# Very Early Optical Observations of GRBs 110530A and 140629A

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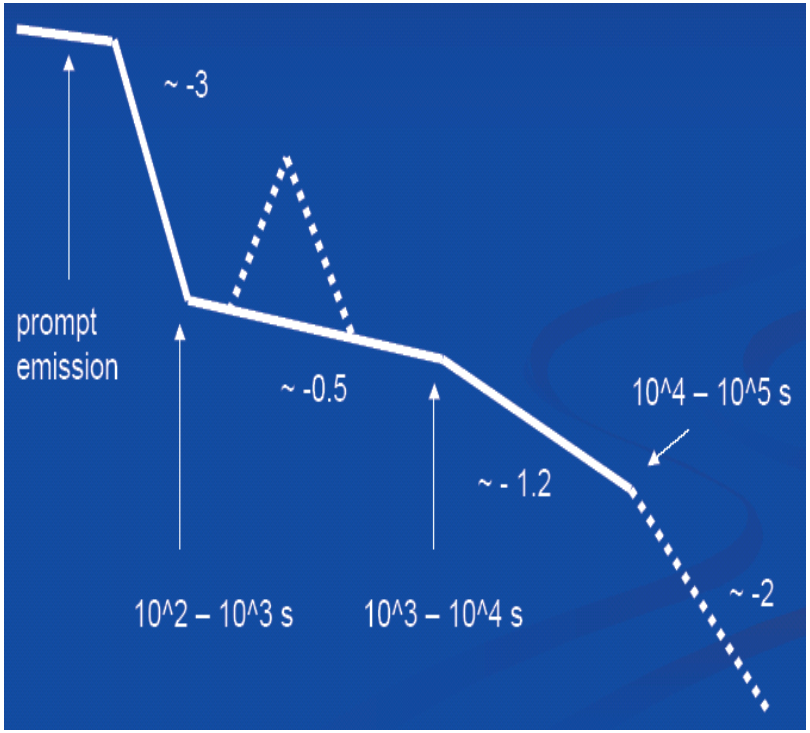
# Outline

- Introduction
- Very Early Optical Observations of GRB 110530A
- Very Early Optical Observations of GRB 140629A
- Conclusions

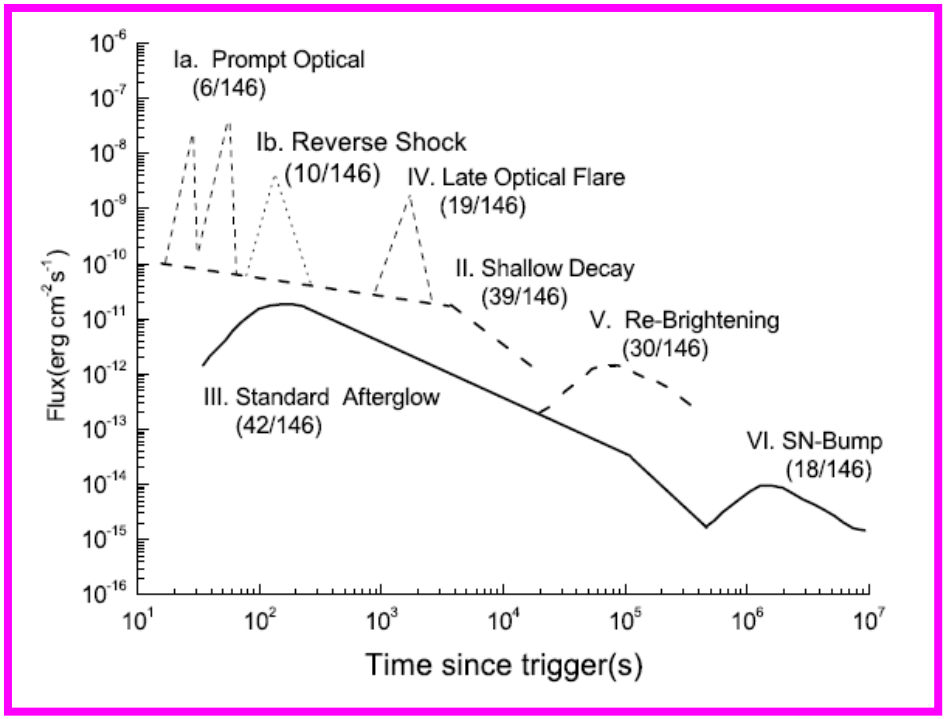
# Afterglows and Their Interpretations (XRT & Optical)

