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Tracing tidal interactions in WR galaxies using GMRT HI 21cm-line emission observations

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Abstract. We present the recent results obtained with HI 21cm-line survey and Hα survey of about 20 WR galaxies. The HI images show tidal tails and other features attributable to a recent tidal encounter. The preliminary results indicate that galaxy-galaxy tidal interactions is the main cause of star formation in these galaxies. In a few cases, the companion galaxy is not known visibly and is most likely to be a low mass HI cloud or another faint dwarf galaxy. This study will be useful in understanding star formation trigger in galaxies, particularly in low mass systems such as dwarf galaxies.

Keywords : galaxies: interaction – galaxies: Wolf-Rayet – galaxies: dwarf – galaxies: ISM

1. Introduction

Wolf-Rayet (WR) galaxies are a subset of HII galaxies in which the recent episode of intense star-formation is only a few Myr old (Schaerer et al. 1999). WR galaxies are identified through presence of broad emission lines of He, N, C and O in their visible light spectrum (Conti 1991), which are believed to be originating in the stellar winds of massive O/B stars in their short-lived WR phase just before their explosion as supernovae. Due to the presence of significant number of short-lived WR stars, the WR galaxies shows very recent star-burst. WR galaxies therefore offer an unique opportunity to study onset of triggering mechanisms of star formation in galaxies.

Tidal interactions between galaxies have been confirmed by various observations and theoretical simulations, to be the main cause for onset of massive star formation in galaxies in low galaxy-density environments (e.g., in groups or fields) (cf. Lopez-Sanchez & Esteban 2008). The SDSS has recently identified several hundreds of new

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WR galaxies, many of them are classified as dwarf galaxies. Most of the WR galaxies detected in SDSS show disturbances in their optical/NIR images. However, a small subset of WR galaxies does not show any tidal feature in their optical images. Some of these galaxies also do not reside in multi-galaxy environments making it difficult to establish that tidal interaction is the sole mechanism for the star formation. We have studied the catalogue of WR-galaxies prepared by Schaerer et al. (1999) and Brinchmann et al. (2008), and examined the morphological classes of these galaxies. We then selected the apparently isolated WR galaxies to observe in HI 21 cm-line using the Giant Meterwave Radio telescope (GMRT) as the HI line is the best tracer for interactions between galaxies. Additionally, to see the star formation scenario in these galaxies, Hα imaging are being performed using 1.3 meter Devasthal Fast Optical Telescope (DFOT) and 2-meter telescope of the Inter University Centre for Astronomy and Astrophysics (IUCAA) Girawali Observatory (IGO). We have also used some archival data, namely SDSS photometric and spectroscopic data, IRAS Far Infra-Red data and FIRST 20-cm Radio continuum data to support our observations.

2. Initial results

The initial results of this survey over a sample of about 20 WR galaxies shows that the galaxy-galaxy tidal interaction could be the cause of massive star formation in galaxies. We have detected the tidal interaction features in the form of tails, bridge, plumes and isophotal twisting using our HI line observations from GMRT. The tidal interaction features in few cases are shown in Figure 1. In this figure, the HI column density contours are overlying on the grey-scale dss image of the WR galaxies, namely, CGCG 038-051, UGCA 116, IC 2828 and MRK 996. The interaction feature seen in these galaxies are the followings:

CGCG 038-051 — This is a case of wrapping galaxy. The HI contours are clearly twisted in this system.

UGCA 116 — In this case, a clear bridge between the galaxy and a small faint companion. Such a bridge is not visible in its optical image.

IC 2828 — The HI contours are twisted in this galaxy also. Additionally, the HI contours are not symmetric to the grey-scale optical image.

MRK 996 — The HI contours are quite asymmetric with the optical grey-scale image.

