Interaction/Merger-Induced Starbursts in Local Very Metal-Poor Dwarfs: Link to the Common SF in High-Redshift Young Galaxies

S.A. Pustilnik[1], Ekta[2], A.Y. Kniazev[3,1], J.N. Chengalur[2], L. Vanzi[4]

[1] Special Astrophysical Observatory, Nizhnij Arkhyz, Russia; [2] National Centre for Radio Astronomy, Pune, India;

[3] South African Astronomical Observatory, Cape Town, SAR; [4] European Southern Observatory, Santiago, Chile

Introduction

Widespread galaxy formation from pregalactic gas took place in the first 1–3 Gyr after the Big Bang, with most of them forming in low-mass halos (i.e., M in the range of 10^7-10^{10} $M_\odot$). Observations at high redshifts (z= $4-7$) are, however, mainly limited to the rare massive "tip of the iceberg" objects. Detailed studies of the properties and the evolution of more common lower-mass young galaxies will have to await the next generation mega telescopes. Although the properties of early galaxies are poorly constrained, it seems reasonable to assume that they should share the following three attributes, viz. a) they should be much more metal-poor than typical local galaxies; b) they should be very gas-rich, and c) due to the much higher galaxy density in the early Universe, interaction/merger induced galaxy-wide SF should be one of the main SF modes. Fortunately, there exist in the local Universe analogs of low-mass young galaxies whose properties can serve as a first approximation for understanding those of the main population of high-redshift galaxies. These are very rare so-called eXtremely Metal-Deficient (XMD, Z = $Z_\odot$/30 - $Z_\odot$/10) blue compact galaxies (BCGs).

Method and Results

We have conducted a multi-wavelength study (including optical/NIR morphology/photometry, HI imaging and velocity mapping, and Hα-line kinematics) of a sample of such XMD BCGs and found in at least of a half of them (20 objects) clear evidences that strong interactions or mergers with low-mass objects, provide a trigger mechanism for their observed starbursts. We present here as examples 9 such XMD BCGs arranged in a Toomre-like sequence (see Fig. 1 and 2). At one end we have well detached, both in HI and optical light, system of interacting BCG HS 0822+3542 and LSBD 0822+3545. In the middle we see objects like SBS 1129+576, SBS 0035–052 E and W and I Zw 18 and its companion 'C', still well detached in optics from their companions, but showing bridges, tails and common envelopes in HI. At the opposite edge we see 'two-nuclei' objects like HS 2236+1344, and probable completed mergers like DDO 68 and HS 2134+0400. A more detailed analysis for some of these galaxies is either already published, or submitted (see references). For others the data should be presented during a year.

