Gamma-Ray Absorptions in the SED of QSO and the Evolution of Large Scale Structures.

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1a. QSO paradigm

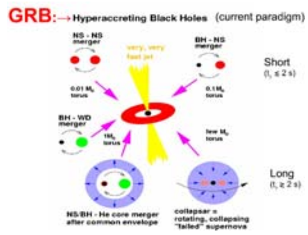
1. Introduction

Recently introduced absorption method that is based on the detection of the resonant absorption troughs in the gamma regime (Iyudin et al. 2005a) has all the qualities to become a practical tool to measure the baryonic absorption columns along the line-of-sight from point source towards the observer, as well as to derive the redshift of the point source. The pencil-like γ-ray beam from QSO (and GRB) probes all absorbers on the line-of-sight, including the baryonic matter in the QSO's (GRB) host galaxy, as well as the matter in the Milky Way halo (Iyudin et al. 2005b).

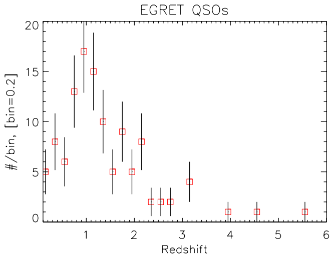
Assuming that gravitational coupling of the baryonic and of Dark Matter holds, it is possible to use the measured absorption columns to constrain the shape of the Milky Way Dark Matter halo, as well as to probe the evolution of the baryonic matter content in the halo of the QSO hosting galaxies. QSOs at redshifts of $\sim$6 do provide the means to probe baryonic content and the metallicity of the massive galaxies containing SMBH, while γ-rays from GRBs, that originated from Pop III stars collapsing to BHs, can provide the probe of baryonic content of proto-galaxies up to the redshifts of $\sim$15–20, e.g. for the ages of Universe of $\leq 10^9$ years.

1b. GRB paradigm

Ruffert and Janka (1998)

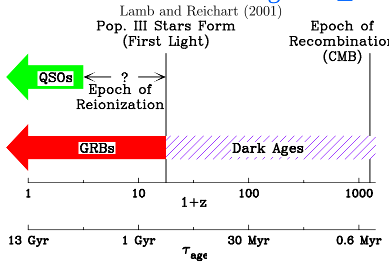


2a. EGRET's QSO z-distribution



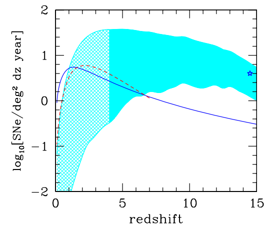
2b. Probes of the Universe Ages of $\leq 10^9$ yrs

Lamb and Reichart (2001)



2c. GRBs from PopIII

Scannapieco et al. (2005)

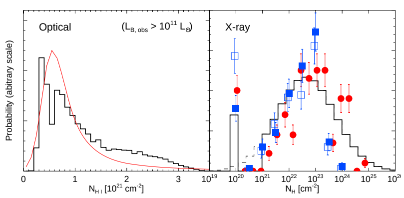


Absorption columns of a given quasar derived from the UV or optical observations are always $\sim$100 times smaller than the X-ray derived columns (Arav et al. 2002; 2003). Similarly, one expects to have the same kind of relation, based on the ratio of the typical energies, that is valid for the γ-ray regime.

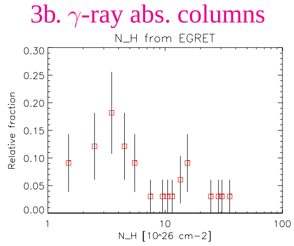
Absorption columns for GRBs were found to be distributed from 10^{20} cm^{-2} to 10^{23} cm^{-2} (Reichart & Price 2002). Absorbing columns for GRBs that originated from PopIII massive stars can be higher. These can be tested with *GLAST* for long and bright GRBs detected by LAT or GBM/LAT observations.

3a. QSO's absorption columns

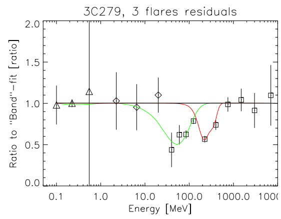
Hopkins et al. (2005)



3b. γ-ray abs. columns



3c. 3C279 absorption



3d. GRB abs. columns

Reichart and Price (2002)

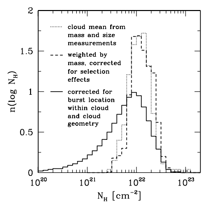
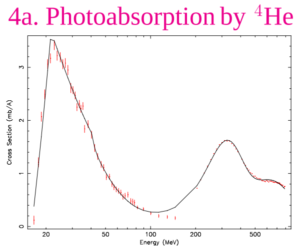


Fig. 4a shows regimes of the resonance-like photoabsorption by nuclei: GDR at $\sim$ 25 MeV; and Δ-isobar resonance at 325 MeV

4a. Photoabsorption by ^{4}He



4b. Gamma-ray absorption

The absorption columns of a γ-ray bright quasar found with the γ-ray absorption method (Iyudin et al. 2005a) are of the order of 10^{26} cm^{-2}. With the superior sensitivity of *GLAST* absorbing columns as low as $\sim 10^{25}$ cm^{-2} will become measurable, while *AGILE* is well suited to verify absorption results of EGRET and to extend them. The absorption columns and redshifts of γ-ray bright quasars detected by *GLAST* will enable us to follow the evolution of the QSO hosting galaxy halo mass, starting from the redshifts $\sim$0 backwards up to z$\approx$6.

Based on the properties of the EGRET detected blazars, Sowards-Emmerd et al. (2005) identified $\sim$700 candidates to be detected by *GLAST* from X-ray and radio surveys in the northern hemisphere. A similar number of candidates is expected south of decl.=0^o. The absorption columns and redshifts of the long and hard GRBs detected by LAT, or by *GLAST*'s calorimeter, will provide data to probe the mass of the proto-galactic halo starting from the redshifts $\sim$0 backwards to z$\approx$20. Here we assume that combined effects of redshift and of time dilation will produce little or no decrease in the observed SED of GRB, like in the case of afterglows (Ciardi & Loeb 2000; Lamb & Reichart 2001; Gou et al. 2004).

We note, that in order to probe proto-galactic haloes at z$\approx$15 we will need a γ-ray telescope with comparable sensitivity to that of *GLAST*, but in the energy range of $\sim$0.5 MeV to $\geq$50 MeV. This energy range is needed in order to cover both resonance-like photoabsorption troughs at $\sim$25/(1+z) MeV and 325/(1+z) MeV, and to have few energy bins outside of the absorption regions to constrain the continuum shape.

Conclusion The γ-ray absorption method can provide an info on the evolution of Ω_b starting from the beginning of the reionization epoch. The sensitivity and an energy range of *GLAST* will allow to follow evolution of the baryonic halo of QSO host galaxies up to z$\approx$6. To probe the proto-galactic haloes at z$\approx$15 one will need a 1 MeV to 100 MeV range telescope with the sensitivity comparable or exceeding that of the *GLAST*.

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