## X-ray afterglows




Zhang et al. 2006

## Optical afterglows

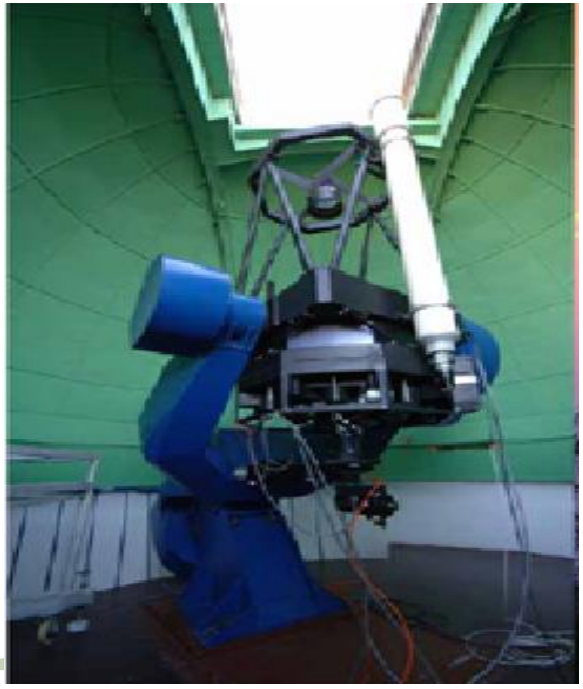



Li et al. 2012

# 0.8m TNT and 2.16m Telescopes at Xinglong Observatory

**Really appreciate the support of Tsinghua University and National Astronomical Observatory!**

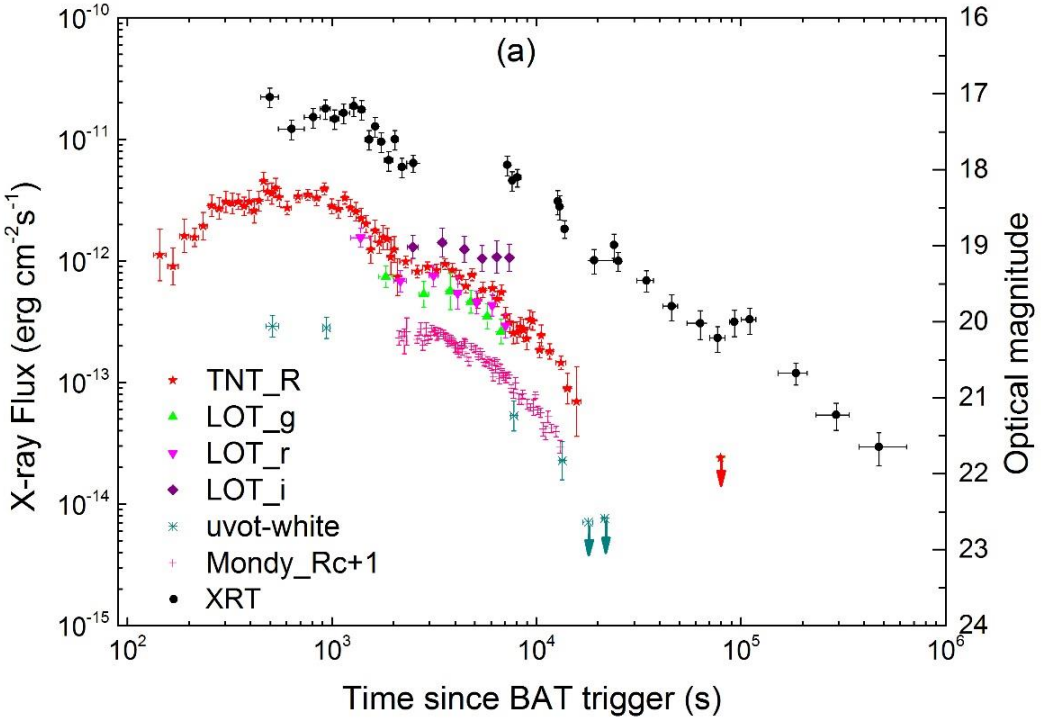
| | |
|---|---|
| **Aperture:** | **0.8-m** |
| **Focal Ratio:** | **f/10** |
| **Rotational Speed:** | **2 deg/sec** |
| **CCD:** | **PI 1300** |
| **Pixels:** | **1340*1300** |
| **FOV:** | **11.4' * 11.1'** |
| **Filter:** | **UBVRI** |

# The Observations of GRB 110530A

**Swift-BAT:**

- **T90: 19.6 sec**
- **Fluence: 3.3e-7 erg/cm^2**
- **Redshift z<2.7 (GCN 12054)**
- **Assuming z=1**




