III Stueckelberg - Pescara

GRB 061007 : A progress report

Izzo Luca

International Center for Relativistic Astrophysics

2008 July 10

Brief Summary

- Introduction to the source
- The fit in the ”fireshell” model
- The GRB in the ”Guida-relation”
- Cosmology with GRB : cosmography

Introduction

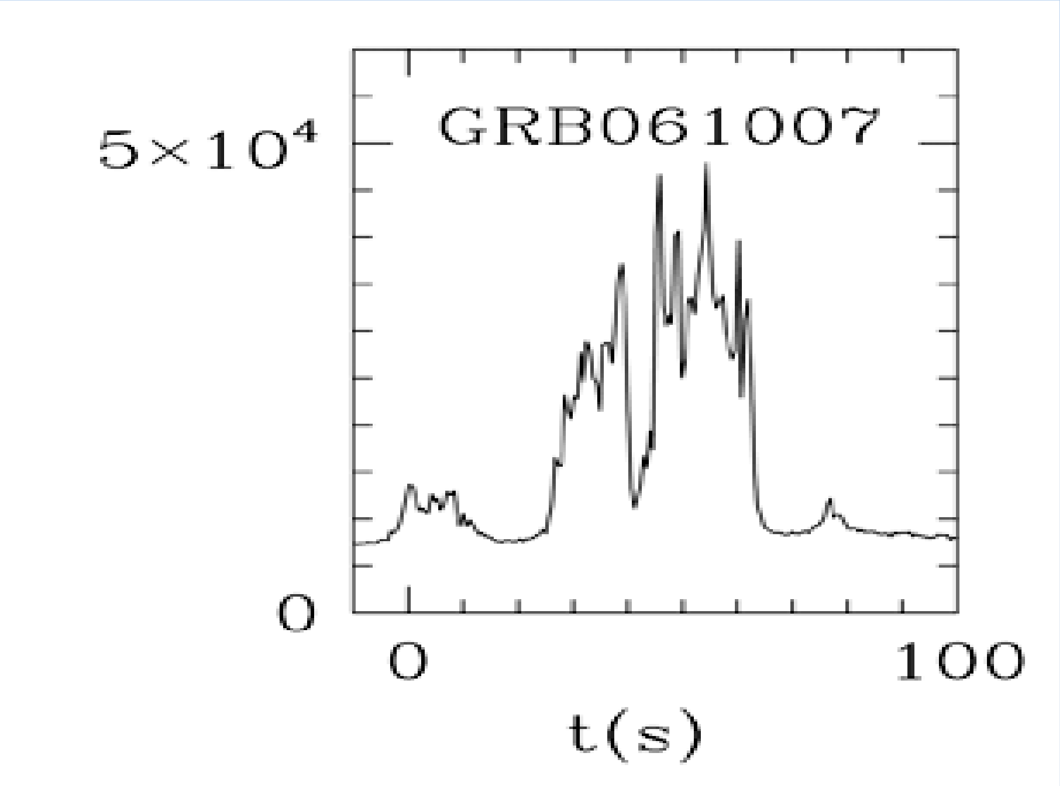
- One of the most luminous GRB ever observed (now is the third) :
  - At $z = 1.26$ and $V < 11.1$
- Fluence (Konus-Wind) $S_{\gamma} = 2.49 \times 10^{-4}$ erg cm^{-2}

→ $E_{iso} \sim 10^{54}$ erg

...in the standard cosmology : $\Omega_m = 0.27$ and $\Omega_\Lambda = 0.73$...

