difference in their flux level which would be expected if the X-ray emission correlates spatially with the TeV emission. Also, the neutral hydrogen column density obtained from the spectral fit is significantly lower than that previously found for PSR J1907+06. This suggests that the observed X-ray emission could be diffuse Galactic emission not associated with MGRO J1908+06.



N_H (10^{21} cm^{-2})	1.3 ± 0.6
Photon Index	0.9 ± 0.2
Flux 0.4–7.2 keV (10^{-12} ergs cm^{-2} s^{-1})	3.8 ± 0.3





N_H (10^{21} cm^{-2})	0.9 ± 0.8
Photon Index	0.8 ± 0.2
Flux 0.4–7.2 keV (10^{-12} ergs cm^{-2} s^{-1})	2.6 ± 0.3

Conclusion

We have analyzed XMM-Newton data of the bright, extended TeV gamma-ray source MGRO J1908+06 and detect diffuse X-ray emission from the vicinity of the source. It is however not yet clear whether this emission is associated with the gamma-ray source or diffuse Galactic X-ray emission. Further analysis will determine whether the X-ray emission originates from MGRO J1908+06 and provide X-ray flux estimates or upper limits. Our measurements will provide constraints on the synchrotron emission from MGRO J1908+06 and thus on the processes of particle acceleration.