

Template for LSST Italy report

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Abstract

This report includes the activity of the LSST quintuplet “RR Lyrae, Cepheids and Luminous Blue Variables to constrain theory using LSST observations”. In the last year, i) we actively participate to Transients and Variable Stars and Stars, Milky Way & Local Volume Science Collaboration activities; ii) we begin to build a theoretical database for RR Lyrae and Cepheid light curves for a wide range of masses, periods and chemical compositions transformed in all the adopted filters and, in particular, in the LSST filters ugrizy; iii) we collaborate to the preparation of more White Papers on LSST Cadence Optimization.

1 Quintuplet Information 2018

- P.I.: Ilaria Musella, researcher, INAF - Osservatorio Astronomico di Capodimonte
- co-P.I.: Marco Limongi, first researcher, INAF - Osservatorio Astronomico di Roma (external to the quintuplet)
- co-P.I.: Marcella Marconi, first researcher, INAF - Osservatorio Astronomico di Capodimonte (external to the quintuplet)
- Maria Ida Moretti, postdoc, INAF - Osservatorio Astronomico di Capodimonte
- Alessio Marino, PhD, INAF - Osservatorio Astronomico di Roma and Dipartimento di Fisica e Astronomia, Università La Sapienza, Roma
- Michele Fabrizio, postdoc, INAF - Osservatorio Astronomico di Roma and Space Science Data Center - ASI
- Paola Marrese, researcher, INAF - Osservatorio Astronomico di Roma

2 Quintuplet Information 2019

Below you can find my proposal to be discussed during the meeting in Rome.

- P.I.: Ilaria Musella, researcher, INAF - Osservatorio Astronomico di Capodimonte
- co-P.I.: Marco Limongi, first researcher, INAF - Osservatorio Astronomico di Roma (internal to the quintuplet)
- co-P.I.: Marcella Marconi, first researcher, INAF - Osservatorio Astronomico di Capodimonte (external to the quintuplet)
- Roberto Molinaro or Silvio Leccia, both researchers, INAF - Osservatorio Astronomico di Capodimonte
- Maria Ida Moretti, postdoc, INAF - Osservatorio Astronomico di Capodimonte
- Giulia Somma, PhD, Dipartimento di Fisica "Ettore Pancini" Università Federico II - Napoli, INAF - Osservatorio Astronomico di Capodimonte

2.1 Scientific Collaborations:

- I. Musella, M. I. Moretti joined Transients and Variable Stars (TVS) and Stars, Milky Way & Local Volume (SMWLTV) Science Collaborations. In particular, in the TVS context, they have joined "Review variability characterization parameters planned for the Level 1 and Level 2 LSST" (RevVar) and "Deep Drilling Fields and Mini-Surveys" (DDF & MS) Task Forces. Moreover, they are contributing to the TVS Roadmap Document (see Sect. 4).
- M. Marconi joined TVS and SMWLTV Science Collaborations.
- M. Fabrizio and P. Marrese joined TVS and SMWLTV Science Collaborations and participated to the activities of "Stellar variability in crowded fields" and "Deep Drilling Fields and Mini-Surveys" Task Forces
- A. Marino joined TVS and SMWLTV Science Collaborations.
- I. Musella is member of the Photometric LSST Astronomical Time-series Classification Challenge (PLAsTiCC).

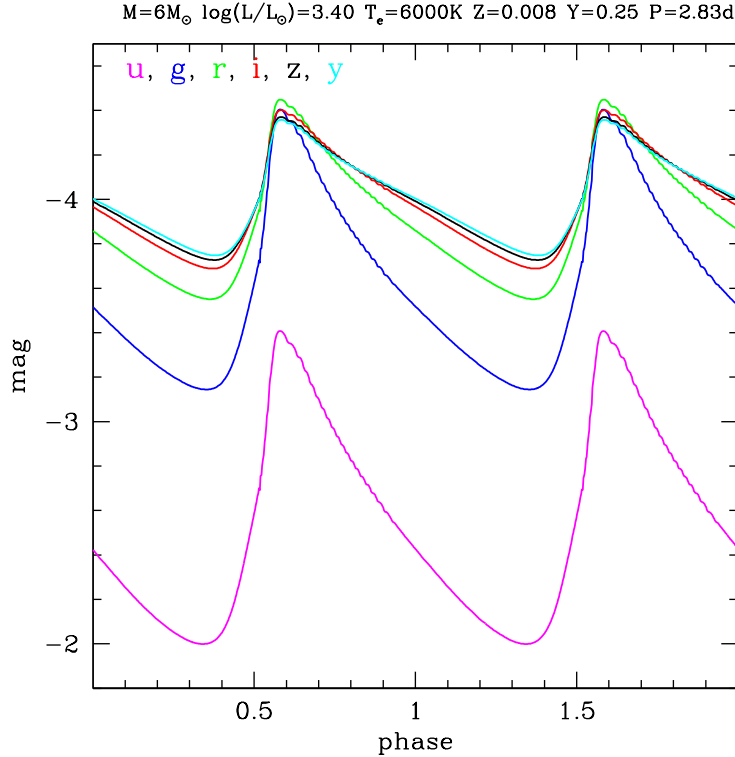


Figure 1: An example of the theoretical light curve for a Classical Cepheids. The input physic parameters and the obtained period are labelled on the top of the figure.

3 Scientific Activity

The scientific activity of our group has been devoted i) to produce a theoretical database for RR Lyrae and Cepheid light curves in various filters and in particular in the ugrizy LSST filters and ii) to prepare more White Papers on LSST Cadence Optimization.

