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Core collaApse Supernovae parameTers estimatOR

a novel software for data analysis

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Abstract. In this poster we presented the novel open-access software for core collapse supernovae optical analysis: `CASTOR`. This software enables the reconstruction of synthetic light curves and spectra via a machine learning technique that allows to retrieve the complete parameter map of a supernova having as only input the multi-band photometry data. This approach is particularly significant in view of the Large Synoptic Survey Telescope (LSST), which will create a deficiency in spectroscopic data necessary to confirm the nature and fully characterize each event.

The advent of the Large Synoptic Survey Telescope (LSST) [1], with its unprecedented depth of observation and rate of discovery, is foreseen to enlighten our knowledge of several astrophysical phenomena and, in particular, of Core Collapse Supernovae (CCSNe). In view of the upcoming era of LSST, we developed the open-access software `CASTOR` (Core collApse Supernovae parameTers estimatOR) [2]. This software enables a complete characterization of a supernova event for which only multi-band photometry (i.e. optical light curves) is available. The main results of the analysis range from the explosion properties to the progenitor star mass and radius. `CASTOR` is publicly available on GitHub[1].

`CASTOR` is built upon three different modules that can be applied separately. The first module allows a direct comparison between the available light curves of the supernova-of-study with the light curves of a database built with 115 CCSNe from the literature (in constant update). The comparison is performed via chi-squared test, and it aims to find the supernova which best matches the photometric behavior of the supernova-of-study. The best resembling supernova is called «reference supernova». The second module leverages the Gaussian Process (GP) interpolation method to create synthetic spectra for the supernova-of-study, following the methods described in [3]. In particular, the interpolation is performed using a combination of the observed spectra of the «reference supernova» and the interpolated light curves of the supernova-of-study. The synthetic spectra are built within the same spectral and temporal coverage of the available data, allowing the most reliable interpolation. The third and last module of `CASTOR` uses synthetic light curves and spectra to retrieve the parametric map

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[1]https://github.com/AndreaSimongini/CASTOR

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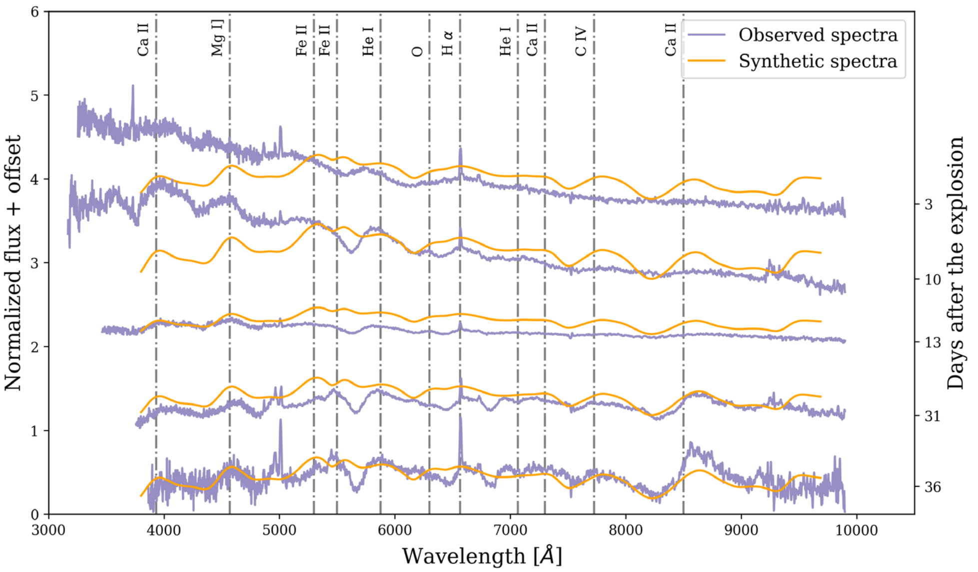

Figure 1. Comparison between the observed (purple) and the synthetic (orange) spectra of SN 2015ap, performed at different epochs.

of the event. In particular, parameters are estimated under specific assumptions: spherical symmetry of the explosion, perfect adiabaticity at peak luminosity, mass conservation, partition of energy between neutrinos and photons and modified black-body law of emission. Therefore, `CASTOR` estimates general parameters of the event (time of the explosion, time at maximum, absorption, redshift, distance), of the explosion (luminosity, energy, mass of nichel), of the ejecta (velocity, mass), of the photosphere (temperature, radius) and of the progenitor (mass, radius). A demonstration of the usage of `CASTOR` is shown in [2], where we analyze SN 2015ap [4] comparing the estimated parameters with those previously estimated by [5]. In Fig. 1 we show some synthetic spectra compared with the observed spectra of SN 2015ap at different epochs taken from [6].

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