The GalRSG Project: Red Supergiants on the Brink of Core-Collapse

Mario Lauriano
INAF-Osservatorio Astronomico di Palermo &
Dip. di Fisica ed Astronomia, Università di Padova

Collaborators: **F. Bocchino, M. Miceli, S. Orlando, O. Petruk, A. Pastorello , M. Limongi, A. Chieffi, Y. Maruccia, L. Izzo, N. Pinciroli Vago**

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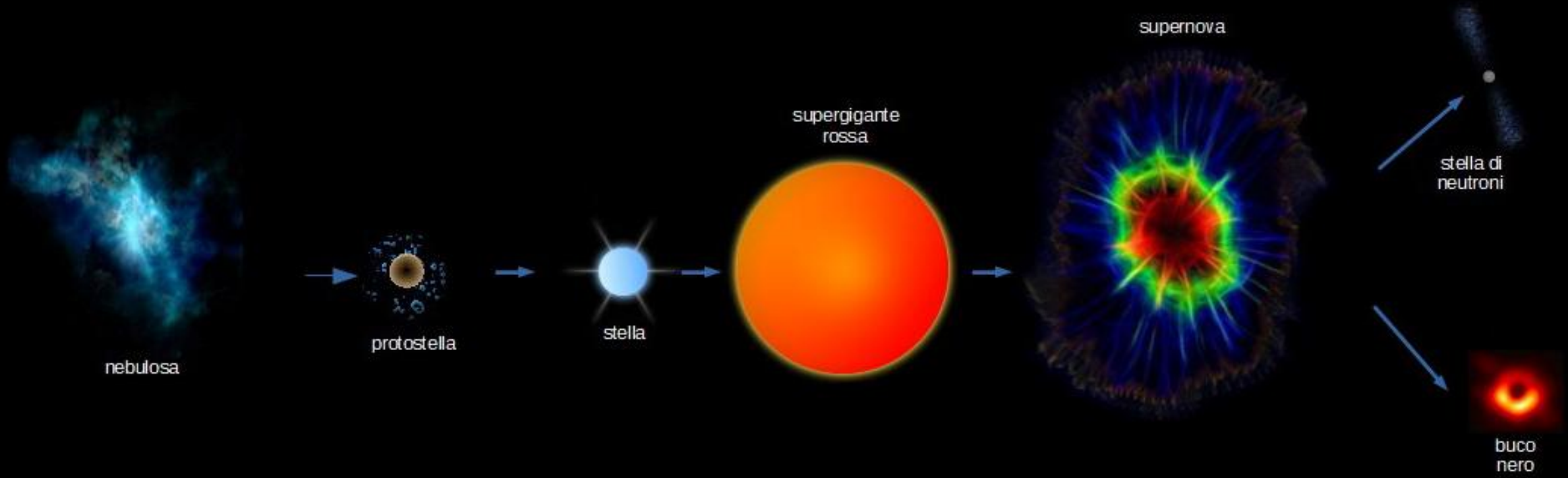
INAF School of AI