The WR galaxy MRK 996 is a very interesting object which is previously cited as non-interacting galaxy by Thuan et al. (1996). It is an nuclear Elliptical (nE) BCD Galaxy having mini-spiral arms. It has some asymmetries in its morphology. The envelope is more extended to the northeast side. The majority of globular clusters around MRK 996 are found to the south of the galaxy. The asymmetry is also seen in

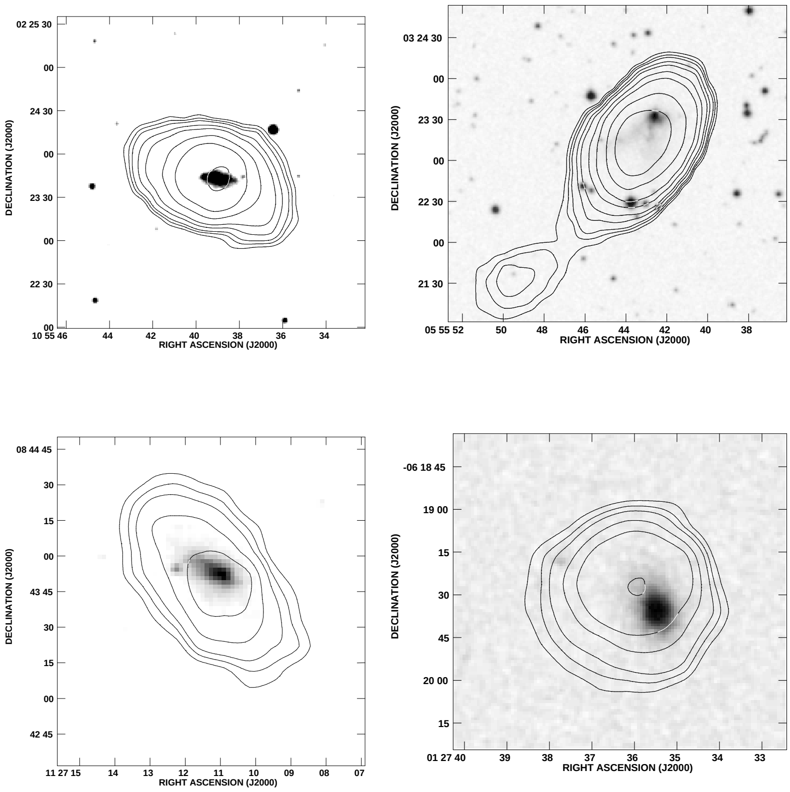

Figure 1. The total HI contour maps overlying on grey-scale dss image of few WR galaxies (starting from left to right): CGCG 038-051, UGCA 116, IC 2828 and MRK 996.

the HI distribution in the galaxy (Figure 1), which shows the tidal interaction in this system. Additionally, the Hα observation of this galaxy (Jaiswal & Omar 2013) shows that the Hα emission disk is misaligned by $\sim 40^\circ$ from its old stellar disk (figure 2). It implies fresh supply of gas to center which is most likely due to a recent tidal interaction event. MRK 996 is found to be a radio deficient galaxy with a 'q' value of $\sim$3. This shows that MRK 996 don't have enough number of supernova events for a long time.

The galaxy sample, however not complete, gives a clear indication that the tidal interaction could be the fundamental cause of star formation in WR galaxies. The detection of tidal interaction features in the apparently isolated systems shows the possibility of faint dwarf companions.

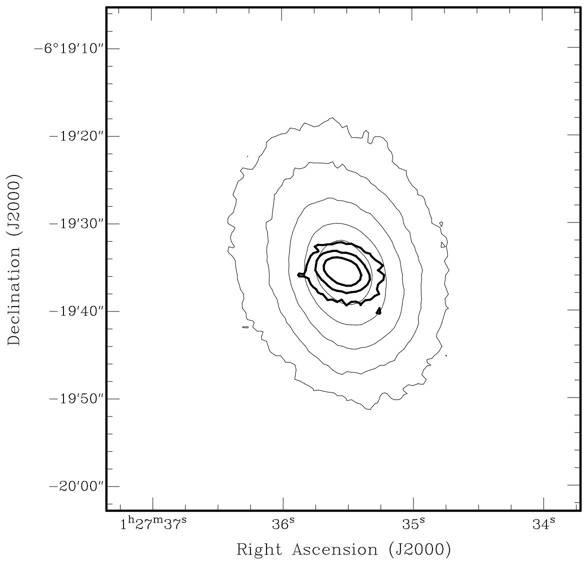

Figure 2. The Hα iso-intensity contours (thick line) overlying on SDSS r-band iso-intensity contours (thin line); contour levels are in logarithmic scale.

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