

# Observations and study of Hyper-Luminous Gamma-Ray Burst GRB 221009A at the Kyiv comet station

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GRB 221009A - hyper-luminous, long-duration gamma-ray burst (GRB) detected by Neil Gehrels Swift Observatory on October 9, 2022 and classified as the brightest GRB ever detected. In this work, we are presenting the results of our observations and photometric analysis of GRB221009A at the Kyiv comet station, as a part of international GRANDMA network (Global Rapid Advanced Network Devoted to the Multi-messenger ad-dicts). Additionally, our study includes calculations of physical parameters and analysing the possibility of supernova association with this gamma-ray burst.

We observed the optical afterglow of GRB221009A on AZT-8 with Moravian-C4 16000 CCD camera, in Johnson-Cousins R and I filters. For photometric reduction of our data we used and investigated methods of transient object photometry in the following software: MaxIm DL, STDpipe (simple transient detection pipeline) and Astrometrica, using Pan-STARRS1, Gaia DR2 and USNO-B1 catalogs. Our first observation was obtained on 2022-10-10: 1.223 days after the trigger of Gamma-Ray Burst Monitor and the Large Area Telescope of the Fermi observatory. We continued observations the next five days, overall we obtained 371 images in R filter and 165 images in I filter with 30s or 60s exposure. In GRANDMA database we uploaded stacked images: 14 in R and 2 in I filters, with exposure from 300s to 6660s, for better object visibility. During this time, the brightness decreased from  $18.31^m$  to  $20.48^m$  in the R filter and from  $18.14^m$  to  $20.13^m$  in the I filter. The photometric error varies from  $0.03^m$  to  $0.46^m$  (R filter) and from  $0.01^m$  to  $0.98^m$  (I filter). It was found experimentally that for the photometric system on the Kyiv Comet Station it is optimal to use comparison stars  $1^m$  brighter than the object, relative to the largest magnitude during photometry in MaxIm DL. Additionally, it was calculated that the absorption of galactic dust for GRB221009A in the SF11 system is:  $A_v = 4.1034^m$ , and for the SFD system:  $A_v = 4.7714^m$ .

Based on peak energy value:  $E_p = 1060$  keV, reported by GCN CIRCULAR 32668 and our results of photometry, we calculated physical parameters of GRB 221009A:  $M$ ,  $L$ ,  $E_p$ ,  $z$ ,  $E_{\gamma, iso}$ ,  $tb$ ,  $z$ ,  $\Delta\Omega$ ,  $fb$ ,  $E_{\gamma}$ ,  $L_{\gamma, p, iso}$ ,  $\theta_j$  and  $\Gamma$ . We have obtained the value of isotropic bolometric peak luminosity  $L_{\gamma, p, iso} = 3.97 \cdot 10^{53}$  (erg  $s^{-1}$ ) and isotropic bolometric emission energy  $E_{\gamma, iso} = 1.84 \cdot 10^{54}$  (erg), which place it among the most luminous gamma-ray bursts ever detected, more probably makes GRB221009A the most luminous GRB ever detected.

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