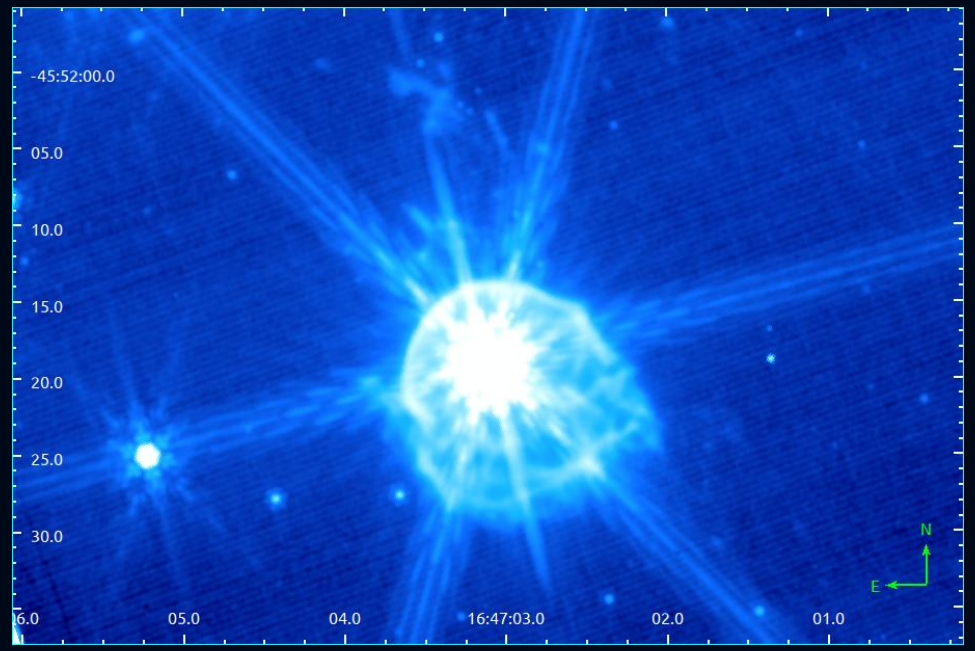
Artistic impression - Credit: Magann / Getty Images

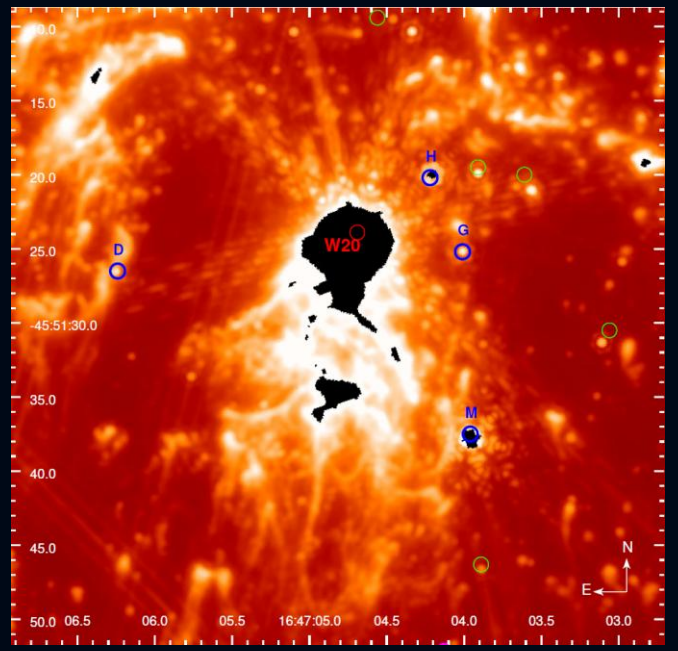
STELLAR EVOLUTION

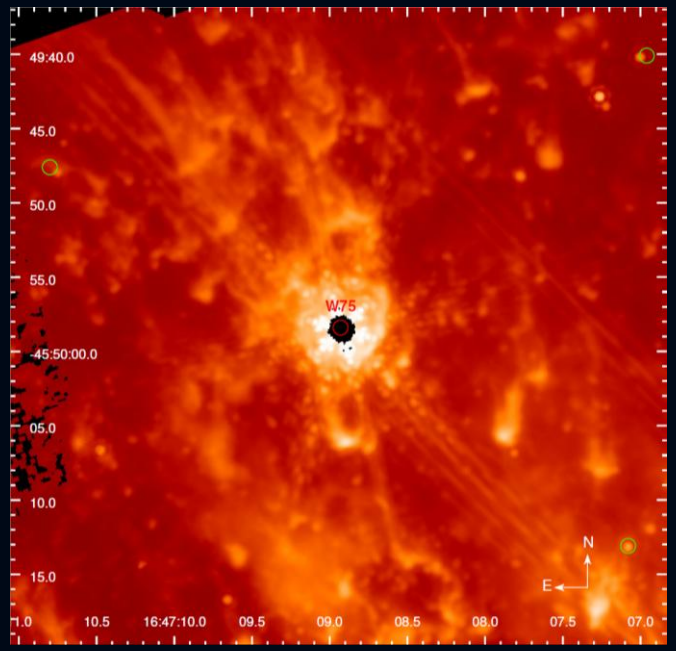


WHAT ARE WE LOOKING FOR?