**Consistency:**

**X-ray**
**R band**
**Other Optical Bands**

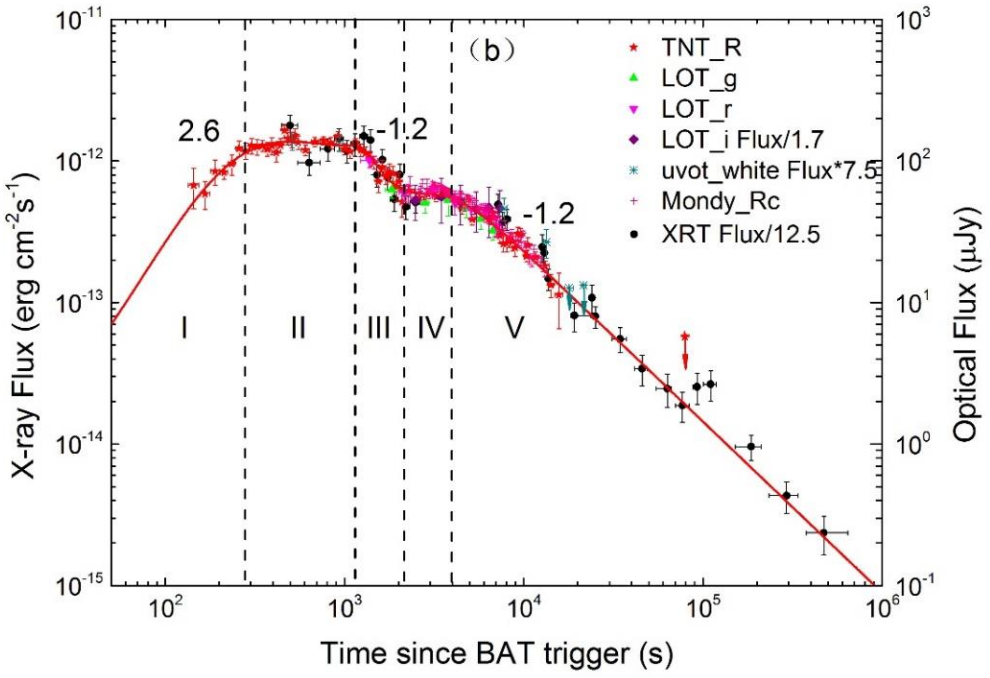
**Same Emission Component**

# Empirical Analysis of GRB 110530A

**Plateau I : 275s~1.3ks**
**Plateau II : 2~4ks**

$$F = F_0 \left[ \left( \frac{t}{t_b} \right)^{\omega\alpha_1} + \left( \frac{t}{t_b} \right)^{\omega\alpha_2} \right]^{1/\omega}$$

**An early rise-plateau-decay-second hump-decay phase is unique, compared with the previous reports such as GRBs 071025, 091024, 110213A, 141221A.**



# Physical Implications of GRB 110530A

>**External Forward Shock+**
**Delayed Energy Injection**
**(Geng et al. 2013 ).**