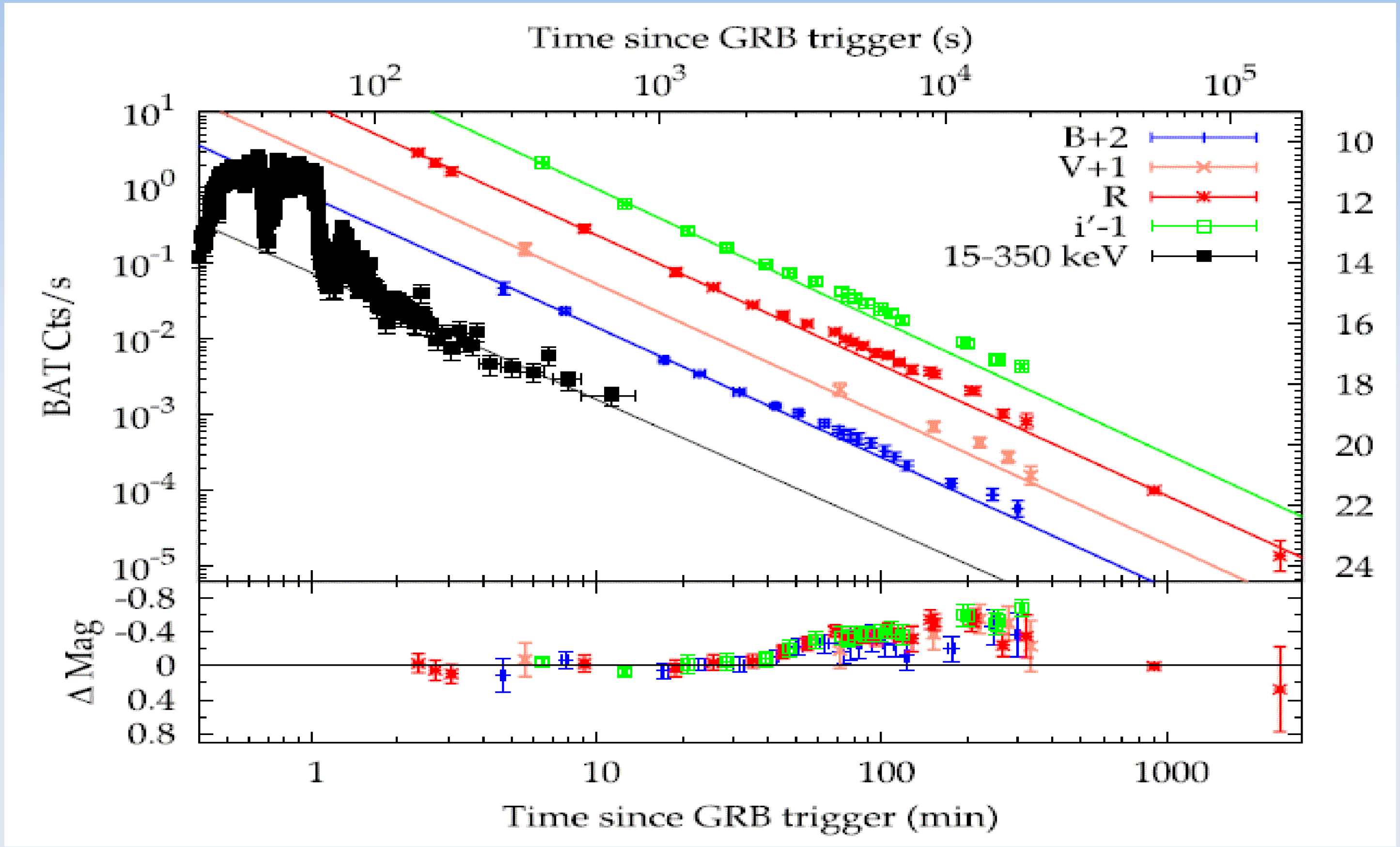
- Characteristic light curve : simple decay in all of the bands, lack of a break in the X-ray and UV-optical bands

Light Curve



BAT Light Curve (Beaver-Tooth shape...)

