MOVIE@Rubin-LSST: enabling early science

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In collaboration with STEP@INAF group and TVS SC
This is a project connected with MOVIE scheda (PI Marconi)

THE AIM: The near future will be a goldmine in the field of stellar transient and variability thanks to the **LSST survey at the Vera Rubin Observatory.**

The huge amount of pulsating stars data hosted in different environment with different stellar composition and star formation histories will enable the stellar community to

1. Map out the three-dimensional structure of the studied systems.
2. Explore the relationship between the properties of the pulsating stars and their chemical composition, aiding in the refinement of theoretical models.
3. Detect potential extended halos encircling the observed systems, as well as recognize streams and areas of increased stellar density in the Galactic field. These findings offer crucial insights into the mechanisms governing the formation of both the Galactic and stellar systems.

The first Rubin's light is expected in early 2025. This short time that separates us from the first LSST release scheduled by the end of 2025 is crucial as we must prepare for the exploitation of this unique opportunity.

The main goal of this project is to enable the Rubin LSST early science with pulsating stars and it is based on two pillars: 1) researcher exchange; 2) the deliverable of software and notebooks dedicated to the understanding of how to maximize pulsating star early science with LSST

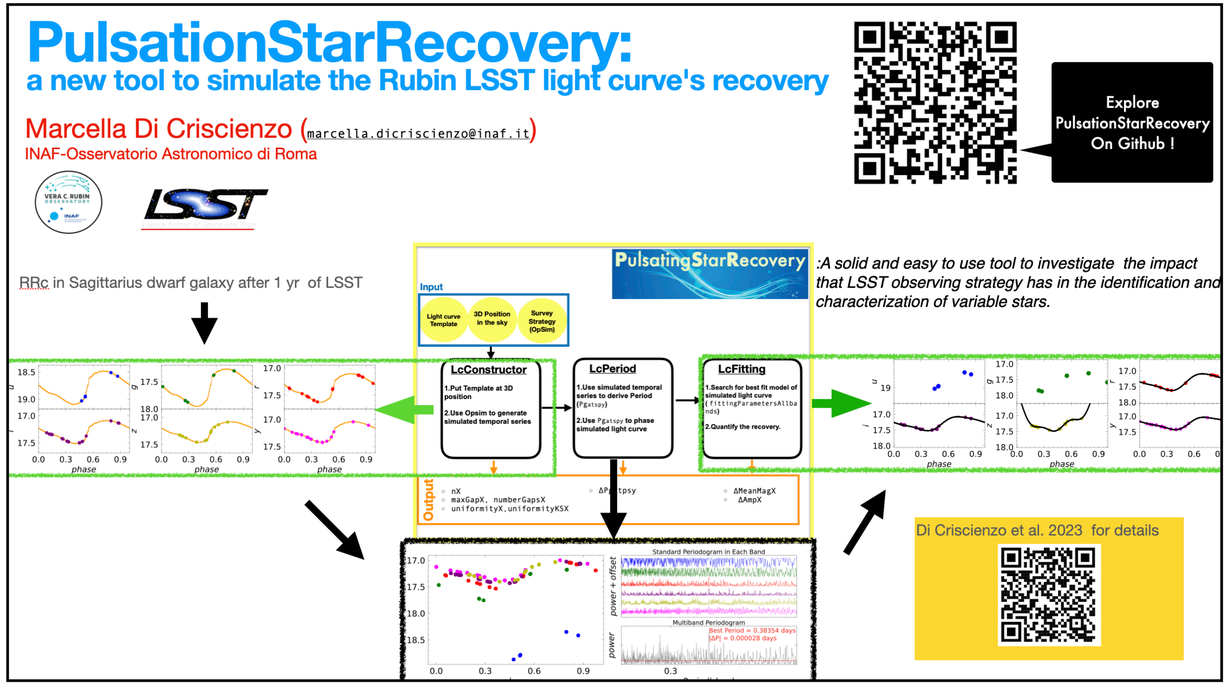
FUNDING:The requested amount of funding was 15,000 euros, mainly intended to support researcher exchanges and the participation of the Principal Investigator (PI) and collaborators in conferences. Currently, approximately 5,000 euros have been expended. This sum covered internal researcher exchanges between Naples and Rome, as well as the our participation in three conferences related to this project (IUAS376, LSST@Europe4, and STARS), where the developed tool within this project was showed. There are plans to allocate the remaining funds for the purchase of a desktop computer and to fund a research stay at Tokyo University to collaborate with Professor Matsunaga on LSST observation plan on LPV and Mira.This visit will serve to replace the originally planned exchange with Rachel Street, considering the delayed disbursement of funds and the availability of the guest, which was arranged before the start of this mini grant.

