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Radio/X-ray Monitoring of Two Gamma-ray Binaries: 1FGL J1018.6-5856 and LMC P3

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Context. Gamma-ray binaries are a rare subclass of high-mass binary systems composed of a compact object (either a neutron star or a black hole) and an O- or B-type stellar companion. These systems exhibit broadband non-thermal emission that peaks in the gamma-ray regime and serve as ideal laboratories for studying relativistic particle acceleration, wind–wind interactions, and extreme radiative environments.

Aims. This study investigates the gamma-ray binaries 1FGL J1018.6-5856 and LMC P3, discovered in 2011 and 2016 respectively. Using phase-resolved 2019 MeerKAT L-band radio observations alongside archival Swift-XRT X-ray data, we aim to:
i Perform a comprehensive radio analysis of both systems, and
ii Conduct a radio/X-ray cross-correlation analysis to explore the physical connection between these emissions and constrain the dominant emission mechanisms

Results. Both 1FGL J1018.6-5856 and LMC P3 appear as compact, unresolved sources in MeerKAT L-band continuum images, each exhibiting clear sinusoidal modulation on its orbital period. In 1FGL J1018.6-5856, a persistent, low-surface-brightness extension is visible to the southeast of the compact core, however deeper analysis is needed to confirm its association with the binary system.

Their in-band spectral indices confirm a non-thermal synchrotron radio emission origin. Notably, both systems display a strong flatter-when-brighter trend, where the spectral index α flattens at radio maxima and steepens at minima, supporting shock-acceleration and cooling scenarios common in relativistic wind interactions.

Discrete correlation functions between radio and X-ray emission reveals a significant coherence in both binaries. X-ray variations lead the radio by ~ 1 day in 1FGL J1018.6-5856 and by ~ 4 days in LMC P3, along their respective 16.5507-day and 10.301-day orbits. These lags align with a synchrotron-cooling model in which energetic electrons radiate X-rays near the shock interface before cooling and emitting at radio frequencies downstream.

Conclusions. The timing, spectral, and cross-correlation signatures consistently point to a collision- powered scenario, where particles are accelerated in the wind-wind interaction zone. The results therefore provide further indirect evidence that the compact companions in both 1FGL J1018.6-5856 and LMC P3 are neutron stars.

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