Theoretical light curves are based on nonlinear convective pulsation models for a wide range of mass and chemical composition that allow to obtain all the observables as means, periods and amplitudes and to theoretically build observational tool as period-luminosity and period-luminosity-color relations useful to compare and interpret the observed pulsation properties. On this basis, it is possible, for example, to study the dependence on the chemical abundance of the variable properties and/or to obtain a theoretical calibration of the extragalactic distance scale. These models are also part of the PLAsTiCC. The full database for Classical Cepheids, with metallicity and helium content typical of the Large Magellanic Cloud ($Z=0.008$ $Y=0.25$), will include about 21000 models with a very large range in mass, luminosity, temperature and mixing length (ongoing PhD Thesis G. de Somma).

An example of the theoretical light curve for a Classical Cepheid in the LSST filters obtained for a Classical Cepheids is showed in Fig. 1.

Members of this quintuplet are involved in the preparation of three White Papers.

All the members are authors of the White Paper titled “The Gaia-LSST Synergy: resolved stellar populations in selected Local Group stellar systems” (P.Is. G. Clementini and I. Musella) that has been prepared in collaboration with the quintuplet “The Gaia-LSST Synergy: from pulsating stars and star formation history to WDs” (PI G. Clementini) and with some members (Paolo Ventura, Marcella Di Criscienzo and

Ester Marini) of the quintuplet “Multiperiodicity as a tool to investigate stellar physics”. This project aims to observe with the LSST six Local Group stellar systems of different morphological type (also including the new discovered candidate “ultra-diffuse” galaxy Antlia 2) and to characterize the selected targets using different stellar tracers as RGB stars and pulsating variable stars of different type/parent stellar population spanning the whole classical instability strip (namely: RR Lyrae stars, Cepheids of different types, SX Phoenicis and delta Scuti stars), LPVs, and turn-off main sequence stars. In particular, the target selection and the strategy has been planned by I. Musella, G. Clementini and V. Ripepi and the metric simulations have been performed by I. Musella, M. I. Moretti and M. Di Criscienzo.

For this White Paper, we need to modify and use some LSST metrics (see Sect. 4 for details) to simulate (through a Montecarlo method) our planned observations and to evaluate the probability to observe various type of variables of different periods, amplitudes and mean magnitude. For a detailed description of this project see the attached file Clementini_Musella.pdf.

I. Musella and M. Marconi has also contributed to the White Paper “Mapping the Periphery and Variability of the Magellanic Clouds” (P.I. Knut Olsen) that proposes a combination of a modified Wide-Fast-Deep survey, a mini-survey of the South Celestial Pole, and a Deep Drilling-style survey to produce a 3-D map of the Magellanic System and to provide a detailed census of the transient and variable populations in the Clouds (for details, see the attached file Olsen.pdf).

I Musella, M. Fabrizio, P. Marrese and M. Marconi also collaborated to the White Paper “unVEil the darknesS of The gAlactic buLgE (VESTALE)” (P.I. G. Bono) whose main aim is to provide a complete census of old ($t \geq 10$ Gyr, RR Lyrae, type II Cepheids, red horizontal branch), intermediate age (red clump, Miras) and young (classical Cepheids) stellar tracers across the Galactic Bulge (for details, see the attached file vestale3.pdf).

4 Scientific and technical deliverables

4.1 Proposals:

- “The Gaia-LSST Synergy: resolved stellar populations in selected Local Group stellar systems” (P.Is. G. Clementini and I. Musella) - Clementini_Musella.pdf
- “Mapping the Periphery and Variability of the Magellanic Clouds” (P.I. Knut Olsen) - Olsen.pdf
- “unVEil the darknesS of The gAlactic buLgE (VESTALE)” (P.I. G. Bono) - vestale3.pdf

4.2 Documents:

- The Photometric LSST Astronomical Time-series Classification Challenge (PLAsTiCC): Data set (<https://arxiv.org/abs/1810.00001>)

4.3 Technical deliverables

We developed two notebooks <https://bit.ly/2QuNieS> and <https://bit.ly/2Quvcd1> to get the fields we are interested and to know the number of planned pointings in the different filters on the different selected fields and using an existing metric (PeriodicStarMetric.py) to get the fraction of recovered variable stars on the basis of period, amplitude and mean magnitude (in *ugriyz*) of the different types of variable stars (see White Paper Clementini_Musella.pdf for details).

1. Clementini_Musella.pdf
2. Olsen.pdf
3. vestale3.pdf

5 Other information

5.1 Zoom Teleconf

- International TVS Science Collaboration teleconf (two per months) - I. Musella and M. I. Moretti
- Subgroup TVS leaders teleconf (two per month) - I. Musella and M. I. Moretti
- Roadmap teleconf (one for month) - I. Musella and M. I. Moretti
- RevVar and DDF & MS Task Forces teleconf (one for month) - I. Musella and M.I. Moretti
- "Stellar variability in crowded fields" teleconf - M. Fabrizio and P. Marrese

5.2 Meetings

- I. Musella, M.I. Moretti, M. Marconi and A. Marino attended to LSST TVS workshop 2018 - Naples April 9-11, 2018 - INAF – Osservatorio Astronomico di Capodimonte (I. Musella and M. Marconi also in the Organising Committee)
- I. Musella attended to LSSTEurope3 - Building Science Collaborations - Lyon, 11-15 June 2018 with and Oral contribution to the Session 7A: Workshop: Local Volume, MW, Stars & Planets: L3 Requirements/ DDF/minisurveys titled "Pulsating stars as population tracers and distance indicators: Teo-obs comparison"
- I. Musella attended to the Mini-Workshop on "Metrics Analysis Framework (MAF)", Torino, September 17-19, 2018 with an oral contribution titled "Pulsating stars as population tracers and distance indicators: Teo-obs comparison"
- I. Musella and M. Marconi attended to the LSST – Large Synoptic Survey Telescope – Special Programs Workshop - Palermo, October 8–10, 2018

6 References