ESO Science Archive Facility - Phase 3 Data Release Description
ESO programme CORALIE legacy data, Data Release DR1
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CORALIE Phase 3 Legacy Program Data Release Description

Data Collection	CORALIE historical planet-search program
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Document Authors	Danuta Sosnowska, Stéphane Udry, Damien Ségransan

Abstract

The data being released come from the observations of a large, well-defined planet-search program around solar-type stars, conducted with the CORALIE spectrograph installed on the Euler 1.2m telescope in La Silla, CHILE and were taken between 1998 and 2024. It contains 65502 observations of 1702 targets with the total size of 1.38 TB.
The spectrograph offers a wavelength range from 390 to 690 nm. The spectral resolution is close to 60000. The spectrograph is fed with two fibres, one fibre (fibre A) is placed on the object, the second fibre (fibre B) can be used to simultaneously collect light from a reference calibration source or from the sky. A Fabry-Perot (FP) cavity was installed on CORALIE in June 2015 and is used as simultaneous reference to measure the instrumental drift between the calibration time and the actual beginning of the observations as well as throughout the night. Before June 2015 the ThAr lamp was used as simultaneous reference. Several major updates were brought to the instrument in 2007, 2014 and 2024 introducing offsets in the zero-point radial velocities for the corresponding periods.
This release contains data from the Legacy planet-search program of CORALIE. They were reduced using the Data Reduction Software (DRS) version 3.6.0 developed and adapted from the ESPRESSO pipeline by the Geneva Observatory team with help from ESO. It includes extraction of the spectrum, flat-fielding and wavelength calibration. The spectra are not flux calibrated. A cross correlation with a stellar reference mask is executed to calculate the radial velocity (RV) of the observed object.

Overview of Observations

The data released are from the historical homogeneous radial-velocity monitoring of some 1650 solar-type stars over 26 years conducted by the exoplanet team in Geneva. The sample was built from the Hipparcos catalogue, defining a volume-limited sample adequate for a robust statistical analysis of the occurrence of giant planets around solar-type stars. The limit in distance is 50 pc for G dwarfs and follows a decreasing linear trend between K0 and K9. This linear colour dependence was introduced to account for the increasing faintness of targets at a given distance when going toward later spectral types. The limit was set by the size of the Euler telescope, with the goal of still reaching an RV precision of 5 m/s in a 30-minute exposure time. The sample definition is presented in Udry et al. (2000). By construction of the sample, targets are evenly spread in right ascension. They are all in the southern hemisphere. They are bright, covering a range up to V=~10 in magnitude.

Three major interventions were applied to the system in 2007, 2014 and 2024, each introducing an offset of the radial velocities and a different level of precision for the corresponding periods. The present release stops at the last intervention and thus contains spectra from 3 different versions of the instruments: CORALIE98, CORALIE07 and CORALIE14. Corresponding offsets and precisions are described in Ségransan et al. (in prep).

The sample includes close visual binaries for which, depending on the separation, composite or "polluted" spectra are provided. For double-line spectroscopic binaries (SB2), no identification of the RV of each component is performed.

Release Content

The data frames are tagged "CORALIE" in the ESO archive user interface.[1] The release contains the science data from the CORALIE Legacy Program for exoplanets search. Each science spectrum is compatible with the phase 3 data format. The following associated files are provided together with the S1D science spectra, extracted, de-flatted, de-blazed, BERV corrected and spliced (S1D_FINAL_A):

- extracted, de-flatted, 2-dimensional (order-by-order) science spectra (S2D_BLAZE_A)
- extracted, de-flatted, de-blazed, 2-dimensional (order-by-order) science spectra (S2D_A)
- extracted, de-flatted, de-blazed and spliced reference spectra (S1D_FINAL_B) (not present if the fibre B was not illuminated)
- drift matrix for the instrumental drift (DRIFT_MATRIX_B) (only when the fiber B was illuminated by the ThAr or FP lamps)
- cross correlation function (CCF_A)

