Title : will be set by the publisher
Editors : will be set by the publisher
EAS Publications Series, Vol. ?, 2002

GLOBULAR CLUSTERS AS THEY CAN BE SEEN IN LY-ALPHA AND H-ALPHA AT $Z > 1$

Eugene O. Vasil'ev[1]

Abstract. Fluxes in Ly-alpha and H-alpha lines from Proto Globular Clusters (PGCs) at redshifts $z > 1$ are estimated. Two possible sources are considered: HII regions and supernovae remnats in PGCs. Intensities in Lyα and Hα lines are calculated. It is shown that such PGCs can be detectable for the ongoing and future projects (VLTI, NGST).

1 Introduction

Globular Clusters (GCs) are the oldest relics in galaxies. In the Milky Way galaxy there are at least three distinct populations of GCs, for which we may expect three different scenarios of their formation and evolution. Possible detection of emission from bright phases can help us to understand how the GCs did form.

We present the estimated fluxes in Lyα and Hα lines from two different energy sources of GCs: bright HII regions around massive stars, supernovae (SN) remnants embedded in dense molecular cloud. Here we present estimates of the energy fluxes in Lyα and Hα of HI expected from these sources and compare them with the sensitivity limits for the VLTI (2UT+AT, AMBER) and NGST.

2 HII regions

For a Salpeter IMF the number of stars with bright HII regions for a cluster of $10^5 M_{\odot}$ is about 200. We assume for such stars: lifetime – 10^7 yr and the yield of ionizing UV photons per baryon – 10^4 (Tegmark 1994). The average GC diameter and internal gas density is 20 pc and $10^3 - 10^8$ cm^{-3}, respectively. Under these assumptions HII regions from individual stars overlap and form a single central Stromgren zone. We calculate the fluxes from such GCs. The fluxes obtained are small for being detected at $z > 1$ by VLTI. However it is possible for the top-heavy IMF. The NGST sensivity provides opportunity to detect the radiation even for standard IMF (fig. 1).

[1] Physics Department, Rostov State University, Rostov on Don 344090 RUSSIA, e-mail: eustarru@mail.yahoo.co.uk

DOI: (will be inserted later)

3 Supernovae remnants

It is very likely that mass density in protogalactic gas clouds was larger than in the observed giant molecular clouds. One therefore can expect that SN remnants present in the early stages of GCs were expanding into a much denser medium than even recently observed in SN remnants in molecular clouds. For a two order of magnitude lower metallicity of GC most of the thermal energy of SN remnant will be emitted in recombination lines of hydrogen and helium. We assume that recombination lines emit (mostly Lyα and Hα photons) when the postshock temperature is around $10^5 - 3 \times 10^5$ K. At these stages the thermal energy of the remnant is about 20-30 % of the total SN energy. We assume that $0.5E_{th}$ converts to Lyα, and $0.05E_{th}$ to Hα emission. All the photons are emitted in one recombination time, t_{rec}, and the duration of the Lyα/Hα flash is $t_{flash} = t_{rec}$. Therefore, the intensity of a SN remnant is proportional to the density of surrounding gas, or inversely proportional to t_{flash}. It is seen on fig.1 that VLTI and NGST sensitivity is sufficient to observe the radiation with some range of the gas density.

4 Summary

VLTI with the existing imaging and spectrometric devices cannot detect fluxes from HII regions of GCs at their initial stages, however, its sensitivity is quite sufficient to observe SN remnants in GCs at $z > 1$. The advantage of observations of recombination lines from SN remnants in young GCs is that the duration of these stages is several orders of magnitude longer than the duration of isolated SN event, and therefore the probability of detection of SN in early universe is proportionally higher than previously estimated (Miralda-Escude & Rees 1997).

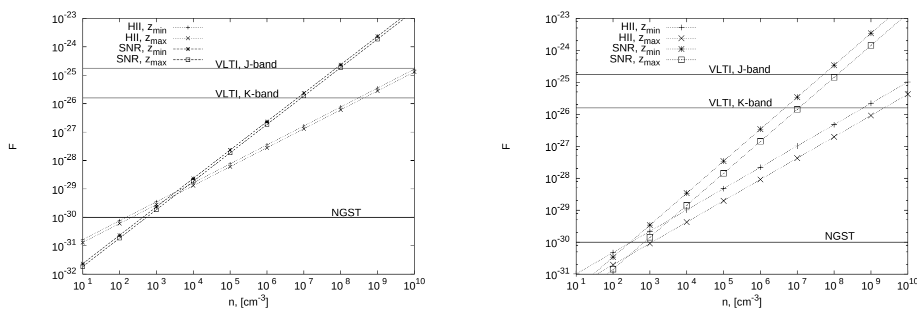

Fig. 1. Spectral flux ($R = 1000$) vs. density in Lyα (left) and Hα lines. Constrain on z means the line should have redshifted in order to be observed in J-K bands.

References

Miralda-Escude & J., Rees, M.J., M, 1997, ApJ, 478, 57
Tegmark, M., 1994, PhD thesis, Univ. of Berkeley