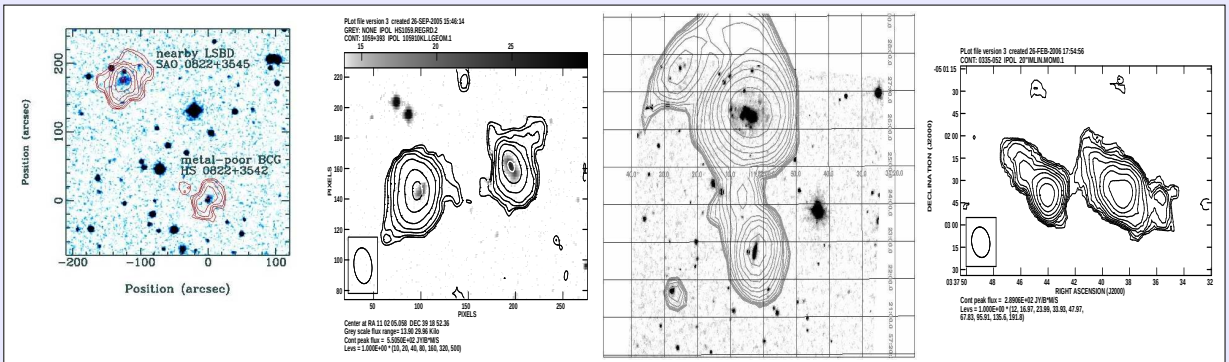

Fig. 1: The sequence of interacting/merging dwarf systems with XMD galaxy components. a) XMD BCG HS 0822+3542 interacting with LSBD SAO 0822+3545 at 11 kpc. Contours show the GMRT HI maps (Pustilnik et al. 2003; Chengalur et al. 2006). b) GMRT HI map overlayed on the optical image of XMD BCG HS 1059+3934 (on the E) interacting with its companion KUG 1059+395 at the projected distance of 25 kpc. c) GMRT HI map overlayed on the optical image of XMD BCG SBS 1129+576 (on the S) merging with the starburst galaxy SBS 1129+577 at 29 kpc (Ekta et al. 2006). d) GMRT HI map of the unique pair of merging XMD galaxies SBS 0335–052 E and W at 22 kpc in projection (also Pustilnik et al. 2001).

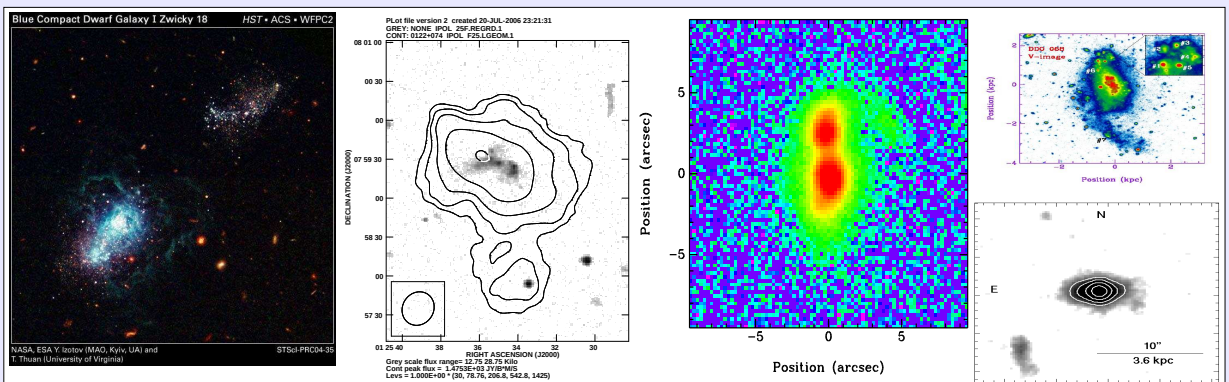

Fig. 2: The sequence of interacting/merging dwarf systems with XMD galaxy components. a) The HST image of XMD BCG I Zw 18 and its faint companion 'C' at 1.6 kpc to NW (Izotov & Thuan 2004). b) The GMRT HI map overlayed on the optical image of the XMD galaxy HS 0122+0743 consisting of two merging components in contact. c) The WFI R-band image of the XMD galaxy HS 2236+1344 representing advanced merger of close mass components. d) Top panel: The V-band image of the XMD galaxy DDO 68 probably representing the completed merger (Pustilnik et al. 2005) Bottom panel: the WFI B-band image of the XMD BCG HS 2134+0400 probably representing completed merger (Pustilnik et al. 2006).

Discussion

Since both SF (through cooling rate and the IMF) and its feedback (through the massive star evolution and interaction with the ISM) depend substantially on the ISM metallicity, comprehensive multiwavelength studies of local XMD galaxy mergers, coupled with theoretical modeling, should give us the insight into star formation in young high-redshift galaxies. While the available observational data on these XMD galaxies already provide us with useful parameters, new observations in NIR and radio molecular lines, MIR and radiocontinuum, UV and X-rays could give important constraints for modeling of such systems, and thus to advance us in the understanding of similar young galaxies at high redshifts.

References

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