The total size of the dataset is 1.38 TB, with:

- 326 932 files (main spectra and ancillary files)
- 1702 targets observed
- 65502 observations
- 397.5 GB of science spectra

Release Notes

Reduction methods are the ones used commonly to reduce spectroscopic data, except the wavelength calibration which is a particular algorithm developed for the instruments not having the FP. The reduction consists of the following steps:

- Cleaning from the detector signature (bias, dark current, gain)
- Extraction (the optimal extraction is used)
- De-flatting & de-blazing
- Wavelength calibration (drift method, all the wavelength calibration products are in vacuum)
- BERV correction (data are in barycentric reference system)
- Drift correction
- Merging of Echelle orders (splicing)

The timing of a small fraction of the data may be inaccurate by several minutes due to various hardware and software issues over the years. This may translate into radial velocity errors of a few m/s.

Data Reduction and Calibration

A detailed description of the ESPRESSO pipeline, used for CORALIE data reduction, can be found in the pipeline user manual which is available from ESO pipeline web pages:
https://www.eso.org/sci/facilities/paranal/instruments/espresso.html
This data set has been reduced with the pipeline version 3.6.0.

Wavelength calibration

The FP was installed on CORALIE only in June 2015, so through the lifespan of CORALIE FP exposures were not always available. Therefore the wavelength calibration solution chosen is the one called "drift map method" (Dumusque et al., 2021). It consists of measuring the drift of Thorium lines with respect to a reference wavelength solution on both fibers. The drift can be computed in pixels or in km/s. For CORALIE the velocity drift was chosen. A two-dimensional polynomial fit is

[1] http://archive.eso.org/scienceportal/home?data_collection=CORALIE

calculated on the matrix of differences between the actual ThAr-ThAr extracted spectrum and the reference spectrum. The actual wavelength solution is obtained by shifting the reference wavelength solution accordingly.

Barycentric correction

The wavelengths in the science spectrum are corrected to the barycenter of the solar system. The Barycentric Earth Radial Velocity (BERV) is computed using the target coordinates and proper motions and date/time of the exposure. It is stored in the header keyword "HIERARCH ESO QC BERV".

Correction for instrumental drift

The CORALIE spectrograph is fed with two fibers simultaneously. Fibre A is placed on the scientific object. Fibre B is used to record the FP or ThAr source during the science exposure. The instrumental drift between science observation and the wavelength calibration to be used, is calculated and corrected in the wavelength solution. For the observations done with SKY or DARK on fibre B, the drift is not computed.
Before June 2015 only ThAr lamp was available as a reference. Since June 2015 mainly the FP is used as a simultaneous reference in science observations.

Contamination induced by calibration source

In the exposures where the fibre B is illuminated with the ThAr lamp, the contamination from the strong/saturated ThAr lines can appear on the fibre A. This effect is measured with dedicated calibration frames. The correction for the contamination from the ThAr lamp is applied at the extraction level.

Cosmic ray hits

Cosmic ray hits are cleaned from the extracted science frame using a histogram threshold.

Spectrum extraction

The spectra are extracted using the optimal extraction algorithm, which uses the cross-dispersion orders profiles that are obtained from the spectral flat fields.

Radial velocity calculation

The science recipe computes the cross-correlation function (CCF) of the extracted spectrum in wavelength-order space with respect to a binary template of a given spectral type. The radial velocity (RV) is then obtained from a Gaussian fit to the CCF. Template masks for G-, K- and M-type stars are available within the pipeline. The results are written into the "HIERARCH ESO QC CCF *" header keywords of the reduction products. The measured RV value can be found in "HIERARCH ESO QC CCF RV" keyword, the corresponding error in "HIERARCH ESO QC CCF RV ERROR" keyword and the used mask in "HIERARCH ESO QC CCF MASK" keyword.

Calibrations used for data reduction

Table 1 lists the required calibration types that are needed for the reduction of science data. Please check the pipeline user manual for further details.

