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Hunting for Isolated Warm Gas Clouds in the Virgo Cluster of Galaxies

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Hunting for isolated warm gas clouds in the Virgo cluster of galaxies

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Project Description

Galaxies are island universes where stars find home. Galaxies are strongly clustered in the universe with the densest parts as galaxy clusters. Galaxy clusters are composed of hundred to thousands of galaxies, gravitationally bound together with a typical total mass of 10^{14} - 10^{15} $M_{\odot}$. Most baryons (or regular matter) in galaxy clusters are in the hot ($T \sim 10^7 - 10^8$ K) intracluster medium (ICM). Cluster galaxies soar through the ICM and the interaction with the ICM plays a vital role in galaxy evolution, mainly through ram pressure stripping (RPS). The last 10 - 15 years have witnessed a burst of observational evidence of ram pressure stripping on cluster galaxies, which allows us to study important processes in galaxy evolution and cosmic structure formation.

Among all tracers of ram pressure stripping, Hα remains as the most efficient one for the high sensitivity of the current optical telescopes. he Hα emission traces warm, ionized gas from the in terstellar medium still in the galaxy or already stripped from the galaxy. Recently we were granted a large program with the 3.5m Canada-France-Hawaii Telescope (CFHT) telescope in Hawaii to pro duce a Hα survey of the Virgo cluster, A Virgo Environmental Survey Tracing Ionised Gas Emission (VESTIGE) (PI: Boselli, Co-I: Sun and others). The Virgo cluster is the closest galaxy cluster and this new survey, taking advantage of the 1 deg^2 field-of-view of the MegaCam, will provide the state of-art data to study ram pressure stripping with the warm, ionized gas on Virgo cluster galaxies. Our team also has multi-wavelength supporting data for the Virgo cluster.

In this RCEU project, we will examine all the VESTIGE Hα data available to search for isolated Hα clouds away from galaxies. A few examples of such kind of clouds have been discovered from some initial analysis and a complete sample will be important for us to understand ram pressure stripping, the survival of stripped clouds in clusters, and the related significant questions. Our sci ence goals are: 1) searching for isolated Hα clouds far away from Virgo galaxies. As there can be a lot of optical artifacts, each candidate will also be verified within the VESTIGE or using the the Next generation virgo cluster survey data in the optical broad bands. At the end of the project, a sample of isolated Hα clouds will be constructed. 2) studying the multi-wavelength properties of the newly discovered isolated Hα clouds with the archival data and prepare for follow-up observations with additional proposals.

Student Duties, Contributions, and Outcomes

The RCEU student is expected to work 320 - 340 hours in total for this RCEU project. The student will work on the pipeline products of the VESTIGE data from CFHT. The net Hα image of each field is ~ several GB and there will be 50 - 100 net Hα images. The student will proceed the research with the following steps: 1) get familiar with the VESTIGE data and download some net Hα images. 2) examine 5 - 10 fields first to select isolated Hα clouds visually and using the software SExtractor on binned images. Dr. Sun will do the same for such a small sample to compare results. 3) expand the work to the whole survey fields and build a sample of isolated Hα clouds. 4) As there

can be many contamination features from optical artifact, for each candidate, we will also examine individual frames to validate them. We will also examine other survey data on the Virgo cluster for verification. We may need to have 2-3 classes for all the candidates, based on their significance. 5) examine the multi-wavelength properties of the selected Hα clouds with the archival data.

Interesting Hα clouds will be followed up by Dr. Sun's group with more proposals (that would likely bring research grants to the UAH). The results by the student will play an important role in our future proposals and papers on isolated cold/warm clouds in galaxy clusters. The student will be included in any publications with the sample. The student is also expected to present a poster on the project at a regional conference. Upon the finish of the project, the student will have real experience of astronomical research, gain a deeper understanding of galaxies and galaxy evolution, obtain the programming skill important for the future career, and develop problem solving skills both analytically and numerically.

Student Selection Criteria

The successful applicant should have a good academic record (GPA > 3.3) and have finished in troductory physics classes. The successful applicant should also have experience with computer programming (with e.g., python, or C) and scripting (with e.g., python, or shell). Previous experi ence with ds9 is also preferred.

Faculty/Research Staff Mentorship

The mentor (Dr. Sun) has a large research group in the Department of Physics and Astronomy, with two postdocs and three graduate students. Both the mentor and his postdocs/graduate students will interact with the RCEU student in regular basis and provide close tutoring. Dr. Sun's senior graduate students, Will Waldron and Sunil Laudari, are experts on HST data analysis and python programming and will also interact with the student regularly. Dr. Sun's postdocs are all experienced programmers and will help to train the student in regular basis. At the initial stage of the project, the student and the mentor will meet about 2 hours per day to start the project. Early start in the spring semester is also encouraged. After the initial stage, the student will work more independently, consulting with the mentor and other group members when needed, also with weekly meetings with the mentor. Office space for the student will be provided in the Optics building. Laptop and workstation access can also be provided.

Safety and Contingency Plan

This project does not require any lab work so can be easily adopted to the remote format if any restrictions in 2021 limit face-to-face contacts or on-campus activities. Dr. Sun has one RCEU student in the summer of 2020. With emails, zoom meetings, shared desktop and shared documents and software, it is as effective as in-person meetings.