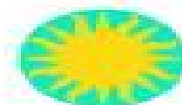




Towards a More Standardized Candle Using GRB Energetics & Spectra



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Abstract

The use of γ -ray bursts (GRBs) energetics for cosmography has long been advanced as a means to probe to redshifts beyond those possible with Type Ia SNe, to the epoch of deceleration. However, though relatively immune to systematic effects of dust extinction, the prompt energy release in GRBs, even when corrected for jetting geometry, is far from being a standard candle. Recently, two groups (Dai et al. and Ghislanda et al.) have claimed that by using the newly discovered relation between the apparent geometry-corrected energies (E_γ) and the peak in the rest frame prompt burst spectrum (E_p), GRBs now provide meaningful constraints on Ω_b , Ω_Λ and the quintessence parameter w . In presenting the first self-consistent formalism for correcting GRB energies with a thorough accounting for observational uncertainties, we demonstrate that the **current sample of 18 GRBs is simply inadequate for cosmography** when compared to results from Type Ia supernovae, large-scale structure, and the microwave background. **The proper use of the relation clearly brings GRBs an impressive step closer toward a standardizable candle**, but until the physical origin of the E_p - E_γ relation is understood, additional corrections are discovered, and a larger and homogeneous determination of prompt-burst and afterglow observables exists (e.g., from *Swift*), bold claims about the utility of GRBs for cosmography will have to wait.

The E_p - E_γ relation

Although the E_p - E_γ relation is a highly significant correlation (Spearman $\rho = 0.88$, null probability $= 1.1 \times 10^{-10}$), **the relation itself is not well fit by a power law** [$E_\gamma = \alpha(E_p/10^{51} \text{erg})^\beta$] across a range of cosmologies, with a reduced $\chi^2_r = 3.22$ (16 dof) in the standard cosmology ($\Omega_b, \Omega_\Lambda, h_0 = (0.3, 0.7, 1)$) and a minimum $\chi^2_r = 3.20$. The correlation, however, does provide a simple empirical correction to help standardize GRB energetics.



The (weak) cosmological dependence of the E_p - E_γ relation. The best-fit power-law relation for a representative set of cosmologies are shown as a series of lines. Only the data for a standard cosmology of $(\Omega_b, \Omega_\Lambda, h_0) = (0.3, 0.7, 1)$ is shown for clarity with upper/lower limits indicated with arrows. **Notable outliers** are indicated with a large square surrounding the data points. The best fit values of the slope (η) and normalization (κ) are shown inset. Note that the data for a standard cosmology (with best fit $\eta = 0.70 \pm 0.07$) essentially brackets the fits across all cosmologies, excepting only the extreme cosmologies with $\Omega_b = 0$ and $\Omega_\Lambda = 1$.

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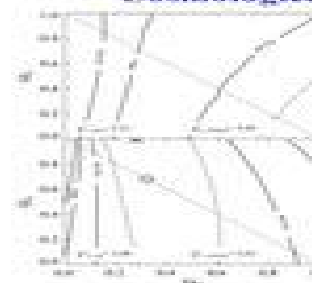
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The GRB Hubble Diagram



Are GRBs really useful for cosmology? Shown is the improvement of GRB Hubble diagrams for $(\Omega_b, \Omega_\Lambda, h_0) = (0.3, 0.7, 1)$. From top to bottom there is a continual reduction in scatter after applying corrections to the energetics (i.e. different standard candle assumptions). E_{iso} is the isotropic equivalent prompt γ -ray energy release, $E_\gamma = E_{iso}fb$ is the geometry-corrected energy where $fb = 1 - \cos(\theta)$ is the beaming fraction, and $E_{\gamma,cor} = E_\gamma(\alpha/E_p)^{1/\eta}$ is a further correction, making use the E_p - E_γ relation. **Future empirical correlations, perhaps to be found in *Swift* data, will be necessary for GRB standard candles to be competitive with Type Ia SNe as cosmological distance indicators.**

Cosmological Parameter Determination



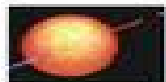
χ^2 contours for the GRB Hubble diagram constructed using the corrected energy $E_{\gamma,cor}$. Top panel includes errors on correlation slope η and intercept κ . Bottom panel assumes fit parameters are known *a priori*. Although the fits are marginally acceptable (minimum $\chi^2_r = 2.2$, [top]), **the shape in the χ^2 surface and hence the best fit values and uncertainties for Ω_b and Ω_Λ are dominated by outliers in the E_p - E_γ relation, and thus not yet meaningful.**

Conclusion

Although cautious optimism is warranted with the addition of an order of magnitude more data, and possible new empirical corrections to GRB energetics in the *Swift* era, **GRBs are currently not useful for cosmography.**

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www.cosmicbooms.net: A Clearinghouse for GRB and Afterglow Observables and Energetics. Here you will find a compilation of observables (jet break time, density, fluence, etc.) useful in determining GRB energies, constraining the Ghislanda and Amati relations, and beyond. All of the data contained herein are public.



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recap buffy the vampire slayer s2e4 inca mummy girl - May 14 2023

web back at buffy s ampata s trunk has arrived from the bus depot and as buffy starts to open it the fake ampata tells her not to bother she distracts buffy by talking more about the inca mummy s ceremonial seal the camera briefly shows that inside the trunk is the mummified corpse of the real ampata

inca mummy girl buffyverse wiki fandom - Aug 17 2023

web sci fi inca mummy girl is the fourth episode of the second season of buffy the vampire slayer and the sixteenth episode in the series written by matt kiene with joe reinkemeyer and directed by ellen s pressman it was originally broadcast on october 6 1997 on the wb network mummy may i buffy

[inca mummy girl novel buffyverse wiki fandom](#) - Jun 03 2022

web inca mummy girl is a buffy the vampire slayer novel and english language teaching reader it was written by jacquie bloese based on screenplay by matt kiene and joe reinkemeyer it was originally published on september 19 2005 by scholastic contents 1 synopsis 2 behind the scenes 2 1 production 2 2 other 3 references synopsis

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web oct 31 2017 a mummy rises from the grave to suck the life out of sunnydale high students on buffy the vampire slayer season 2 episode 4 join us in rewatching inca mummy girl

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web jul 10 2008 in the earlier episode willow is very excited about her outfit a puffy eskimo suit that covers her body from head to toe in halloween she resists buffy s suggestion that she dress up as a

buffy the vampire slayer inca mummy girl tv episode 1997 imdb - Apr 13 2023

web during a field trip to the local museum s inca exhibition weirdo student rodney munson breaks the ceramic plate which seals the protective curse in the coffin of an incan mummy who rises giving him a kiss which instantly mummifies him and gives her back life

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web oct 1 2020 an incan princess mummy is reanimated in sunnydale where she sucks the life force from others in order to stay alive we are watching via the original releas

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web at the bus station ampata is attacked by the mummy that escaped and by the time buffy xander and willow get there there s a girl waiting for them who is claiming she s ampata

mummy buffyverse wiki fandom - Jul 16 2023

web sci fi mummy was a preserved corpse that could be reanimated into an undead being in the 15th the inca princess was sacrificed and mummified with a cursed seal that made sure that she would not awake she eventually became part of the inca princess exhibit touring places like boston atlanta new