PHD PROGRAM 2023

Studying the low surface brightness universe with CASTLE (the Calar Alto SchmidT-Lemaitre Explorer): science preparation and exploitation

Supervision:

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Figure 1. Left : the CASTLE Dome installed at the summit of the Calar Alto observatory (Spain). Right: *Low surface brightness environment of ETG NGC0474. Image obtained with the MegaCam camera at CFHT (Coleum+2012)*

Aim: The PhD work proposed here is two-fold: 1/ Preparation of the CASTLE telescope operations and observations by means of simulations and data reduction pipeline development and 2/ Preparation of the science observations and exploitation

Context: The Calar Alto Schmidt-Lemaitre-Explorer is a new observatory hosting a small 35cm telescope which innovative design makes it a dedicated facility to observe the Low Brightness Universe. The telescope is currently under construction and will be installed in Spring 2024, with a first light planned for summer 2024.

The recent years have known a renewed interest for low surface brightness structures around galaxies (e.g. star forming extended disks, tidal or merger features) and diffuse galaxies in general (including giant low surface brightness galaxies such as Malin 1, and the so-called "Ultra-Diffuse galaxies", a term coined in Van Dokkum et al. 2015). This interest is largely due to progresses in instrumentation and pipeline, although observations are still made difficult by the instrumental artifacts in the image resulting from the combination of reflections in the optical design, PSF, etc. The CASTLE innovative design should greatly reduce these drawbacks.

Work to be done

As the telescope is currently under construction, the work to be done is split into several activities to be undertaken during the course of the thesis:

1/ Preparation of models to simulate what the telescope is about to observe and extract anticipated performances.

This activity is to be undertaken early in the thesis and will be done using real existing data from e.g. the Canada France Hawai Telescope (CFHT). The student will work in close interaction with world expert of this topic at LAM and at the Strasbourg Observatory (S. Boissier, S. Lombardo and PA Duc).

2/ Participation to the development of the data reduction pipeline,

This activity is the core tool of thesis. The student will work on the development of the telescope data reduction pipeline under the supervision of experts at LAM (S. Lombardo) and Strasbourg Observatory (PA Duc). The student will work in close interaction with the LAM Science Data Center (CESAM).

3/ Participation to the installation and commissioning of the telescope

The student will be part of the telescope team that will install the telescope at Calar Alto and will participate to the assembly, alignment, testing, performance extraction and commissioning of the telescope. The skills acquired during the pipeline development phase will be crucial for this activity, as the data acquisition, reduction and exploitation are the core of the activity.

Also, if interested, the student will have the opportunity to work on the instrumentation aspects during the assembly, installation and commissioning phase.

She/he will thus benefit from the technical expertise of the telescope experts (E. Hugot, E. Muslimov, S. Lombardo) and the grad student working on it (J. Liu).

4/ Scientific exploitation of the telescope.

The student will apply the knowledge developed so far to analyze observations of LSB objects from CASTLE or existing observatories (e.g. optical properties of the LSB outer regions of "XUV" galaxies selected to be extended in the UV). During this part of the thesis, she/he will benefit from collaborations with various institutions (Stoney Brook University USA, Observatoire de Strasbourg, Instituto Astrofisico de Andalucia etc.).

Skills

Strong skills in Python programming are required for this PhD work. Knowledge about instrumentation for astrophysics are an asset for the participation to the assembly of the telescope, and of image processing for the data analysis.

Environment, Outputs and Enrichment for the student:

The student will be part of an international team gathering experts from France, Spain, Poland, and the US. The student will be involved in the regular meetings of the consortium.

The student has to be autonomous and pro-active. She/he will benefit from various expertise from the supervisors, either on the technical aspects for the data reduction pipeline development to be done together with the LAM Science Data Center (CESAM), or on the scientific aspects with recognized experts of the field of Low Surface Brightness Universe.

The student will have the opportunity to work on the instrumentation aspects during the assembly, installation and commissioning phase. She/he will thus benefit from the technical expertise of the team building the telescope.

At the end of the thesis, the student will have acquired the skills about how an observatory is built and how it works.

LAM, ObAS and Calar Alto

The LAM is one of the largest Astrophysics Lab in France, and has a long-term experience in ground/space instrumentation development and observatories building. The LAM teams participated to the VLT instrumentation, the future NASA Roman Space Telescope instruments, the NASA JWST science preparation.

The Strasbourg Observatory (ObAS) has a world leading expertise in the field of Low Surface Brightness Universe and data reduction. ObAS is deeply involved in the CFHT and LSST observatories for years.

Calar Alto is a Spanish/German Observatory located in the Sierra Nevada. Frequent travel there will occur during the course of the thesis.

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