>**Parameter Results:**

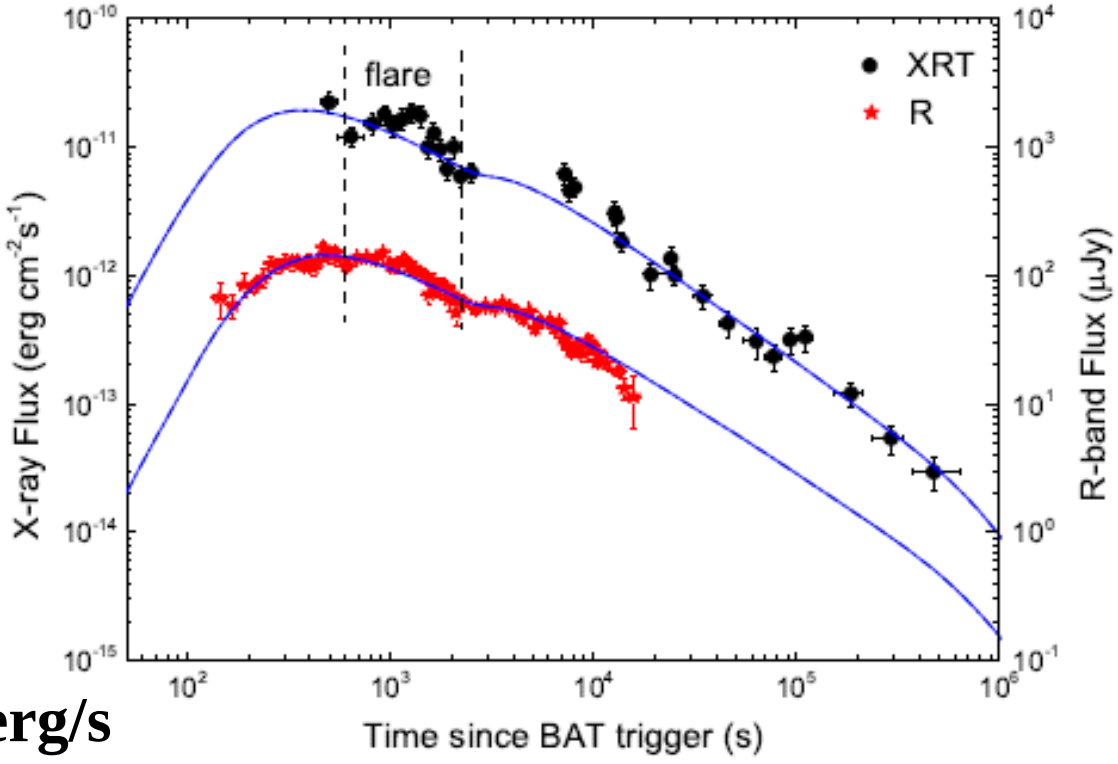
$\Gamma_0$=91

$\varepsilon_e$=0.086

$\varepsilon_B$=1.64e-6

n=13.3 $cm^{-3}$

$E_{K,iso}$=2.28e53 erg




Injection: $t_s$=2390s

$t_e$=3000s, $L_0$=4.0e50 erg/s

q=-0.18 for $L = L_0 t^{-q}$

Energy Injection ~ 3.39e52 erg

# Baryonic or Magnetized Jet of GRB 110530A?

## Jet for prompt emission

$\eta_\gamma = E_{\gamma,iso}/(E_{K,iso} + E_{\gamma,iso})$

**Excluding injection:**

$\eta_\gamma \sim 0.83\%$

**Including injection:**

$\eta_\gamma \sim 0.73\%$

**The outflow for the prompt emission could be baryonic**

## Jet for afterglow

$B = 0.165\ Gs$

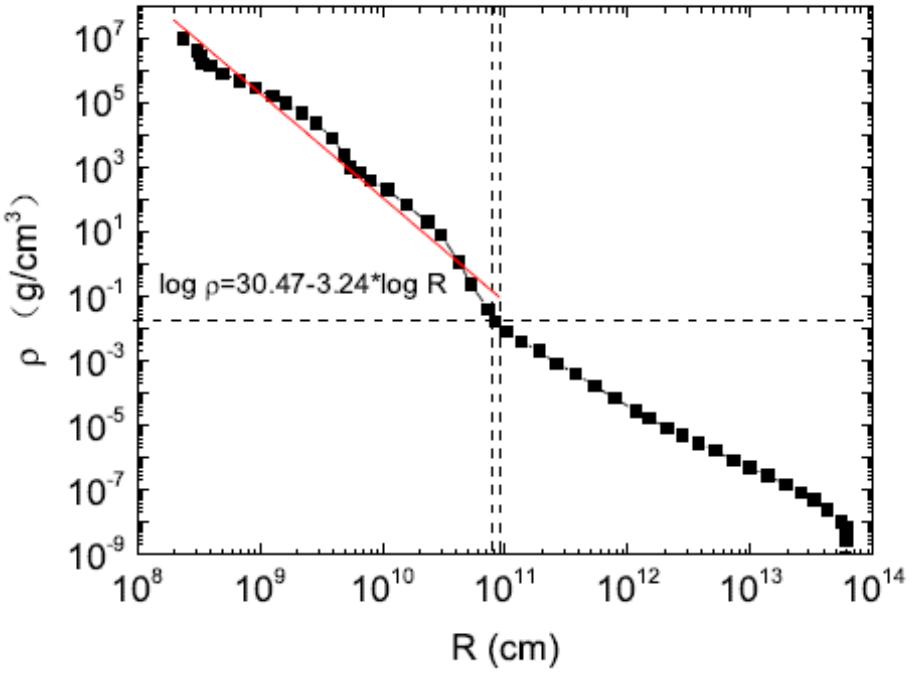
$\sigma = P_B/L_K < 0.04$

**The magnetization of the afterglow jet is σ <0.04, suggesting that the afterglow jet is also baryonic.**

# Possible Sources of the Delayed Energy Injection

## Fall-back Accretion for 110530A

$$R_{fb} \sim 6.85 \times 10^{10} cm (M_{BH}/3M_{\odot})^{1/3} (t_{fb}/10^{3}s)^{2/3}$$