MASS-LOSS EVENTS OF RED SUPERGIANTS







Circumstellar Medium (CSM) around Red Supergiants with JWST

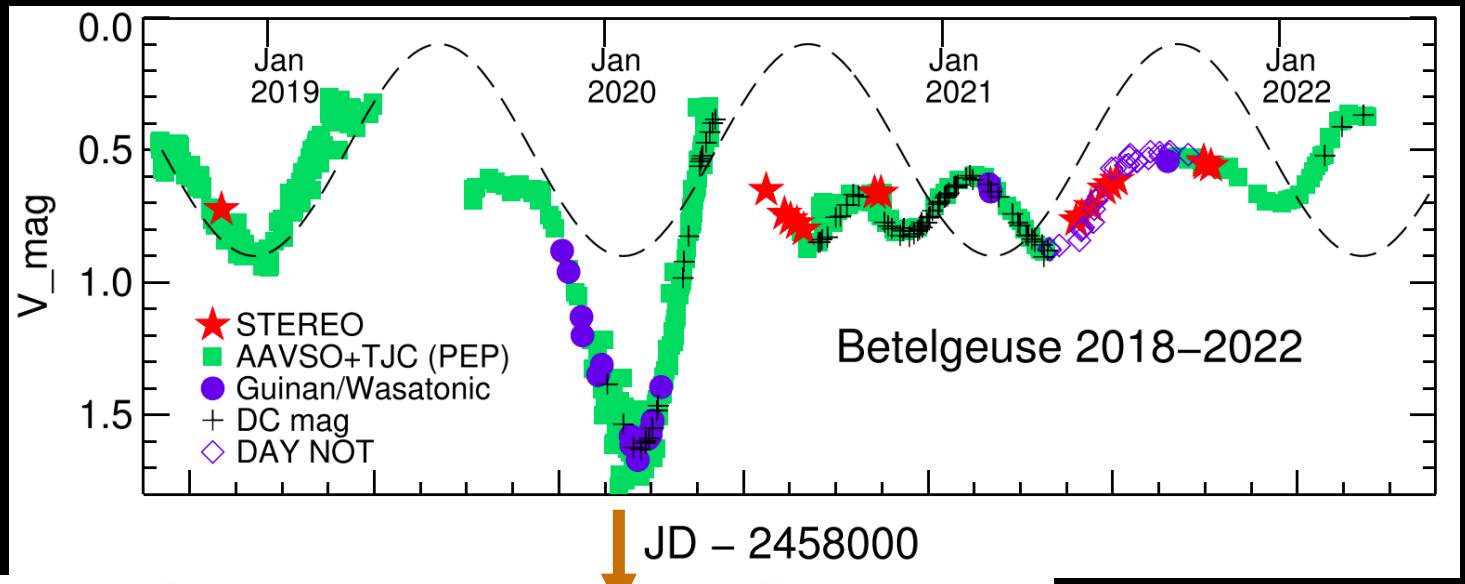
(Guarcello+25, Astronomy & Astrophysics)

RSGs can undergo brief but intense mass-loss episodes on timescales ranging from thousands of years to centuries, years, months, and even days before the supernova.

PRE-SUPERNOVA OUTBURST: THE CASE OF BETELGEUSE

Energy injection in the envelope produces detectable modifications in the light curves.
(Jacobson-Galán+22, Davies+22, Morozova+18,20)

