Tirna Deb

Title

Atomic Hydrogen disks as tracers of galaxy transformation in Abell 2626 and beyond

Abstract

The extended, fragile, collisional atomic hydrogen (HI) gas discs in galaxies are excellent diagnostic tracers of gravitational and hydrodynamic processes in the cosmic environment they are residing in and also reservoirs for star formation. Within a galaxy cluster, both gravitational perturbations (tidal interactions, harassment, etc.) and hydrodynamic processes (thermal evaporation, ram pressure stripping (RPS), etc.) are at play. However, it is not clear yet which of these processes dominate the transformation of galaxies from star forming and gas rich, to quiescent and gas poor. I am investigating the influences of the global and local cosmic environment on the evolution of galaxies, both from the HI morphologies of galaxies in different locations of cluster substructures and the multi-wavelength case studies of the striking galaxies. From the new MeerKAT telescope observations of A2626 volume, I am studying the spatially resolved morphologies of the 219 HI detected galaxies, covering a range of cosmic environments. By identifying the cluster substructures and characterising their environments, I investigate the relative importance and effects of the various physical mechanisms that are responsible for reshaping galaxies. In addition, I am also studying the detailed cases of HI gas stripping in the “jellyfish galaxies”, the extreme examples of RPS with in-situ star formation in the tails. I have analysed the multi-phase (neutral, molecular, ionised gas) ISM of jellyfish galaxies JW100 and JO204 from multi-wavelength MeerKAT or JVLA, MUSE and ALMA observations. I will talk about how HI observations contribute to understanding the multiphase gas stripping in these jellyfish galaxies.

Tirna Deb

Curriculum Vitae

Landleven 12
9747 AD Groningen, The Netherlands
deb@astro.rug.nl
https://tirnadeb.net/

Personal Information

Date of birth	11th June, 1994
Nationality	Indian
Gender	Female
Preferred Pronouns	she/her
ORCID	https://orcid.org/0000-0003-1078-2539

Education

2017–present **PhD student in Astronomy**, *Kapteyn Astronomical Institute*, Groningen, The Netherlands, *Thesis: "Atomic hydrogen disks as tracers of galaxy transformations in Abell 2626 and beyond"*.
Advisor: Prof. Marc Verheijen in Kapteyn Institute, Groningen, The Netherlands

2014-2016 **Master of Science in Physics**, *Presidency University*, Kolkata, India, *Thesis: "Estimation of total AGN Feedback in clusters of galaxies"*.
Advisor: Prof. Somak Raychaudhury in IUCAA, Pune, India

2011-2014 **Bachelor of Science, Honours in Physics**, *Presidency University*, Kolkata, India.

Publications

[1] **Mapping H I in Abell 2626: Data release and catalogue**, *accepted for publication in A&A*.
Healy, J -***Deb, T.***(joint first author), Verheijen, M., Blyth, S-L, Poggianti, B. M., Serra, P., Ramatsoku, M., Vulcani, B.

[2] **GASP XXV: Neutral hydrogen gas in the striking jellyfish galaxy JO204:**.
Deb, T., Verheijen, M., Gullieuszik, M., Poggianti, B. M., Gorkom ,van, J., Ramatsoku, M., Serra, P., Moretti, A., Vulcani, B., Bettoni, D., Jaffé, Y. L., Tonneson, S. & Fritz, J., 23-Apr-2020, In : Monthly Notices of the Royal Astronomical Society. 494, 4, p. 5029-5043 15 p.

[3] **GASP - XVII. H I imaging of the jellyfish galaxy JO206: Gas stripping and enhanced star formation:**.
Ramatsoku, M., Serra, P., Poggianti, B. M., Moretti, A., Gullieuszik, M., Bettoni, D., ***Deb, T.***, Fritz, J., van Gorkom, J. H., Jaffé, Y. L., Tonnesen, S., Verheijen, M. A. W., Vulcani, B., Hugo, B., Józsa, G. I. G., Maccagni, F. M., Makhathini, S., Ramaila, A., Smirnov, O. & Thorat, K., Aug-2019, In : Monthly Notices of the Royal Astronomical Society. 487, 4, p. 4580-4591 12 p.

[4] **The high molecular gas content, and the efficient conversion of neutral into molecular gas, in jellyfish galaxies:**.
Moretti, A., Paladino, R., Poggianti, B. M., Serra, P., Ramatsoku, M., Franchetto, A., ***Deb, T.***, Gullieuszik, M., Tomicic, N., Mingozzi, M., Vulcani, B., Radovich, M., Bettoni, D. & Fritz, J., 24-Jun-2020, In : Astrophysical Journal Letters. 9 p.