Late afterglow

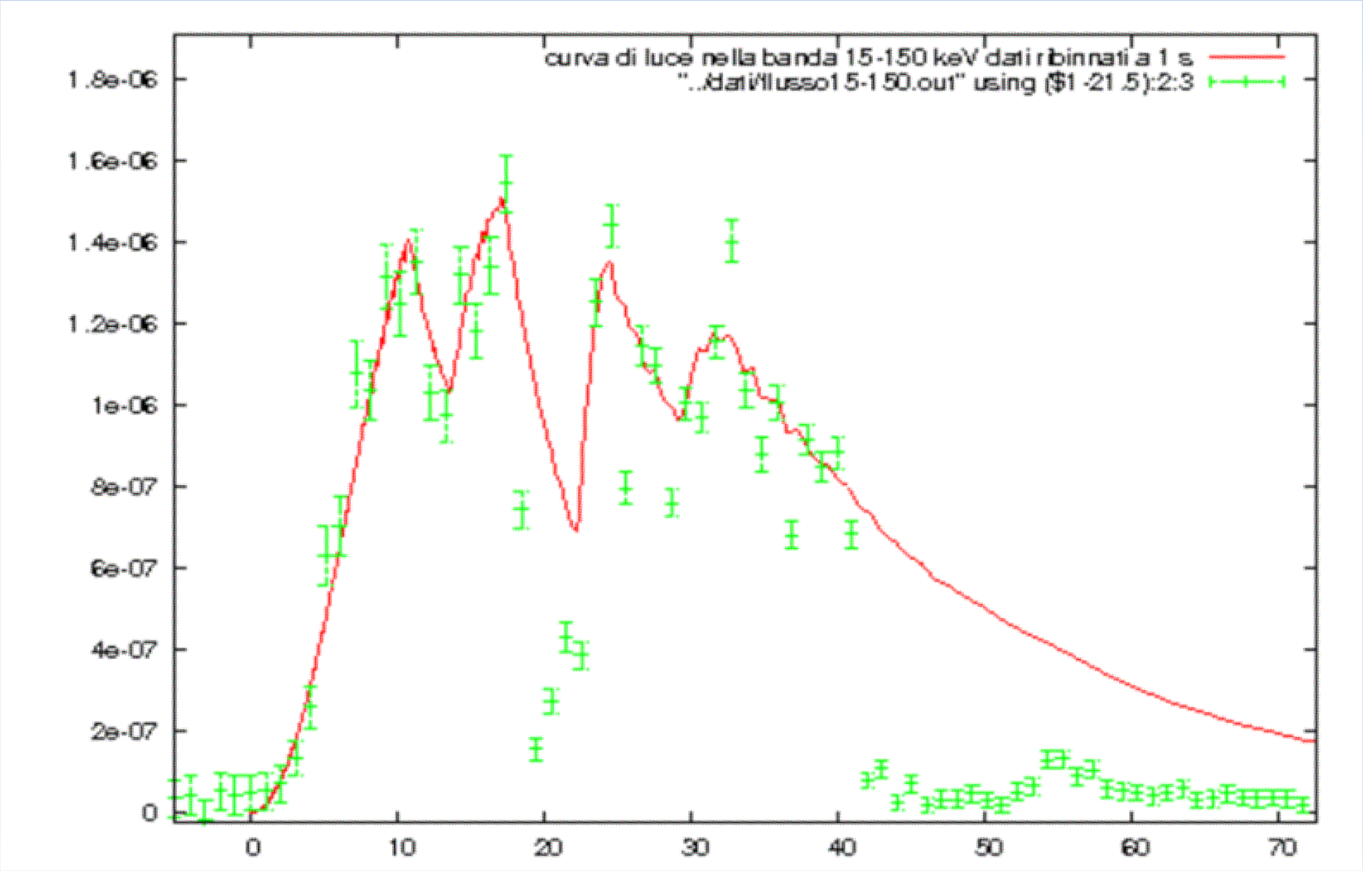


Courtesy Schady et al.

