X-ray Plateaus in Gamma-Ray Burst Afterglows and Their Application in Cosmology

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For gamma-ray bursts (GRBs) with a plateau phase in the X-ray afterglow, a so-called L-T-E correlation has been found which tightly connects the isotropic energy of the prompt GRB (E_{γ,iso}) with the end time of the X-ray plateau (T_a) and the corresponding X-ray luminosity at the end time (L_X). Here we show that there is a clear redshift evolution in the correlation. Furthermore, since the power-law indices of L_X and E_{γ,iso} in the correlation function are almost identical, the L-T-E correlation is insensitive to cosmological parameters and cannot be used as a satisfactory standard candle. On the other hand, based on a sample including 121 long GRBs, we establish a new three parameter correlation that connects L_X, T_a and the spectral peak energy E_p, i.e. the L-T-Ep correlation. This correlation strongly supports the so-called Combo-relation established by Izzo et al. (2015). After correcting for the redshift evolution, we show that the de-evolved L-T-Ep correlation can be used as a standard candle. By using this correlation alone, we are able to constrain the cosmological parameters as \( \Omega_m = 0.389^{+0.202}_{-0.141} \) (1\sigma) for the flat ΛCDM model, or \( \Omega_m = 0.369^{+0.217}_{-0.191}, w = -0.966^{+0.513}_{-0.678} \) (1\sigma) for the flat wCDM model. Combining with other cosmological probes, more accurate constraints on the cosmology models are presented.