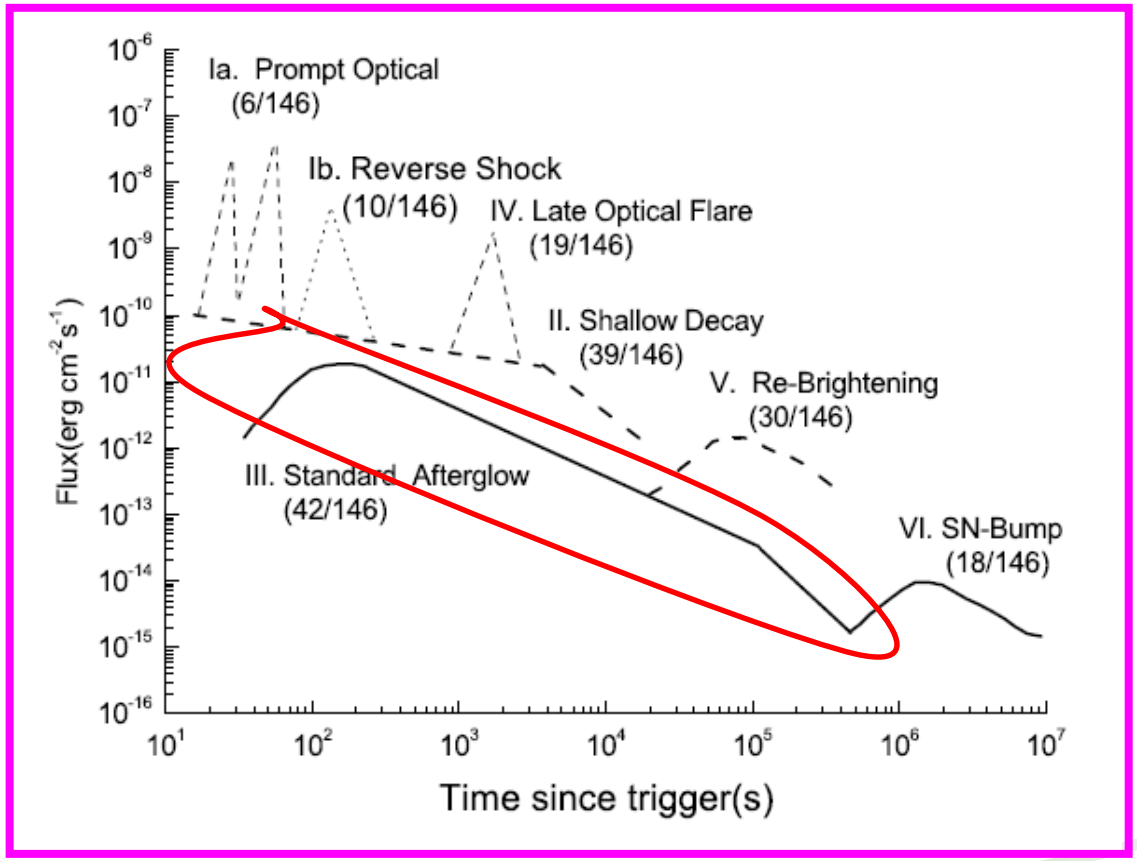

**Assuming $M_{BH} = 3M_{\odot}$**

**The total collapsed /fall-back mass ($7.5M_{\odot}$) is about a fraction of 30% of the progenitor star ($25M_{\odot}$).**

Woosley & Weaver (1995)