Dupree+22, The Astrophysical Journal



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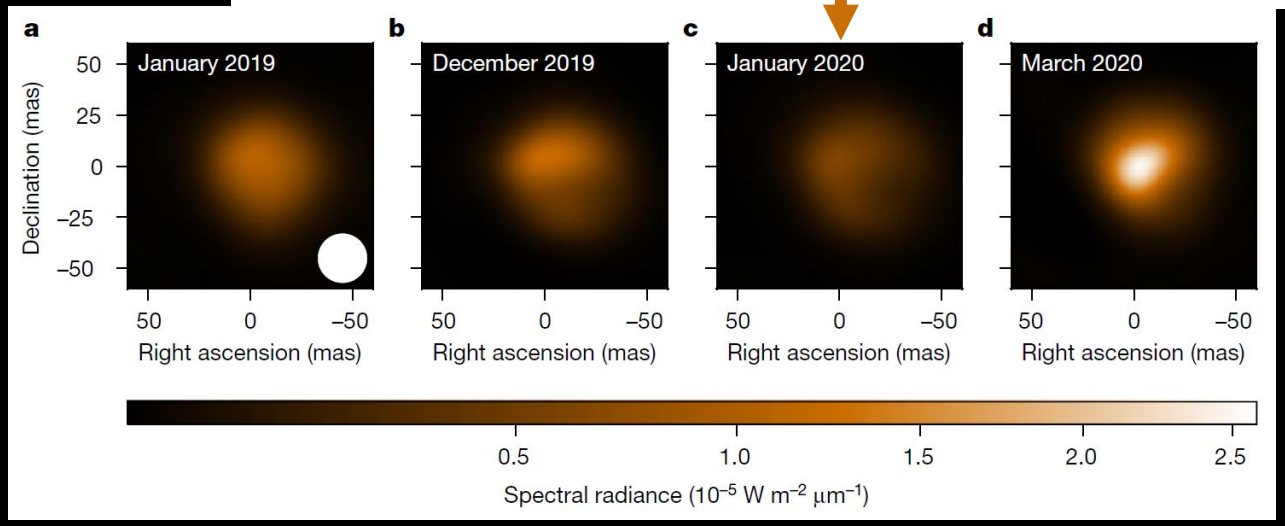


Montargès+21, Nature

GalRSG CATALOGUE AND ONGOING OBSERVING CAMPAIGN

STAR CATALOGUE

Lauriano et al. 2026, in press,
A New Catalogue of Galactic Red Supergiants for direct detection of episodic mass-loss events

