STAR FORMATION & TIDAL INTERACTIONS IN WOLF – RAYET GALAXIES

AMITESH OMAR,
SUMIT JAISWAL, ABHISHEK PASWAN

ARYABHATTA RESEARCH INSTITUTE
NAINITAL, INDIA
Wolf Rayet specific spectroscopic line features indicate presence of wolf-rayet (most massive and the youngest) stars in the galaxy.

**The WR phase:**

- Appears nearly a 1–2 million year after the initiation of the star-burst
- Lasts only for about 5 million year or so.

- WR galaxies are therefore high temporal resolution tracers of the most recent episode of star formation activities in galaxies.

- That makes WR galaxies excellent objects to study triggering mechanisms of star formation in galaxies.
SDSS identification of WR galaxies (Brinchman, Kunth & Durret 2008)

No. of WR galaxies identified are nearly 2000 in the nearby Universe ($z < 0.2$)
The overall star formation rates (SFR)

The Hα morphology reveals mergers, tidal features?

HI morphology reveals galaxy–galaxy interactions, faint companions such as HI cloud, LSB dwarfs etc.

The observations are combined with data in other bands (far-ultraviolet from GALEX, far-infrared (IRAS etc.), 1.4 GHz radio (VLA–NVSS, FIRST) to constrain SFR.

Internal extinction in galaxies & line contaminations in Hα band–pass filter is determined from the SDSS spectroscopic data (limited to 3” fibre diameter) – needed for accurate Hα photometry.
The WR region can be almost always identified as the brightest and the bluest region in the galaxy.
The scatter is large among dwarf WR galaxies: Extinction estimates?, radio deficient?, SFR calibration?
SFR (FUV/Hα) ratio has slight dependence on metallicity. *SFR-flux calibration issue?*

Such a trend was also seen in another sample of WR galaxies by Lopez-Sanchez (2010).
‘q’ (radio–FIR correlation) parameter hints at a possible trend within the normal scatter limits from Yun et al. (2001)

Indicates radio deficiency in dwarf WR galaxies: Starburst is still young and has not produced enough supernova events responsible for radio emission.
Mrk 996 – dwarf WR galaxy: A case study

Metallicity = 0.2 solar

SFR (Hα & FIR) estimates as $0.5 \, M/yr$, (corrected for low metallicity, line contaminations, & extinction)

- Expected 1.4 GHz radio flux
  
  non-thermal \sim 5 \, mJy
  thermal \sim 0.5 \, mJy

- Detected flux @ 1.4 GHz
  = 0.5 (+/- 0.2) \, mJy

- Indicates that supernovae events have not taken place from the present episode of massive star formation in the galaxy. (Radio deficient galaxy in radio–FIR correlation)

- Supported by large N/O ratio in the galaxy compared to other dwarf galaxies.

- Mrk 996 is a very recent merger as revealed by Hα observations.
1.4 GHz radio continuum contours on optical image

UM 311 (v=1675 km/s) is a HII region complex on the face on spiral galaxy NGC 450 (v=1761 km/s)
- radio emission is seen from this complex
- CO emission is also detected from UM 311 (Cormier et al. 2014)

- Indicates that UM 311 complex is a dwarf galaxy undergoing minor interaction with NGC 450.
Dwarf WR galaxy

HI contours

Hα contours

Extra-plannar HI

Early type galaxy; Gas disk (?) misaligned with stellar disk.

➢ Accretion of HI? Interaction with HI cloud?
No HI detection;

Multiple nuclei – merger?, mostly ionized gas in the galaxy

[Ha EW ≈ 363 (intense starburst)]
Irregular HI velocity field (multiple systems)
Indicates merger? Or accretion?
Multiple nuclei, plumes in Hα?
EW = 82 Å (starburst)

HI velocity field is irregular
Interaction with HI clouds/dwarf galaxy?
HI clouds/interaction with dwarf galaxy?
No HI data obtained yet.
Very intriguing star formation morphology
HII region?
Summary

- We find that Wolf–Rayet region in galaxies is always associated with a distinct brightest HII region in the galaxy.

- The Hα image reveal intense star formation with hints of multiple nuclei, misaligned Hα disks – indicative of merger or interactions.

- HI images/velocity field in many cases – supports the interaction hypothesis. The interactions appear to be minor (with low mass objects like dwarfs, HI clouds?)

- Accretion of gas in these galaxies – a good possibility.

- WR galaxies are ideal objects to study star–burst triggers in galaxies.