# Afterglows and Their Interpretations (the Optical)---The Next Case

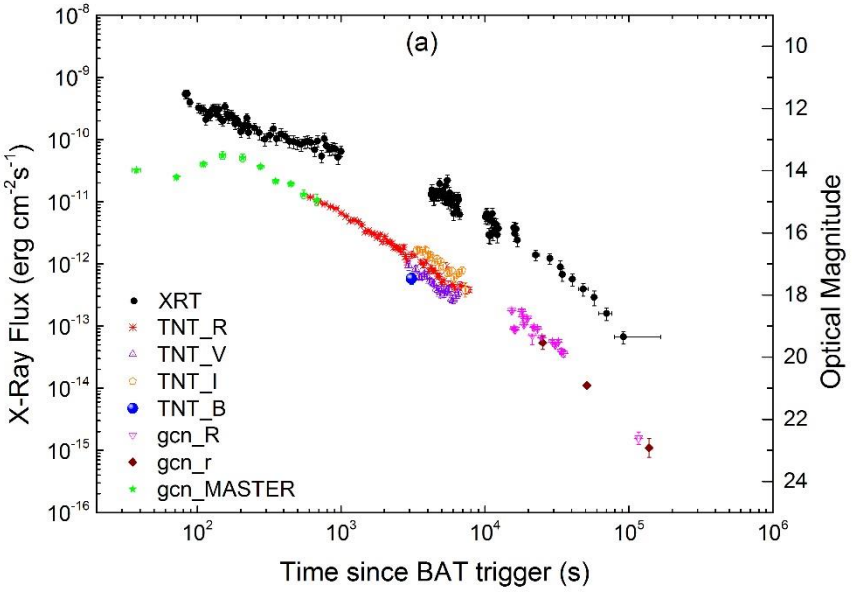
## Optical afterglows

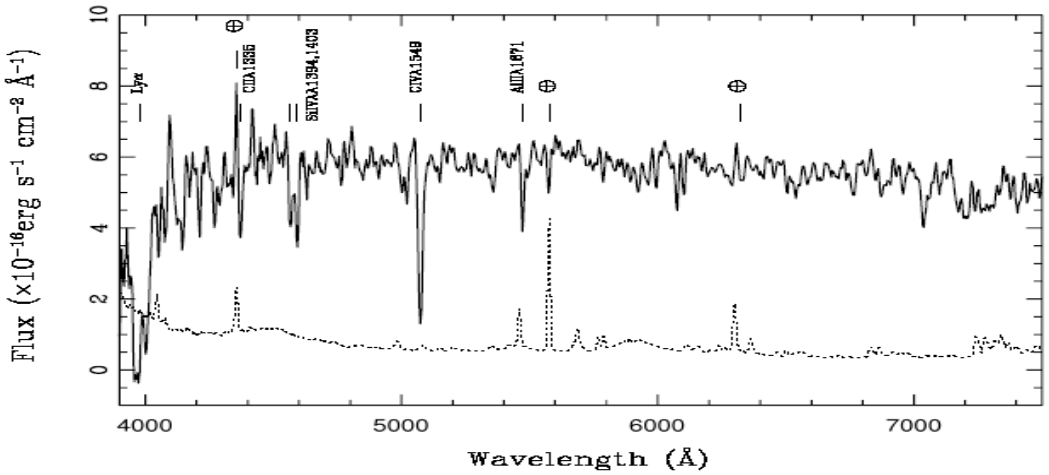



Li et al. 2012

# The Redshift Measure and Afterglow Observations of GRB 140629A

1. **Multi-band light curves by TNT@~600s---2.15h after the burst**
2. **Early optical afterglow spec by 2.16m@1h, get the redshift of z=2.275+/-0.003**
3. **Later host research by NOT@20141014, down to the limit of about R~24 mag**



