

Environment of The Gamma-Ray Burst GRB971214 : A Giant HII Region surrounded by A Galactic Supershell

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Among a number of gamma ray bursts whose host galaxies are known, GRB971214 stands out for its high redshift $z \geq 3$ and the Ly α emission line having a P-Cygni type profile. The P-Cygni type profile is interpreted to be a direct consequence of the expanding supershell. From a profile fitting analysis we estimate the expansion velocity of the supershell $v_{\text{exp}} \approx 1500 \text{ km/s}$ and the neutral column density $N_{\text{HI}} = 10^{20} \text{ cm}^{-2}$. It is argued that the redshift $z = 3.418$ of the host galaxy proposed by Kulkarni et al. (1998) need to be revised to be $z = 3.425$ from our profile analysis.

The measured redshifts in other absorption features exhibit a bimodal distribution, which strongly implies that there exist at least two physically distinct regions responsible for metallic absorption; one is a hot and static medium and whereas the other is cold and expanding.

The observed Ly α profile is fitted well by a Gaussian curve with its width $\sigma = 5.0 \text{ \AA}$ and $f(\lambda = 5380.8 \text{ \AA}) = 0.675 \mu \text{ Jy}$, which gives us a Ly α luminosity $L_{\text{Ly}\alpha} = 1.8 \times 10^{42} \text{ ergs s}^{-1}$. This luminosity permits a simple estimate of the electron number density in the HII region $n_e = 40 \text{ cm}^{-3} \left(\frac{L}{L_{\text{Ly}\alpha}} \right)^{0.5} \left(\frac{R}{100 \text{ pc}} \right)^{-1.5}$ and the ionizing radiation that is comparable to the illumination by about 10^4 O5 stars. We estimate the star-formation rate to be $R_{\text{SF}} \approx 7 \text{ M}_{\odot} \text{ yr}^{-1}$ with the internal and the Galactic extinction corrected. This value gives a good agreement with the one estimated from the UV continuum at $\lambda = 1500 \text{ \AA}$.

The theory on the evolution of supernova remnants is used to propose that the supershell is at the adiabatic phase, with its radius $50 \text{ pc} \leq R \leq 600 \text{ pc}$, its age $10^4 \text{ yrs} \leq t \leq 2 \times 10^5 \text{ yrs}$, assuming the input energy has a range of $10^{52} \text{ ergs} \leq E \leq 10^{55} \text{ ergs}$. For the estimated radius of the supershell, we estimate the kinetic energy of the supershell to be $6 \times 10^{53} \text{ ergs} \leq E_k \leq 8 \times 10^{55} \text{ ergs}$. These values are very consistent with the hypothesis that the supershell is a remnant of the gamma ray burst.

We also note the similarities between the supershell in GRB971214 and giant

supershells in the remote primeval galaxies and the nearby galaxies including our own Galaxy, M101, NGC 4631. From these results we suggest that the gamma ray burst appears in a giant HII region whose environment is very similar to those in an ordinary starforming galaxies.