- **2.6 m INAF-VST (Paranal, Chile)**

Focused on **field RSGs** since 2023
5 ± 2 days cadence photometry in **i,z**

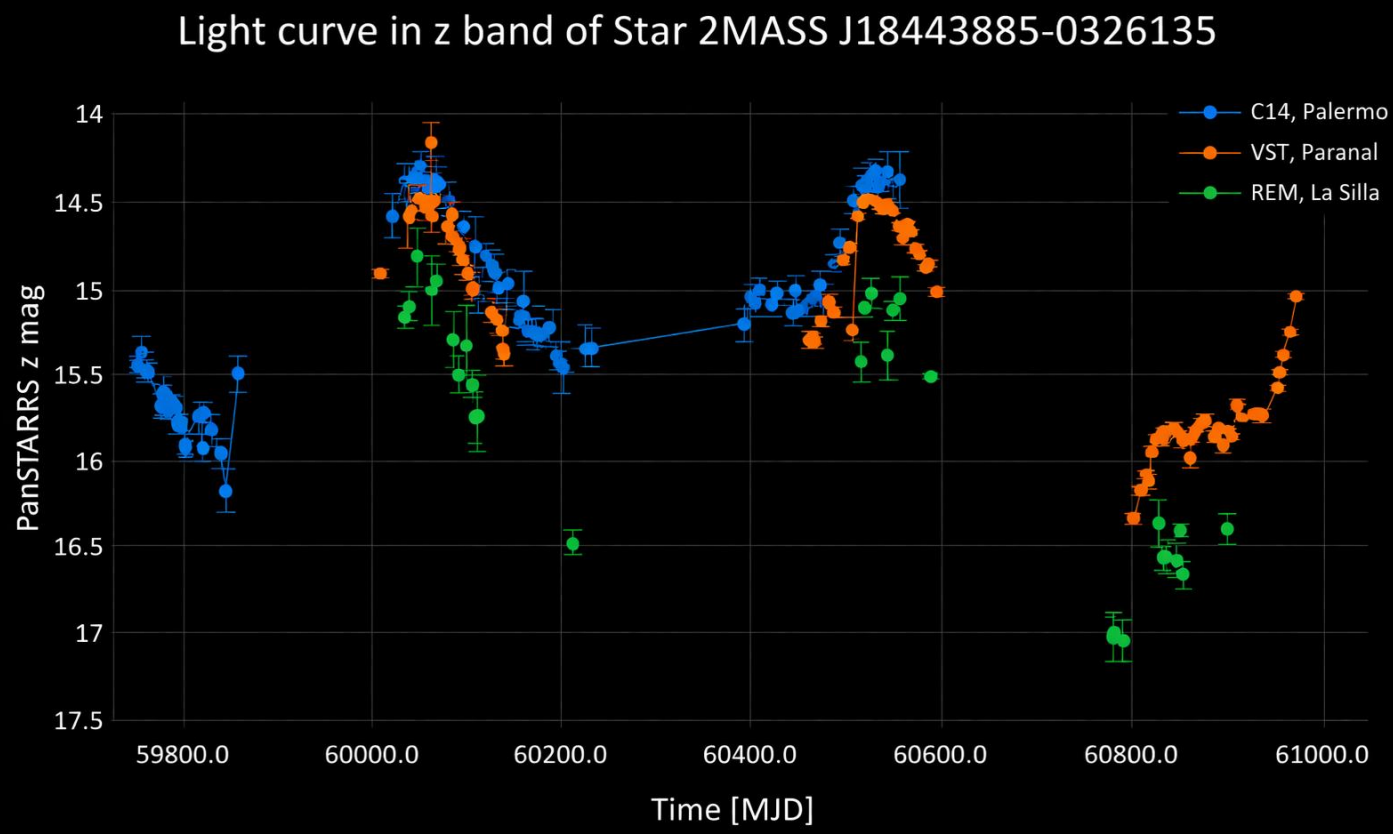
- **60 cm INAF-REM (La Silla, Chile)**

Monitoring of **RSGs in clusters** since 2023
2-day cadence in **g,r,i,z and J,H,K**

Paranal *Observatory Image credit: G. Hüdepohl/ESO*

CLASSIFICATION LIGHT CURVES

ACTUALLY MORE THAN 2,000 LIGHT CURVES JUST FOR GALACTIC TARGETS!



VARIABILITY

INTRINSIC

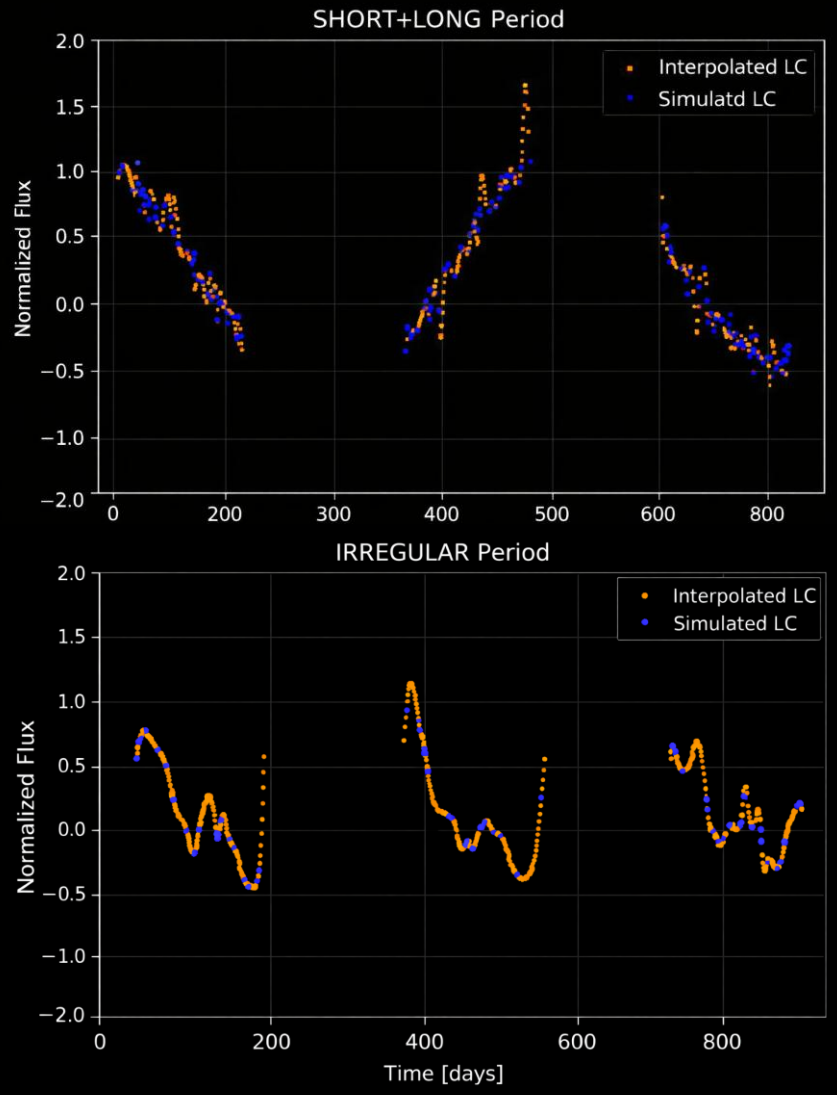
- Radial Pulsations;
- Photospheric convection;
- Nuclear Flashes;
- …

