Host Galaxy of Long Gamma-ray Burst at high redshift

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Outline

- Gamma-ray burst
- Host galaxy
- Simulated galaxy sample
- Conclusions
Gamma-ray burst...

What we know from observations...

1. GRBs are the brightest events in the Universe

2. Are distributed isotropically in the sky
   → cosmological distribution

3. Bimodal burst distribution (Long and Short)
Gamma-ray burst...

Long GRB

Core Collapse of massive stars

Short GRB

Merger of compact objects

Gamma-Ray Bursts (GRBs): The Long and Short of It

Long gamma-ray burst (>2 seconds' duration)

- A red-giant star collapses onto its core...
- Becoming so dense that it expels its outer layers in a supernova explosion.

Short gamma-ray burst (<2 seconds' duration)

- Stars in a compact binary system begin to spiral inward...
- Eventually colliding.
- The resulting torus has at its center a powerful black hole.

*Possibly neutron stars.
Gamma-ray burst...

Why GRBs Are Important???

- Are 100-1000 times brighter at early times than the high redshift QSOs
- Can be detected at high redshift with minimal extinction by intervening gas or dust
- Offer exciting possibilities to study astrophysics in extreme environments, e.g. radiative processes in highly relativistic ejecta
- Provide light candles in the universe to study the intergalactic medium
- The rate of LGRBs should be a biased tracer of the SFR in the universe
- Their cosmological distance give us the potential to probe regions of the universe that are otherwise unknown…

...thanks to the GRBs we are able to study: Reionization, Star Formation Rate and the First Generation of Stars…
Host galaxies...

What we know from observations...

Long GRB

Short GRB

Host galaxies...
In my PhD research, I am focusing my study on Gamma-ray Bursts host galaxies...

Observations of GRBs’ host galaxies are useful to understand the nature of GRBs…but until now only ~60 GRB have associated host galaxies...

...what my contribution is?
I select possible Host galaxies of long GRBs from a simulated catalog of galaxies to study their properties
Simulated galaxy sample

**CATALOG**: We use the galaxy catalogues constructed by **Wang et al. 2008** (MNRAS 384,1301) from two simulations with WMAP1 (same parameters of the MILLENNIUM simulation) and WMAP3 and redshift up to z~10

**IDENTIFICATION of HOST GALAXY**: We adopt the **Collapsar Model** for Long Gamma-Ray Burst

- Young stars with high mass and low metallicity form GRBs
- \( T_c < 5 \times 10^7 \) yr
- \( M > 30 \, M_{\odot} \)
- \( Z < 0.1 - 0.3 \, Z_{\odot} \)

We make use of 3 host sample obtained using stars with:

- **HOST1**: young and massive
- **HOST2**: young, massive and \( Z < 0.3 \, Z_{\odot} \)
- **HOST3**: young, massive and \( Z < 0.1 \, Z_{\odot} \)

Assuming Salpeter IMF and to have 1 GRB per 1000 SNe each galaxy hosting **at least one GRB** event is **host galaxy**
Do LGRBs provides a biased tracer of the cosmic star formation rate?

- LGRBs SFR peaks at higher redshift than cosmic SFR
- The ratio between cosmic SFR and host SFR decrease with redshift
- a z~5 HOST2 measure about 30% of the global SF density and HOST3 only ~10%
- Galaxies at higher redshift form stars at higher rate and lower metallicity
- The redshift distribution shows as the rate of LGRB peaks at z~5 and the number of host is maximum at z~2
Typical LGRBs host galaxies tend to occupy preferentially the low mass end of the galaxy mass function.

The figure clearly shows that HOST3 sample have 90% $M < 10^{10} M_{\odot}$.

The K-band distribution of simulated host galaxies is in agreement with observations.

In average host galaxies have K-band magnitude lower than normal galaxies.
Results in brief

- The host galaxies’ luminosity is well below the $L^*$
- While total LF evolve with $z$, the rate density and the range of $L$ of host galaxies vary midle

- The metallicity of host is in average lower than normal galaxies
- Inner bars errors, model predictions are compatible with them
• Cross correlation function suggests that the probability of finding another host near a GRB host is lower than the probability to find a normal galaxy

**Host galaxies do not reside in high density environments**
Conclusions...

In our simulations we find that

• GRBs may **not be** a good tracer of cosmic SFR
• The rate of LGRBs per host galaxies **increases** with redshift
• Typical LGRBs host galaxies have **low mass**
• In average their mass to light ratio is typical of **young galaxies**
• The host galaxies have **luminosity** well below the characteristic luminosity and their **metallicity** is **lower** than normal galaxies
• Correlation function suggests that host **do not reside in high density environments**
I am sorry if this talk is not perfect…
But I have been busy with something else..........
Thanks...

-Campisi et al. 2009, in preparation…
Gamma-ray burst...

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Gamma-ray burst...

What we know from observations...

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2704 BATSE Gamma-Ray Bursts
Gamma-ray burst...

What we know from observations...

3. What Bimodal burst distribution
Gamma-ray burst...

What we know from observations...

4. The energy spectrum is fitted by the Band function (two power-law)