

Optical Spectroscopic Observations of Gamma-ray Blazar Candidates

A significant fraction of all γ -ray sources detected by the Large Area Telescope aboard the Fermi satellite still lacks a low-energy counterpart. In addition, there is still a large population of γ -ray sources with associated low-energy counterparts that lack firm classifications. Therefore, in the last ten years, we have undertaken an optical spectroscopic campaign to address the problem of unassociated or unidentified γ -ray sources (UGSs), mainly devoted to observing blazars and blazar candidates because they are the largest population of γ -ray sources associated to date.

Blazars represent about 62% of the sources in the γ -ray Fermi-LAT catalog and about 80% of the γ -ray sources associated with a lower-energy counterpart, dominating the γ -ray sky. In particular, about 42% of the Fermi-LAT γ -ray blazars are classified as Blazars Candidates of Uncertain type (BCUs), for which spectroscopic observations are mandatory to confirm their blazar nature. Here we report our recent spectroscopic observations and the state-of-art of our follow-up optical spectroscopic campaign aimed at identifying the nature of blazar candidates, confirming the classification of known blazars, and determining their redshift.

Our last sample of spectroscopic observations includes 62 sources classified in the Fermi-LAT catalog as BCUs, one source classified as a generic active galactic nucleus, and one source classified as a BL Lac in Fermi-LAT and as a blazar of uncertain type in the Roma-BZCAT catalog. We confirmed the blazar nature of all BCUs. We classified 33 of them as BL Lacs, 11 as Flat Spectrum Radio Quasars, and 18 as blazars with nonnegligible host-galaxy emission. We also classified the generic active galactic nucleus as a BL Lac. Finally, we confirmed the classification of the BL Lac. We also reported a lower limit redshift for 43 sources. For 20 sources, we got redshift measurements consistent with the literature values. For the other 21 sources, we obtained their first spectroscopic redshift measurement, while, for two sources, we provided lower limits on the redshift.

Including the sources studied in the present analysis, we either observed or analyzed archival spectra of 435 blazar and blazar candidates during the last nine years, including 129 blazars already included in the fifth edition Roma-BZCAT without precise classification or redshift estimate. We classified 337 sources as BZBs, 47 as BZGs, and 51 as BZQs. We also provided redshift estimates or lower limits for 82 BZBs previously without redshift.

From the results of our campaign, we confirm: that BL Lacs are the most elusive class of extragalactic γ -ray sources and the reliability of mid-IR color-based methods in selecting blazar-like candidate counterparts of unassociated or unidentified γ -ray sources. Our observational campaign is still ongoing, with observations recently acquired and more scheduled for this year.

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