Update and status of the project

During the first year of the project, we acquired the necessary expertise to work with the first data from Rubin, playing with simulations released by LSST Collaborations in both MAF environment (https://www.lsst.org/scientists/simulations/maf) and Rubin Science Platform (https://data.lsst.cloud/). In the contest of survey cadence optimization process in Collaboration with TVS Science Collaboration we developed a tool called PulsationStarRecovery aimed at exploring the consequences of different observational strategies on different scientific cases that involve pulsating stars as RR Lyre, Cepheids and Mira. We make this tool available to the community by putting it on GitHub (https://github.com/MARCELLADC/rubin_sim/blob/main/rubin_sim/maf/mafContrib/PulsatingStarRecovery_MAF.py.).

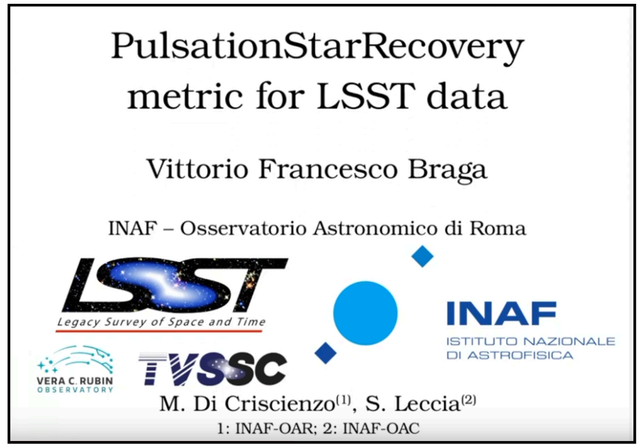
This tool and its initial applications have been described in an article published on the ApJ (Di Criscienzo et al. 2023, ApJ S,265,41D). Furthermore, we apply the newborn metric to simulate LSST observations and recovery of different types of pulsating stars hosted by selected massive stellar systems (19 Local Group dwarf galaxies and the Large Magellanic Cloud) to show how the recovery changes according to distance and variable-star type. We show that this exercise is essential to understand the potential of LSST in this field since excellent recovery is necessary to optimize the use of predicted period–luminosity, period–amplitude, and color–color relations to constrain the cosmic distance scale and the metallicity distribution function of different stellar populations.

We extensively promoted the tool at various international and national conferences, as well as in the SC meetings.



From the Poster at IUAS376, on RR Lyrae stars, Budapest, April, 2023

TALK LSST@Europe5, September 2023 and STAR, October 2023



Kickstarter Colloquia by Vittorio Braga, January 2023
https://www.youtube.com/watch?v=pEZ6rtm5Im0

What remains to be done:

In the second year of the project, we are set to undertake several significant activities aimed at further advancing our research objectives and in particular we are currently delving into a list of scientific cases involving pulsating variables that will be observed by LSST in order to develop tools and notebooks for conducting essential for early science. In particular:

* in collaboration with Michele Trabucchi, we are engaged in the LSST simulation of a LPV population in the WLM galaxy;
* in collaboration with the TVS task force on the Bulge strategy, chaired by Rachel Street, we are investigating the implications that the latest simulations of the observational strategy have on the observation of RR Lyrae stars in the Galactic Bulge direction ;
* with Ilaria Musella and Marcella Marconi , we are uncovering the potential of LSST in observing long-period stars (Musella, Marconi, DC et al. in preparation)
* with Vincenzo Ripepi, we are studying the LSST observation of RR Lyrae stars in the vey outer halo of the Galaxy(Ripepi, Leccia, DCet al. in preparation)

In the end I want to mention that within the end of the project, we hopefully expect the arrival of commissioning data , which will y be used to test our tools .
I would like to underline that the future access to these data will be possible thanks the preparatory work carried out in this first year of this MOVIE project.

Report on project criticalities

The project has encountered relatively few major critical issues. However, it's essential to highlight that the timing of fund arrival significantly impacted the project's schedule. If the funds had been received six months earlier, the initial project timeline could have been met. Fortunately, the subsequent delay did no have significant repercussions due to the LSST schedule also being postponed by six months.

Nonetheless, despite the adjustment in the LSST schedule, certain project tasks, particularly those related to the exchange of researchers, will need to be restructured. Specifically, the planned visit from Rachel Street, initially scheduled for late 2022 (at the same time as the LSST@europe4 meeting), most probably will be replaced with a visit to Tokyo University in Spring 2024 to collaborate with Professor Masunaga on the LSST simulation of LPV and Mira in dwarf galaxies and the galactic bulge.

The shift in the visit, albeit necessary, points to the need for recalibrating certain collaborative activities due to the altered timeline. Despite these adjustments, the core objectives and goals of the project remain intact, with continued progress anticipated in collaboration and research efforts.