EXTRINSIC

- Effect from a binary companion;
- …

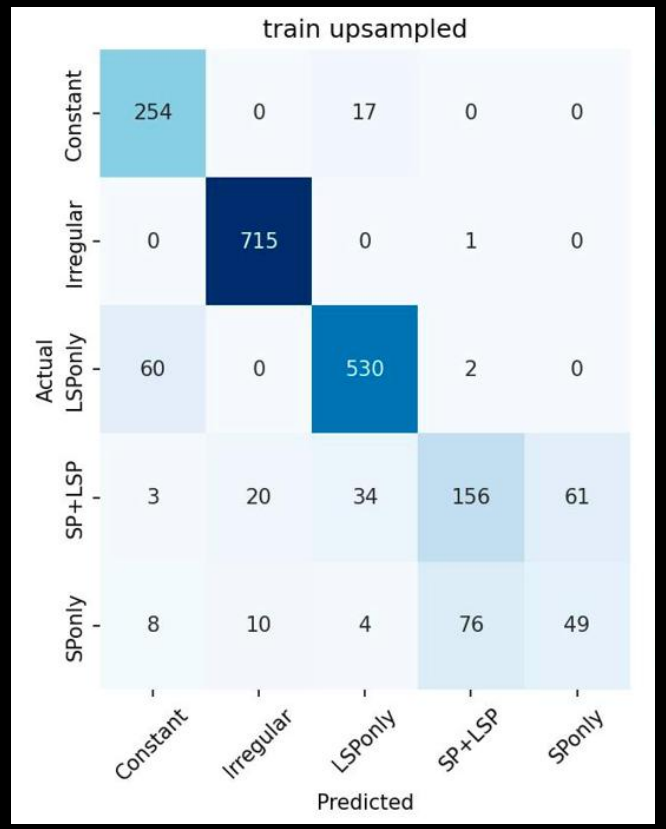
MACHINE LEARNING CLASSIFIER

Simulated light curves of five intrinsic variability classes: from (semi)regular to irregular periodicity and amplitude.



We classified simulated light curves by comparing different supervised ML algorithms (RadomForest, XGBoost, Traditional NN, CNN,...)

Best results was returned from *XGBoost*



FUTURE AIMS

- Improving the photometry of light curves and then performing variability classification on real data using ML algorithms (*XGBoost*, *RNNs ?*);

- Anomaly Detection using ML algorithms (*Variational Autoencoders ?*) in (semi)regular and irregular RSGs, with an ad-hoc alert system;

- Expanding the sample from GalRSG to ExtraGalRSG in order to monitor tens of thousands of RSGs instead of hundreds;

- Images and spectroscopic follow-up of putative ongoing outburst events.