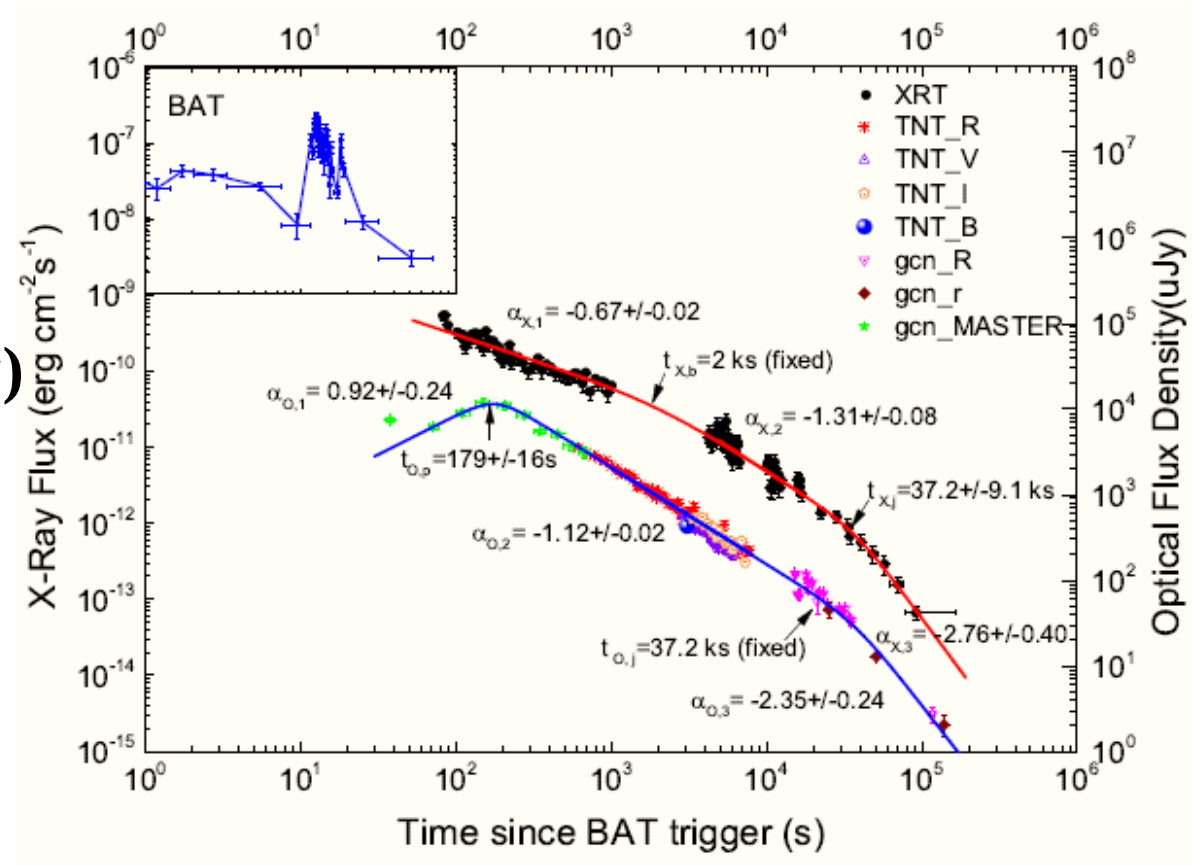



# Empirical Analysis of GRB 140629A

**BAT: -8~+90 sec, peaking at +12 s**

**XRT:**
**Shallow-Normal**
**-Jet Break**
**($t_{X,j} = 37.2 \pm 9.1\ ks$)**

**Optical:**
**Early Onset**
**-Normal Decay**
**-Jet Break**
**($t_{O,b} = 179\ s$ )**



# Physical Implications of GRB 140629A

**Model Parameters :**

$\Gamma_0 = 315^{+44}_{-34}$

$\varepsilon_e$=(1.2±0.1)e-2

$\varepsilon_B$=(1.0±0.1)e-6

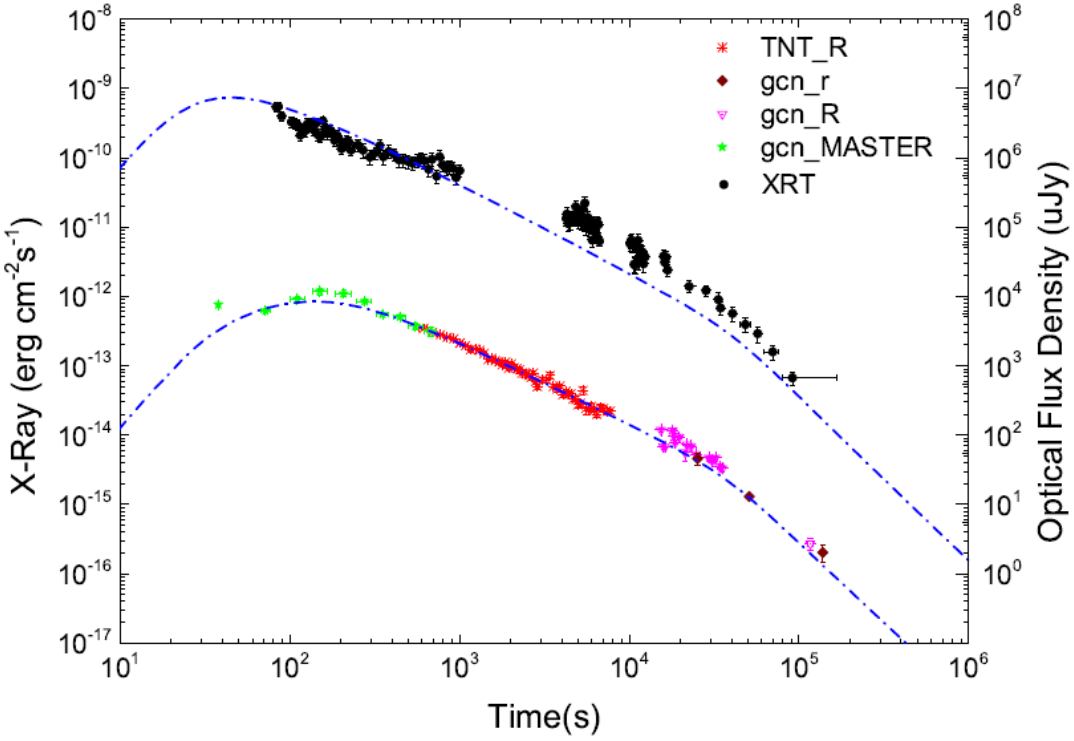
n=60±9 $cm^{-3}$

$E_{K,iso}$=(1.8±0.1)e55 erg

p=2.72±0.07

$\theta_j = 0.04^{+0.02}_{-0.01}$ rad $(2.3^{\circ})$

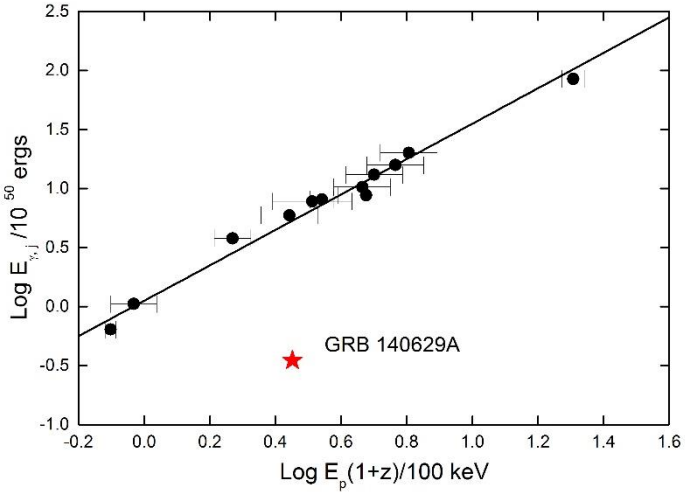
is very small.



