New release of the ELODIE library: Version 3.1

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Abstract. We present ELODIE.3.1, an updated release of the library published in Prugniel & Soubiran (2001, 2004). The library includes 1962 spectra of 1388 stars obtained with the ELODIE spectrograph at the Observatoire de Haute-Provence 193cm telescope in the wavelength range 390 to 680 nm. It provides a wide coverage of atmospheric parameters: T$_{\text{eff}}$ from 3100 K to 50000 K, log g from -0.25 to 4.9 and [Fe/H] from -3 to +1. The library is given at two resolutions: R≈42000, with the flux normalized to the pseudo-continuum, FWHM=0.55Å(R≈10000) calibrated in physical flux (reduced above earth atmosphere) with a broad-band photometric precision of 2.5% and narrow-band precision of 0.5%.

In this new release the data-reduction (flux calibration, reconnection of the echelle orders) has been improved, and in particular the blue region, between 390 and 400 nm has been added.

The FITS files for each spectra, and the measured atmospheric parameters are publicly available. See the ELODIE.3.1 page for more details:

http://www.obs.u-bordeaux1.fr/m2a/soubiran/elodie_library.html
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1. Introduction

The ELODIE library is based on spectra retrieved from the Observatoire de Haute-Provence archive ¹ (Moultaka et al. 2004). The spectra were obtained with the ELODIE spectrograph attached to the 1.93m telescope, they have a spectral resolution of about R=42000 and consists of 67 echelle orders covering in total the wavelength range 389.2 to 680 nm without any gap.

Some of the spectra were acquired for the purpose of building a stellar library, and others were selected from the archive to complete the coverage in effective temperature (T$_{\text{eff}}$), surface gravity (log g) and metallicity ([Fe/H]) and to achieve the flux calibration (by providing enough external comparisons and repeated observations of the same stars).

¹http://atlas.obs-hp.fr/elodie
An early library, not calibrated in flux, was published in Soubiran et al. (1998). The first flux-calibrated release of the library was published by Prugniel & Soubiran (2001), it contained 906 spectra. The last previous release, ELODIE.3 was announced in Prugniel & Soubiran (2004) and represented a major progress in the coverage of the space of atmospheric parameters ($T_{\text{eff}}$, $\log g$ and $[\text{Fe/H}]$).

The present version, ELODIE.3.1 is based on the same collection of spectra than ELODIE.3. Fig. 1, 2 and 3 show the distribution of the 1388 stars of the library in the HR diagram, $T_{\text{eff}} - [\text{Fe/H}]$ and $T_{\text{eff}} - \log g$ planes. The main interest of this new version is the extended wavelength coverage, now including the H & K lines, and limited by the blue limit of the spectrograph. Some important improvements are also summarized in the next section.

The library has been used for population synthesis using the Pegase.HR program (Le Borgne et al. 2004), and these models were used to study the stellar populations of galaxies and star clusters. The advantage of these models is the high spectral resolution provided by the library which allows to constrain...
simultaneously the internal kinematics and the parameters of the stellar population (for instance age and metallicity). Thanks to this library, the analysis is not anymore limited to the low resolution of the spectrophotometric indices. Specific methods for the simultaneous analysis of the kinematics and of the stellar population were developed in Ocvirk et al. (2006) and Chilingarian (2007). It was found that these approaches of full spectrum fitting are increasing the precision on age and metallicity by a factor 3 (a factor 10 on observing time to get the same precision) (Koleva et al. 2006).

The comparison between models based on the current release of the library and other models are presented in Koleva et al (2007a) and validation using Galactic clusters in Koleva et al. (2007b).

We are now preparing a further version, ELODIE.4, which will contain about 5000 spectra. This will allow a better investigation of the effect of the \(\alpha\)-element abundances in stellar populations, possibly by coupling the library with a basis of theoretical spectra as presented in Prugniel et al. (2007).

![ELODIE.3.1](image)

**Figure 2.** Distribution in the \(T_{\text{eff}}\) - [Fe/H] plane. Dwarfs with red dots and giants in green.
2. Reduction procedure

Since the first version of the library, the reduction procedure described in Prugniel & Soubiran (2001) has been improved in several aspects but the general philosophy remains the same. The first steps of the data processing up to the extraction of the orders are made with the standard ELODIE pipeline (Baranne et al., 1996). The reconnection of the orders, and the flux calibration are explained in Prugniel & Soubiran (2001).

The specific points modified in the current release are:

Extension of the wavelength range. In the previous releases the first 4 orders in the blue were not processed because of the difficulty of their re-connection and calibration due to the low signal-to-noise ratio (S/N). The sensitivity of the detector is indeed dramatically dropping near the blue limit. We improved our procedure and we could include the blue region, extending to the H & K lines.

Subtraction of the diffuse light. When working on the blue region of the spectra, we discovered that the diffuse light on the standard pipeline was often under-subtracted. The consequence was that some sharp lines in the blue were not deep enough. The correction that we applied was validated by comparing with spectra from other archives or libraries.

Improvement of the atmospheric parameters. To use the library for population synthesis, a key factor is to obtain the atmospheric parameters of
the stars with the highest accuracy. In the present case, the atmospheric parameters are first compiled from the literature, and an inter-comparison in the library allow to detect inconsistencies and to determine 'internal' values: Each wavelength point of the spectra is modeled as polynomials in $T_{eff}$, $\log g$ and $[\text{Fe}/\text{H}]$ fitted to the compiled parameters and the inversion of this function returns internal determinations of the parameters (see Prugniel & Soubiran 2001, Le Borgne et al. 2004).