Similar decay in all of the e.m. bands: power-law with $\alpha = 1.66 \pm 0.01$

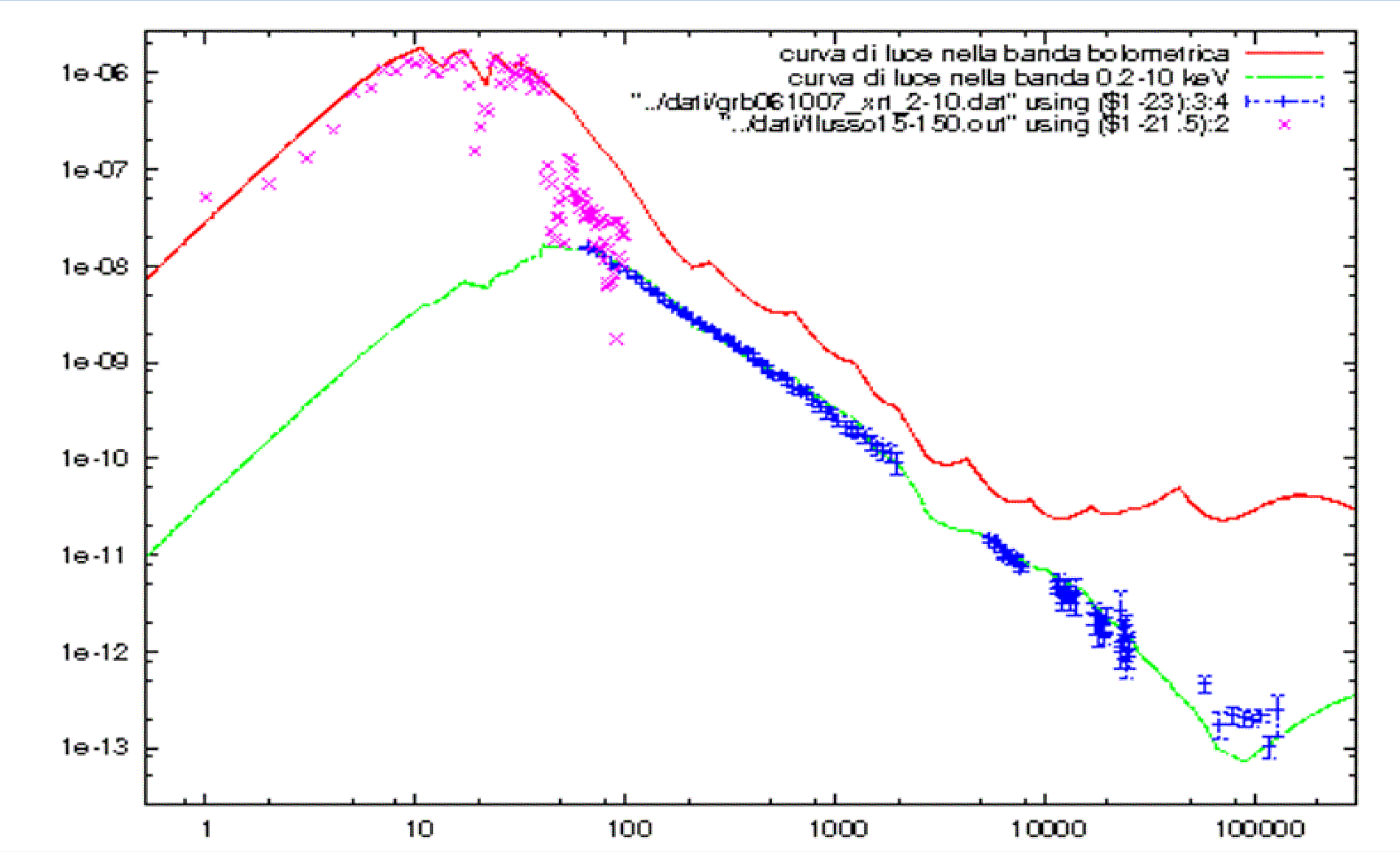
The fit of the GRB

In the fireshell model
15-150 keV (BAT)



The fit of the GRB

0.2-10 keV band (XRT) and the bolometric light curve



Preliminary results

- We identify the first main pulse with the P-GRB, the following peaks are the afterglow peak emission
- Results : $E^{tot}_{e^\pm} = 3.64 \times 10^{53}$ erg ; $B = 2.0 \times 10^{-3}$
- Dyadosphere region between 2.89×10^{7} cm and 3.64×10^{8} cm
- Total number of pairs $N_{e^\pm} = 3.50 \times 10^{58}$,
- Initial Temperature T = 1.76 MeV
- Theoretical isotropic energy emitted in the P-GRB

$$E_{P\text{-}GRB} = 8.5 \times 10^{51} \text{ erg}$$

Preliminary results

- Average CircumBurst medium:
  prompt phase = 0.5 #/cm^3, afterglow phase = 10^{-5} #/cm^3
- Initial Lorentz Gamma Factor of the fireshell $\Gamma_0 = 444.9$
- Energy peak of the νF_ν time-integrated spectrum E_p = 75 keV

...but there are some incongruences...

- the observed P-GRB energy is $E_{P\text{-}GRB} = 2.36 \times 10^{51}$

- the value for the CBM of the afterglow phases is very low...

Preliminary results

...solutions...