[5] **GASP XXVI. HI Gas in Jellyfish Galaxies: The case of JO201 and JO206:**.
Ramatsoku, M., Serra, P., Poggianti, B., Moretti, A., Gullieuzik, M., Bettoni, D., ***Deb, T.***, Franchetto, A., van Gorkom, J., Jeffé, Y., Tonnesen, S., Verheijen, M., Vulcani, B., Andati, L. A. L., de Blok, E., Józsa, G. I. G., Kamphuis, P., Kleiner, D., Maccagni, F., Makhathini, S., . Molnár, D. C., Ramaila, A. J. T., Smirnov, O. & Thorat, K., 04-Aug-2020, In : Astronomy & Astrophysics. 9 p.

[6] **GASP XXXVII: The Most Extreme Jellyfish Galaxies Compared to Other Disk Galaxies in Clusters, an HI Study:**.
Luber, N., Muller, A., van Gorkom, J., Poggianti, B. M., Vulcani, B., Franchetto, A., Bacchini,C., Bettoni, D.,***Deb, T.***, Fritz, J., Gullieuszik, M. , Ignesti, A., Jaffe, Y., Moretti,A., Paladino, R., Ramatsoku,M., Serra,P., Smith, R., Tomicic, N., Tonnesen,S., Verheijen, M., and Wolter, A.

[7] **The role of environment on quenching, star formation and AGN activity:**.
Poggianti, B. M., Bellhouse, C., ***Deb, T.***, Franchetto, A., Fritz, J., George, K., ... Vulcani, B. (2020). Manuscript submitted for publication. In T. T. Storchi-Bergmann, R. Overzier, W. Forman, & R. Riffel (Eds.), Proceedings IAU Symposium No. 359, 2020 IAU.

Research Experience

Doctoral Research Experience

2021 **H I morphologies and kinematics of galaxies in Abell 2626**, *In this work, I am studying in detail the spatially resolved morphologies of the* H I *detected galaxies in Abell 2626 galaxy cluster, covering a range of cosmic environments to understand the relative importance and effect of the various physical mechanisms (such as ram pressure stripping, tidal interaction,harassment etc) that are responsible for reshaping galaxies, by identifying the cluster substructures and characterising their environments*.
Advisor: Prof. Marc Verheijen at Kapteyn Institute, The Netherlands

2021 **Investigating resolved H I/H_2 in the tail of JW100**, *I am investigating spatially resolved ram-pressure efficiencies on the interstellar medium at atomic and molecular gas phases at the tail of striking jellyfish galaxy JW100 and trying to understand the origin of molecular gas that is triggering star formation within the ram-pressure stripped tail*.
Advisor: Prof. Marc Verheijen at Kapteyn Institute, The Netherlands and Prof. Bianca Poggianti at INAF Padova, Italy

2021 **Mapping H I in Abell 2626**, *In this work, I am presenting the observations, analysis methods: an atlas with derived data products such as global profiles,* H I *column density maps and velocity fields, position-velocity diagrams of a 21 cm* H I*-line imaging survey of* ***219*** **H I** ***detected galaxies*** *in Abell 2626 (A2626)*.
Advisor: Prof. Marc Verheijen, Collaborator: Julia Healy at Kapteyn Institute, The Netherlands

2019 **Neutral Hydrogen gas in the striking Jellyfish Galaxy JO204**, *I have presented JVLA-C observations of the extended ram-pressure stripped* H I *tail, studied the interplay of neutral and ionised gas phases in the turbulent stripped tail, modelled the detected* H I *absorption against the central AGN to understand the driving physical mechanism for the observed asymmetry in the* H I *absorption profile*.
Advisor: Prof. Marc Verheijen at Kapteyn Institute, The Netherlands and Prof. Bianca Poggianti at INAF Padova, Italy

Masters Research Experience

2017 **Spectral analysis of the first radio halo in a Planck cluster**, *In this project, I have reduced and analysed GMRT data at 235, 330 and 610 MHz band and JVLA data at 1.4 GHz band of a newly found radio halo in PLCKG171.940.7 cluster to constrain the spectral index and morphology of the radio halo*.
Advisor: Dr. Ruta Kale at NCRA, Pune, India

2016 **Estimation of total AGN feedback in cluster of galaxies**, *I have calculated the total AGN feedback for all the galaxies of a cool core cluster Abell 1644 by reducing and analysing GMRT data at 610 MHz band & JVLA data at 1.4 GHz band and calculating the total radio output and thus estimating the heating of X-ray gas (X-ray observation data from Chandra) and found that contributions from non-central galaxies are not insignificant.*.
Advisor: Prof. Somak Raychaudhury at IUCAA, Pune, India