On one side we have updated the compiled input parameters, using recent publications and fixing errors, and on the other side we improved the polynomial functions used to model the spectra. The present version is better, but, as seen in Fig. 2 and 3, some artifacts persist in the temperature range 6500-7500K at low metallicity (some input metallicities are underestimated).

By comparing the observed spectra with the polynomial model, we get an idea of the quality of the model and of the consistency of the atmospheric parameters. The rms residuals from the 'absolute' model (ie. using the input atmospheric parameters) is 2.0%. The rms residuals from the 'internal' model (iterated using the atmospheric parameters returned after an inversion with the 'absolute' model) is 1.4%. The decrease of the rms
residuals after the iteration is due to an improvement of the consistency of the atmospheric parameters. The final residuals include the effect of the noise and of all the neglected parameters, like rotation, detailed abundances... The internal determination of the atmospheric parameters may be biased with respect to the input values: We checked these biases by averaging them in some regions of the parameters space, and did not find evidence for clear bias.

Tables 1 & 2, and Fig. 4 & 5 compare the Lick indices measured on the ELODIE spectra with those of the Lick (Worthey et al. 1994) and Jones (Worthey & Ottaviani, 1997) libraries. The comparison with the Lick data shows an important spread due to the lower quality of the Lick data, but the comparison with Jones library reveals an excellent consistency. The zero-points are extremely small, and the slope between the two series is close to 1. This test of the slope is critical since it may unveil some data-reduction errors in the cosmic ray clipping, the rebinning or the scattered light subtraction: These three aspects potentially affecting more the strong lines, hence high metallicity stars.
| Index | Offset | Slope | Sigma |
|-------|--------|-------|-------|
| Ca4227 | 0.042  | 0.778 | 0.152 |
| G4300  | 0.019  | 0.930 | 0.321 |
| Fe4531 | 0.007  | 0.853 | 0.247 |
| Fe4668 | 0.023  | 0.935 | 0.470 |
| Hbeta  | 0.022  | 0.951 | 0.143 |
| Fe5015 | -0.142 | 0.889 | 0.359 |
| Mg1    | -0.002 | 0.862 | 0.011 |
| Mg2    | 0.001  | 0.916 | 0.009 |
| Mgb    | -0.032 | 0.885 | 0.204 |
| Fe5270 | -0.036 | 0.980 | 0.253 |
| Fe5335 | -0.019 | 0.975 | 0.215 |
| Fe5406 | -0.007 | 0.936 | 0.203 |
| Fe5782 | -0.012 | 0.733 | 0.119 |
| NaD    | 0.069  | 0.894 | 0.305 |
| TiO1   | -0.002 | 0.886 | 0.010 |
| TiO2   | 0.001  | 0.909 | 0.007 |

Table 1. Comparison with Lick indices from the Lick library. Col. 1: Designation of the Lick index; Col. 2, 3: \( \text{Index(Elodie)} = \text{offset} + \text{slope} \times \text{Index(Worthey)} \); Col. 4: rms dispersion from the linear fit.

3. Data access

The spectra are available as fits files. Three gzipped tarfiles, corresponding to the R=10000, R=42000 libraries can be downloaded, as well as the table of measurements containing the stellar parameters estimated internally and the measured Lick indices. The description of the files and the specific keywords are described on the ELODIE.3.1 web page.

Two versions of the library are constructed. The high resolution (\( R \approx 42000 \)) corresponds to the nominal resolution of the spectrograph, and the low resolution (FWHM = 0.55 Å, \( R \approx 10000 \)) has been produced by a gaussian broadening. The high resolution version is provided normalized to the pseudo-continuum while the low resolution is in physical flux with an absolute calibration (physical units) scaled using Tycho photometry. Accessing the library using the HyperLeda database\(^2\) allows conversions of the flux normalization, or various convolutions and rebinnings.

Users of this library are kindly requested to cite in their publications the original A&A publication (Prugniel & Soubiran 2001) as well as the present astro-ph announcement. The proper denomination of the current version is: ELODIE.3.1.

We are encouraging reports on the usages of this library and encountered difficulties. They will help us to continue to improve the quality.

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\(^2\)http://leda.univ-lyon1.fr
| Index     | offset | slope | σ   |
|-----------|--------|-------|-----|
| Ca4227    | 0.025  | 0.902 | 0.075 |
| G4300     | 0.079  | 0.962 | 0.187 |
| Hbeta     | 0.003  | 0.967 | 0.072 |
| Fe5015    | 0.006  | 0.967 | 0.166 |
| Mg1       | -0.003 | 0.978 | 0.011 |
| Mg2       | 0.000  | 0.961 | 0.007 |
| Mgβ       | 0.021  | 0.997 | 0.072 |
| Fe5270    | 0.012  | 0.992 | 0.057 |
| Fe5335    | 0.001  | 0.952 | 0.061 |
| Fe5406    | 0.008  | 0.998 | 0.047 |

Table 2. Comparison with Lick indices from the Jones library. Col. 1: Designation of the Lick index; Col. 2, 3: Index(Elodie) = offset + slope × Index(Jones); Col. 4: rms dispersion from the linear fit.

Acknowledgments. We thank Observatoire de Haute-Provence, and in particular Sergio Ilovaisky, for maintaining a public archive of their observations. Many improvements of this library were possible thanks to the feed-back of the users.

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