University of Victoria | Graduate Studies

PROGRAMME

The Final Oral Examination
for the Degree of

DOCTOR OF PHILOSOPHY
(Department of Physics and Astronomy)

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2005 Macalester College B.A.

"Gas Flows in Interacting Galaxies: A Multiwavelength Study"

Tuesday, April 15, 2014
9:30am
Elliott Building, room 162

Supervisory Committee:
Dr. Sara L Ellison, Department of Physics and Astronomy, UVic
(Supervisor)
Dr. Chris Pritchet, Department of Physics and Astronomy, UVic
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Dr. Lisa Rosenberg, Department of Chemistry, UVic
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Dr. Ruben Sanchez-Janssen, NRC Herzberg Institute of Astrophysics

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Dr. Michelle Wiebe, Department of Curriculum and Instruction, UVic

Abstract

A galaxy's evolution is quite sensitive to the impact of external influences. In this thesis, the impact of external environment from both large and small scale effects is investigated, along with a study of how the HI gas fraction of a galaxy can modulate a galaxy's response to perturbations by galaxy–galaxy interactions. This thesis makes use of the statistical power of the Sloan Digital Sky Survey Data Release 7 (SDSS DR7) to assemble a large spectroscopic sample of galaxies, select samples of interest, and select control samples of galaxies matched to each galaxy within the sample of interest in mass, redshift, and (if applicable) local density. It is possible to trace a galaxy's internal gas motions which mark its disturbance by using the metrics of star formation rate (SFR) and gas-phase metallicity.

To investigate the influence of large scale environment, a sample of star forming galaxies in a locally dense environment, but relatively isolated from larger scale structure, is constructed. This sample is further divided into groups which are truly isolated from any large scale structure (no cluster potential within 1 Mpc), and those which, in spite of their relative local isolation, are embedded within a larger cluster structure (within 1 Mpc of a cluster). As the local galaxy density is identical between isolated and embedded group structures, a fair comparison between the star forming properties of the galaxies within those group structures can be made. Star forming galaxies whose groups are embedded within a larger structure are found to show statistically lower SFRs than those galaxies whose groups are truly isolated from any larger cluster potential.

The impact of local galaxy–galaxy interactions is subsequently considered. Using a sample of star-forming galaxies in pairs from the SDSS DR7, the enhancement in SFRs and the suppression of metallicities is traced as a function of projected separation (r_p). The metallicity dilution as a function of r_p is presented for the first time. Galaxies in pairs are found to have SFRs and metallicity values which are offset from a carefully selected control sample to separations of at least 80 kpc. Using a suite of simulations developed for the purposes of comparison with these

observational results, a new interpretive framework is developed for enhancements as a function of r_p.

To investigate the role that gas fraction plays in moderating the strength of interaction triggered starbursts, new data is obtained from the Jansky Very Large Array (VLA). The VLA data supplements the existing SDSS data with HI gas masses for a subsample of resolvable galaxy pairs at small r_p. HI masses are obtained and gas fractions are calculated for a sample of 34 paired galaxies. A positive correlation is detected at > 2σ between the gas fraction of a galaxy and the SFR enhancement of that galaxy.

The work presented in this thesis has expanded the understanding of physical variables, both internal and external, which can change the star forming properties of a galaxy through an examination of tracers of internal gas flows in those galaxies.

Awards, Scholarships, Fellowships

2011 – Graduate Student Committee Award for Best Student Talk (CASCA)
2009 – Hélène Peters prize for study in a French-speaking country
2008-2009 – Robert & Jean Gilruth Endowed Scholarship
2005 – Girl Scout Gold Award

Presentations

1. Scudder, J. M., "*Towards a more complete picture of galaxy interactions.*" Physical Processes of Galaxy Formation: Consensus and Challenges, Aix-en-Provence, France. July 2013. (oral)
2. Scudder, J. M., "*Star Formation Rates, Metallicities, and Colours as probes of merger timelines.*" Galaxy Mergers in an Evolving Universe, Hualien, Taiwan, Oct. 2011. (oral)
3. Scudder, J. M., "*SFR & Metallicity Offsets in Interacting Galaxy Pairs.*" Galaxy Formation, Durham, UK. July. 2011. (poster)

4. Scudder, J. M., "*Metallicities and SFRs of merging galaxies.*" CASCA, London, Ontario, Canada. May. 2011. (oral)

Publications

1. Ellison, S. L., Mendel, J. T., Patton, D. R., Scudder, J. M., "Galaxy pairs in the Sloan Digital Sky Survey - VIII: The observational properties of post-merger galaxies." 2013, *MNRAS*, 435, 3627.
2. Patton, D. R., Torrey, P., Ellison, S. L., Mendel, J. T., Scudder, J. M., "Galaxy pairs in the Sloan Digital Sky Survey - VI. The orbital extent of enhanced star formation in interacting galaxies." 2013, *MNRAS* L110.
3. Ellison, S. L., Mendel, J. T., Scudder, J. M., Patton, D. R., & Palmer, M. J. D. "Galaxy Pairs in the Sloan Digital Sky Survey - VII. The merger–luminous infra-red galaxy connection." 2013, *MNRAS*, 430, 3128.
4. Scudder, J. M., Ellison, S. L., Torrey, P., Patton, D. R., Mendel, J. T., "Galaxy Pairs in the Sloan Digital Sky Survey - V. Tracing changes in star formation rate and metallicity out to separations of 80 kpc." *MNRAS*, 426, 549.
5. Scudder, J. M., Ellison, S. L., Mendel, J. T., "The dependence of galaxy group star formation rates and metallicities on large scale environment." 2012, *MNRAS*, 423, 2690.
6. Ellison, S. L., Nair, P., Patton, D. R., Scudder, J. M., Mendel, J. T., & Simard, L., "The impact of gas inflows on star formation rates and metallicities in barred galaxies." 2011, *MNRAS*, 416, 2182.
7. Cannon, J. M., Haynes, K., Most, H., Salzer, J. J., Haugland, K., Scudder, J. M., Sugden, A., & Weindling, J., "The Stellar and Gaseous Contents of the Orion Dwarf Galaxy." 2010, *AJ*, 139, 2170.