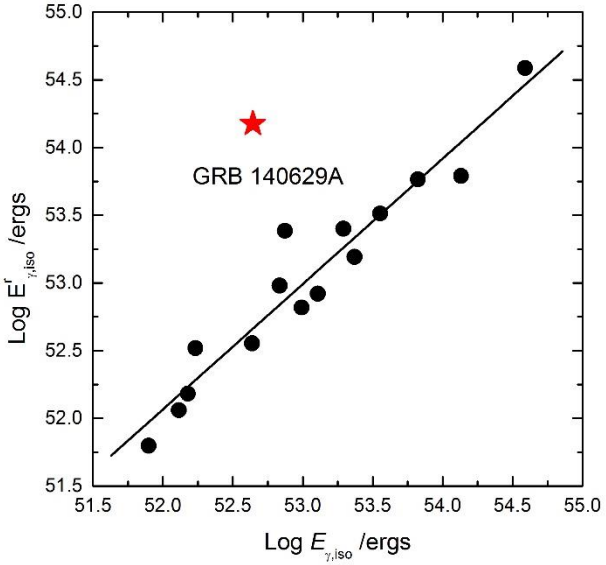

$\eta_\gamma \sim 0.24\%$

**The optical afterglows :**
**A textbook version with respect to the standard external shock models.**

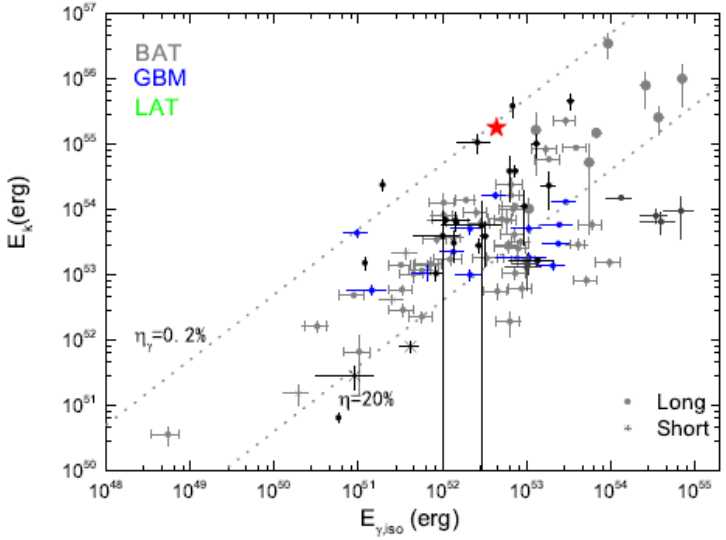
# Testing the Relations by Using GRB 140629A



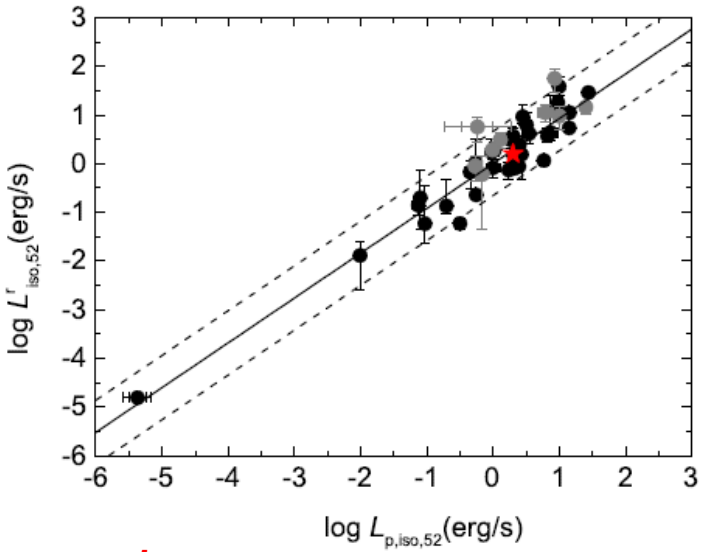

Ghirlanda relation




Liang-Zhang relation




$E_{K,iso}$---$E_{\gamma,iso}$ plane




$L_{\gamma,iso}$-$E'_p$-$\Gamma_0$ relation (Liang et al. 2015)

# Conclusions

- **GRB 110530A:**

**(1) Peculiar broad bump and delayed plateau**

**(2) Standard external shock+ delayed energy injection**

**(3) GRB jet is matter dominated**

**(4) Delayed energy injection: fall-back accretion**

- **GRB 140629A:**

**(1) Photometric and spectroscopic observations**

**(2) The optical: a textbook version**

**(3) It is well consistent with $L_{\gamma,iso}$-$E'_p$-$\Gamma_0$ relation**

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**Thank You !**