2015 **Imaging of a Pulsar detected in GMRT-Parkes Shadowing Project**, *I have worked on imaging data of a pulsar B1749-28 from GMRT-Parkes shadowing project to detect Fast Radio Bursts. I have analysed the light curve of the pulsar which indicated presence of pulsar nulling.*
Advisor: Prof. Poonam Chandra at NCRA, Pune, India

Accepted Proposals

2021 **MeerKAT proposal on An HI perspective on galaxy evolution in Abell 2626 and its surroundings** , *as the PI*.
The principal science objective is to investigate the importance of 'pre-processing' of galaxies in the Perseus- Pegasus filament before they reach the inner cluster environment in A2626. We will also study the gas content of so-called 'back-splash' galaxies that were once inside R_{200} on their infall trajectory

2021 **ALMA proposal on SYMPHANY: SYnergy of Molecular PHase And Neutral hYdrogen in galaxies in Abell 2626**, *as the PI*.
The aim is to obtain crucial information on the molecular gas content in the H I detected star forming galaxies in different environments of A2626

2021 **SMA proposal on SYMPHANY: SYnergy of Molecular PHase And Neutral hYdrogen in galaxies in Abell 2626** , *as the PI*.
The main objective is to observe the CO(2-1) line in nine star forming galaxies in A2626 with SMA. Our targets cover a range of HI deficiencient star-forming galaxies, selected from our volume-limited MeerKAT HI survey of A2626

2021 **INT proposal on Abell 2626: a laboratory for environmental effects from outskirts to the cluster core** , *as a co-I*.
The goal is to characterise the star formation activity and the presence of extraplanar ionised gas associated with galaxies located in various environments.

2021 **IRAM proposal on Molecular gas in the spiral-rich nearby cluster Abell 262** , *as a co-I*.
We proposed to observe CO(1-0) in 30 H I-detected (by Apertif) galaxies inside $2.5R_{200}$ of the nearby cluster Abell 262

2019 **MeerKAT proposal on Mapping H I in Abell 2626 and the tentacles of 'jellyfish' galaxy JW100** , *as a co-I*.
The goal was to investigate the environmental effects on the evolution of galaxies in the cluster A2626 and its surroundings

2019 **MMT/Hectospec proposal on Gas, star formation, galaxy formation in Abell 2626 and beyond** , *as a co-I*.
The aim was to collect optical spectroscopy for the MeerKAT surveyed area to search for kinematic substructure in the infall region and surroundings of A2626

2018 **WIYN/HYDRA proposal on Environment-driven Galaxy Evolution in the A262 region of Perseus-Pisces Supercluster** , *as a co-I*.
The motivation was to collect optical spectroscopy for the galaxies in the 2.5×2.5 deg^2 area of Apertif medium-deep survey

Submitted Proposals

2021 **UVIT proposal on Deep FUV imaging of A2626 galaxy cluster outskirts** , *as a co-I*.
The combination of FUV and H I observations will provide a detailed view of environmental effects on ongoing star formation and gas content from the core to the cluster outskirts in A2626

Honours & Awards

2019, 2020 **Travel Grants**, *Received Leids Kerkhoven-Bosscha Funds support twice to attend the international meetings during PhD.*

2015 **Summer Research Fellowship**, *Selected in 3 month long Visiting Students' Research Programme (VSRP) at NCRA-TIFR in India.*

2011–2016 **Innovation in Science for Inspired Research Scholarship (INSPIRE)**, *Awarded by Department of Science and Technology, Government of India for a period of 5 years for high school, undergraduate and graduate excellence (top 1% nationally in India)*.

2011, 2014 **Scholastic Achievement**, *Secured 11th position among 750,000 students in High school final examination in the state, was selected in Joint Entrance Screening Test (JEST) examination which is a National test for Integrated PhD positions in India.*

Technical Strengths

Data analysis Handling of large multiwavelength survey datasets (both optical and radio); visualisation and analysis of 3D data; radio interferometric data reduction, analysis, source finding both manually and with softwares; radio continuum imaging; 21-cm line synthesis imaging; kinematical and dynamical modelling;

Languages Python, Fortran and C

Software GIPSY, AIPS, CASA, SoFiA, Aladin, ds9, TopCat, SExtractor, gnuplot, LaTeX

Teaching Experiences

2019 Teaching assistant for the course “Observational Astronomy” (Bachelor program in Astronomy, Faculty of Science and Engineering, University of Groningen