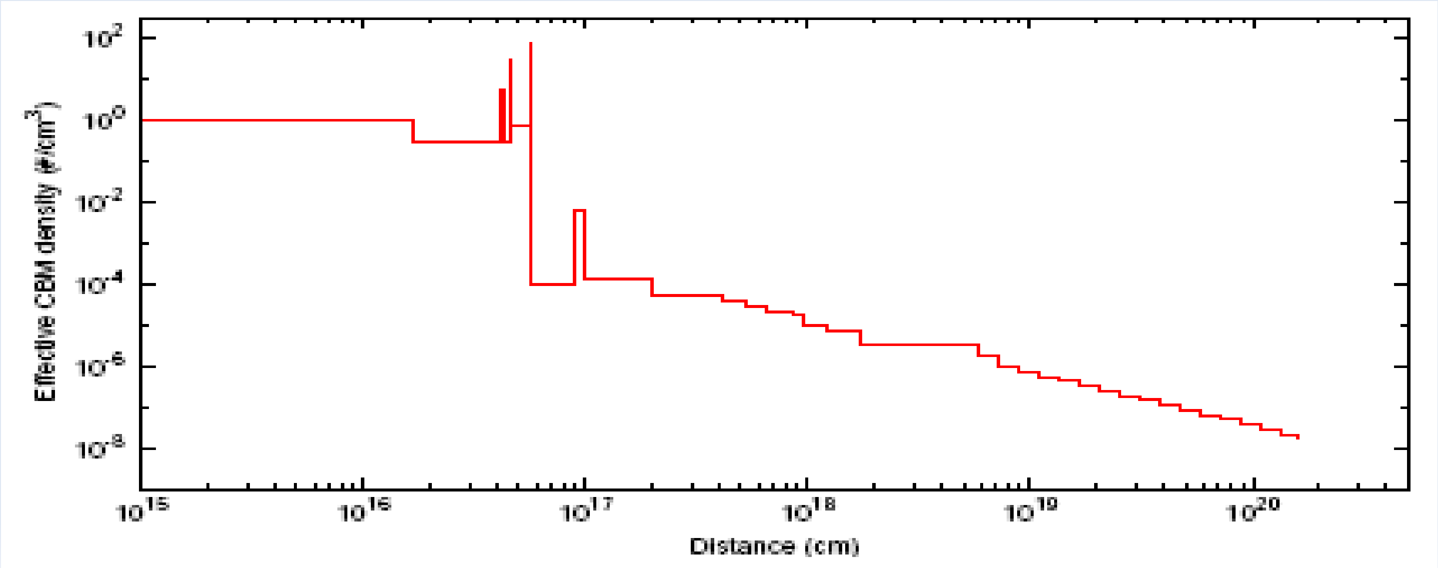
- We need to change the parameters of the the preliminary fit, in order to obtain a P-GRB energy similar to that observed
- In this way we can improve the CBM density... (in Schady et al. 2007 they obtain for CBM the value $n = 0.08\ \#/cm^3$)
- We are also in need to improve the CBM model in order to fit better the light curve (3-D model of the CBM...)

Cosmological implications

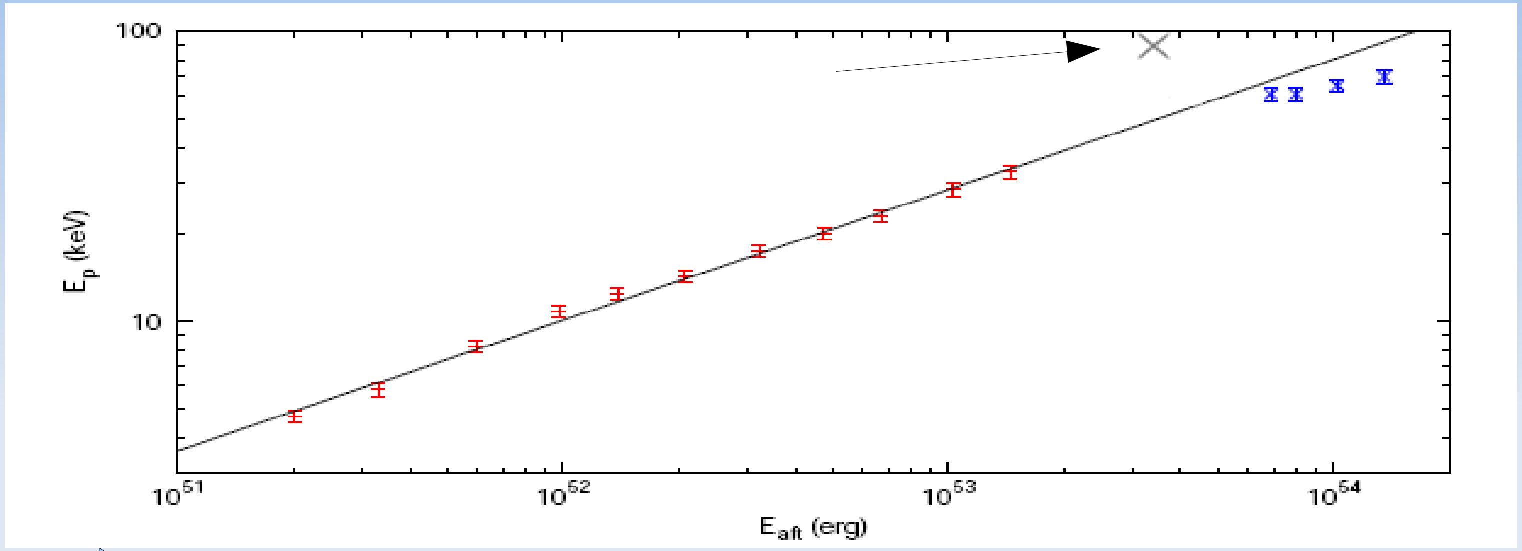
- GRB061007 is one of the most luminous GRB ever observed and thus it is an ideal object to test the cosmological spectral-energy correlations...
- It satisfies the Amati-relation E_p- E_{iso} ...
- ...and a correlation between $L_{p,iso}$ - τ_{lag}
- Can GRB061007 satisfy the "Guida relation" $E_p \propto (E_{aft})^a$?
  - Relation between E_p of the νF_ν total time-integrated spectrum of the afterglow and the total energy of the afterglow E_{aft}
  - Similar to Amati-relation, but in the fireshell model...