Type	Purpose
DARK	Hot pixel map and Master Dark (static product)
LED	Detector flat-field for Bad pixel map (static product)
Order definition flat	Defines the position of the orders on the detector
(Spectral) flat field	Orders profile, spectral flat field and blaze
Wavelength calibration (ThAr)	Wavelength solution. Calibrations with ThAr-ThAr and (since June 2015) ThAr-FP are used for the product
Contamination	Measures the contamination from the ThAr or FP source on fibre B. Only the contamination from the ThAr lamp is corrected. The contamination from the FP lamp is negligible.

Table 1 CORALIE calibrations

The pipeline is always using the calibrations closest in time before the science observation, which have passed the QC.

Data Quality

Static calibrations

All used static calibrations have been quality-reviewed and certified.

QC flag

Each pipeline product is quality checked and contains a set of QC flags, with the global QC, which indicates if the frame has passed the QC (global QC = 1) or not (global QC = 0). Only the products with the global QC = 1 are used for the reduction. The other detailed QC flags indicate eventual problems with quality control. Two checks are done on the science products: the saturation of the raw frame and the quality of the drift.

Data Format

Files Types

The data set for each observation consists of one primary product file (S1D_FINAL_A) and several ancillary FITS sets. The primary CORALIE science data product is a 1D spectrum with merged echelle orders. The file has one table extension. The table columns contain the extracted flux, the wavelength, the error of the flux, and some additional quantities.

Column	Unit	Description
WAVE	Å	Wavelength (in vacuum)
FLUX	el-	Extracted flux, in el-, same as the column FLUX_EL
ERR	el-	Flux error
QUAL	None	Quality: 0 means OK, all other values indicate a problem
SNR	None	Signal-to-noise ratio of the extracted spectrum
WAVE_AIR	Å	Wavelength (in air)
FLUX_EL	el-	Extracted electrons per wavelength bin
ERR_EL	el-	Corresponding error
QUAL_EL	None	Corresponding quality

Table 2 Table columns of primary product file S1D_FINAL_A

There are several additional files associated with the primary product, as shown in Table 3.

Product category PRO.CATG	Product category PROD-CATG	Number	Primary / Ancillary / Ass. tar	Description
S1D_FINAL_A	SCIENCE.SPECTRUM	1	Primary	Extracted, co-added 1-D spectrum of the target (fibre A), phase 3 compatible
S1D_FINAL_B	ANCILLARY.SPECTRUM	1	Ancillary	Extracted co-added 1-D spectrum of fibre B, phase 3 compatible
DRIFT_MATRIX_B	ANCILLARY.DRIFT	1	Ancillary	Drift between science exposure and wavelength-calibration
S2D_A	ANCILLARY. 2DECHELLE.BLAZE. NOSKYSUB	1	Ass. tar	Extracted spectra for each order of fibre A, de-flatted and de-blazed
S2D_BLAZE_A	ANCILLARY. 2DECHELLE.NOBLAZE. NOSKYSUB	1	Ass. tar	Extracted spectra for each order of fibre A, de-flatted
CCF_A	ANCILLARY.CCF	1	Ancillary	Cross-correlation function of fibre A

Table 3 Primary, ancillary and associated products of CORALIE spectra

Acknowledgements

Publications based on data obtained with the CORALIE instrument should quote the following reference papers:

- 2000A&A...356..590U, Udry et al., The CORALIE survey for southern extra-solar planets. II. The short-period planetary companions to HD 75289 and HD 130322
- 2010A&A...511A..45S, Ségransan et al., The CORALIE survey for southern extrasolar planets. XVI. Discovery of a planetary system around HD 147018 and of two long period and massive planets orbiting HD 171238 and HD 204313
- 2023A&A...674A.114B, Barabato et al., The CORALIE survey for southern extrasolar planets. XIX. Brown dwarfs and stellar companions unveiled by radial velocity and astrometry

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- *Based on data obtained from the ESO Science Archive Facility under request number <request_number>.*

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