2017-2018 Teaching assistant for the course “Introduction to Radio Astronomy” (Bachelor program in Astronomy, Faculty of Science and Engineering, University of Groningen)

2013-2017 Teaching experience as a private tutor for high school students, taught Physics, Chemistry and Mathematics

Selected seminars and presentations

2021 **European Astronomical Society (EAS) Annual Meeting**, *Virtual conference*.
Presentation on "An HI view of pre-processing in Abell 2626 and beyond",
link to the talk: https://www.astro.rug.nl/ A2626/TirnaDeb-EAS2021.mp4

2021 **A precursor view of the SKA Sky**, *Virtual conference*.
Presentation at the plenary session on H I science,
YouTube link to the talk: https://www.youtube.com/watch?v=nPl9cSvEdgg

2021 **Laura Bassi Colloquium** , *Invited speaker*.
Colloquium on “Atomic Hydrogen disks as tracers of galaxy transformation in Abell 2626 and beyond",
link to the talk: https://www.youtube.com/watch?v=kOmVh9oQ4iU

2021 **Friday lunch talk at SMA & CfA**, *Cambridge, MA, USA*.
Colloquium on “Atomic Hydrogen disks as tracers of galaxy transformation in Abell 2626 and beyond"

2021 **237th meeting of the American Astronomical Society (AAS)** , *Virtual conference*.
Dissertation talk on PhD thesis

2020 **Tuesday UVa/ NRAO Astronomy (TUNA) Lunch Talk**, *NRAO, Charlottesville*.
Colloquium on “Atomic Hydrogen disks as tracers of galaxy transformation in Abell 2626 and beyond"

2020 **European Astronomical Society (EAS) Annual Meeting**, *Leiden, the Netherlands*.
Contributed talk on “HI morphologies and kinematics of galaxies in A2626 using MeerKAT data"

2020 **GAs Stripping Phenomena In galaxies (GASP) meeting**, *Padova, Italy*.
Invited talk on "Neutral hydrogen view of jellyfish candidate and jellyfish galaxies"

2020 **SARAO Postgraduate Scholarship Conference**, *Cape Town, South Africa*.
Presentation and poster on “Atomic Hydrogen disks as tracers of galaxy transformation in Abell 2626 and beyond"

2020 **Kapteyn Science Day**, *Groningen, The Netherlands*.
Talk on "H I view of A2626 and jellyfish galaxy JW100"

2019 **MIAPP topical workshop Nine Billion Years of Neutral Gas Evolution**, *Munich, Germany*.
Contributed talk on "H I gas in striking jellyfish galaxies JO204 and JO206"

2019 **GAs Stripping Phenomena In galaxies (GASP) meeting**, *Padova, Italy*.
Invited talk on “H I gas in the complex system of JO204 jellyfish galaxy"

2018 **Pathfinders H I Science Coordination Committee (PHISCC) conference**, *Pingtang, China*.
Poster and talk on "H I gas in striking jellyfish galaxy JO204"

2018 **The KIAA forum on gas in galaxies conference**, *Beijing, China*.
Poster and talk on "H I gas in striking jellyfish galaxy JO204"

2018 **H I absorption workshop**, *Dwingloo, The Netherlands*.
Short talk on "Is ram-pressure feeding AGN in jellyfish galaxy JO204?"

2018 **The HI/story of the nearby Universe**, *Groningen, The Netherlands*.
Short talk on "H I view of a jellyfish galaxy"

Schools & Workshops

2018 The 16th Synthesis Imaging Workshop, Socorro, New Mexico, USA

2017 The European Radio Interferometry School (ERIS), Dwingeloo, The Netherlands

2017 NOVA: Fall school on astronomy courses, Groningen, The Netherlands

Professional Memberships

2020-present American Astronomical Society (AAS)

Positions of Responsibility and Other Activities

2019-2020 **Recreational Event Manager, Groningen Organisation for PhD Education and Recreation (GOPHER):** Organized recreational events and workshops including outdoor, social and creative activities in collaboration with the Graduate School.

2018-2019 **Web Administrator and Cultural Secretary, Groningen Indian Students’ Association (GISA):** Contributed in website designing, also organized and performed in several cultural events.

Diploma in “Indian Classical Music” and “Rabindra Sangit” from “Pracheen Kala Kendra", Chandigarh, India: Completed two 7 year Diploma courses and perform regularly in multiple live events.

Diploma in “Fine arts” from “Sarva Bharatiya Charukala Mandir (All India Fine Arts Association)”: Completed a 8 year Diploma degree and regularly paint using different media