The Guida - relation

- Entire afterglow emission $E_{aft} = E^{tot}_{e^{\pm}} - E_{P\text{-}GRB}$
- Peak energy E_p of the νF_ν time-integrated-spectrum re-scaled at z=1.9
- B and the CBM density mask are fixed (in our case they are quite similar to that used by **Guida et al. 2008 arXiv:0806.3705** : B' = 4.55×10^{-3})



Cosmology with GRBs ?



- ⇨ The Guida relation needs to be improved with a third parameter : the Baryon loading B

Once we have a complete relation between E_p, E_{aft} and B, after a calibration, we can compute the luminosity distance from

$$d_l = \left(\frac{E_{aft}(1+z)}{4\pi S_{aft}} \right)^{\frac{1}{2}}$$

where S_{aft} is the bolometric fluence of the afterglow corrected in the rest frame...

Cosmography by GRBs

- The next step would be to connect the luminosity distance obtained for a sample of GRBs to the Hubble series :

$$d_l(z) = d_H z\left\{1+\frac{1}{2}\left[1-q_0\right]z-\frac{1}{6}\left[1-q_0-3q_0^2+j_0+\frac{k\,d_H^2}{a_0^2}\right]z^2\right.$$

$$\left.+\frac{1}{24}\left[2-2q_0-15q_0^2-15q_0^3+5\,j_0(1+2q_0)+s_0+\frac{2\,k\,d_H^2\,(1+3q_0)}{a_0^2}\right]z^3+O(z^4)\right\}$$

where q, j , and s are the cosmographic parameters that are related directly with the cosmological density parameters, Ω_m and Ω_Λ. A similar analysis is done with other GRBs relations **(Capozziello & Izzo *arXiv: 08061120, submitted A&A)***

Conclusions

From a preliminary analysis

- We have to improve the fit of the source
- Need of a 3-D model for the CBM structure of the density
- The Guida relation needs of an implementation of a third parameter in order to fit all of the GRBs
- GRBs can constrain cosmographic parameters of the Hubble law at medium-high redshifts, using also the Guida relation.

...we are working for solve them...

...formulas...

$$w = w_0 + w_a(1-a) = w_0 + w_a z(1+z)^{-1}$$

+

$$E^2(z) = \Omega_M(1+z)^3 + \Omega_X(1+z)^{3(1+w_0+w_a)} e^{-\frac{3 w_a z}{1+z}}$$

where $\Omega_X = 1 - \Omega_M$ & $E(z) = H/H_0$

$$q_0 = \frac{1}{2} + \frac{3}{2}(1-\Omega_M)w_0 \ ,$$

$$j_0 = 1 + \frac{3}{2}(1-\Omega_M)\left[3w_0(1+w_0) + w_a\right] \ ,$$

$$\begin{aligned} s_0 \ = \ & -\frac{7}{2} - \frac{33}{4}(1-\Omega_M)w_a \\ & - \frac{9}{4}(1-\Omega_M)\left[9 + (7-\Omega_M)w_a\right] w_0 \\ & - \frac{9}{4}(1-\Omega_M)(16-3\Omega_M)w_0^2 \\ & - \frac{27}{4}(1-\Omega_M)(3-\Omega_M)w_0^3 \ , \end{aligned}$$