A database for OPD polarimetric observations

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Abstract. This work presents the development of a catalog containing optical polarization information based on publicly available observations obtained at Observatório do Pico dos Dias (OPD) in Brazil. The project focuses on linear polarimetric data obtained using the IAGPOL polarimeter, an instrument that is still in use at OPD. IAGPOL inspired the development of a new instrument recently available at OPD, SPARC4, which works in both polarimetric and photometric modes and takes images in four bands simultaneously. A dedicated pipeline to automatically reduce SPARC4 data is in development, and we intend to use it to reduce IAGPOL data as well. The project is to collect available data with the mentioned characteristics, reduce it, and release it in a Virtual Observatory (VO) format.

Resumo. Este projeto consiste no desenvolvimento de um catálogo contendo informações de observações polarimétricas adquiridas no Observatório do Pico dos Dias (OPD) no Brasil e que estão atualmente em domínio público. O projeto foca em dados de polarimetria linear obtidos com o polarímetro IAGPOL, um instrumento ainda em uso no OPD. O IAGPOL inspirou o desenvolvimento de um novo instrumento recentemente disponível no OPD, SPARC4, o qual trabalha tanto no modo polarimétrico quanto no modo fotométrico e faz imagens em quatro filtros simultaneamente. Uma pipeline dedicada para redução automática dos dados obtidos pela SPARC4 está em desenvolvimento e pretendemos usá-la para reduzir os dados do IAGPOL. O projeto visa coletar os dados disponíveis com as características mencionadas, reduzi-los e disponibilizá-los no formato do *Virtual Observatory (VO)*.

Keywords. Instrumentation: polarimeters – Astronomical databases: miscellaneous – Catalogs – Polarization

1. Introduction

This project aims at providing the scientific community with an open-format catalog of polarimetric observations. This catalog includes linear polarimetric observations conducted at the Observatório do Pico dos Dias (OPD) using the IAGPOL polarimeter (Magalhães et al. 1996).

IAGPOL is an instrument that has generated around 90 publications and is still available at OPD. It is equipped with a filter wheel and contains a half-wave plate for linear polarization and a quarter-wave plate for circular polarization. It supports observations using various filters, with UBVRI being the most commonly used.

The purpose of our project is to collect polarimetric data obtained over more than 20 years in different telescopes, by different observers, with different scientific objectives, reduce it all and deliver the results to community. We estimate that these data should contain the polarization of millions of point sources of the southern sky. To perform the reductions, we will use the software developed to SPARC4, an instrument placed in OPD (Rodrigues et al. 2024) and inspired by IAGPOL, that makes photometric and polarimetric observations. SPARC4 has an dedicated pipeline to perform the reduction of images observed with it. The SPARC4-pipeline (Martioli et al. 2025) processes FITS (Flexible Image Transport System) images reducing both photometric and polarimetric observations.

This project is divided into phases, with the first phase focusing on the development of a prototype. This prototype will utilize a small data sample, specifically the dataset from the previously published study by Rodrigues et al. (2009), about polarimetry of Herbig Ae/Be stars.

The prototype will cover the entire workflow of the project, as showed in Figure 1, from the data retrieval from OPD database to the publication of the catalog on the website. The process includes organizing and preparing the images to en-

sure compatibility with the reduction SPARC4-pipeline. The SPARC4-pipeline will then be used to perform data reduction and calculate all essential quantities. After the data reduction is complete and the relevant quantities are computed, the information will be presented in a VO (Virtual Observatory) format, forming the core of the catalog. This catalog will be made accessible through a website.

Once the prototype is complete and all steps are validated, the same process will be applied to the entire dataset retrieved from the OPD database.

Currently, the project is in the early stages of the prototype development.

2. The data

The data will be recovered from the OPD data bank and downloaded using an FTP prototype. It will be filtered by keywords associated with polarimetric observations. This information will allow us to determine on which days polarimetric acquisitions were made. A script will check all the downloaded data to identify and exclude any corrupted files. This script will also verify if the downloaded data have the requirements to be included in the catalog. For example, the first version of the catalog is focused on half-wave plate only. So any quarter-wave plate should be disregarded. We also plan to include only data obtained using BVRI filters.

Once the data is recovered, it will be automatically organized and corrected if necessary using scripts developed to format it according to the SPARC4-pipeline standard. For images that were not acquired with SPARC4, some modifications must be made to meet the SPARC4-pipeline's requirements. The first step is to correct the data to match the SPARC4 standard. Next, we need to correct the images and their headers. Some images were obtained using the overscan technique, resulting in images larger than real detector size, which are not recognized by the

SPARC4-pipeline. These images must be identified and subsequently trimmed. Another required correction is related to the image headers, which must include all the keywords required by the SPARC4-pipeline. In some cases, missing keywords will need to be created, while in others, existing keywords must be modified to conform to the SPARC4 standard.

3. The reduction

The reduction will be performed using the SPARC4-pipeline dedicated to SPARC4 observations. The SPARC4-pipeline is based on the Astropop package (Campagnolo 2018) and other astronomical packages. Its main module can be executed from the command line, allowing reduction in both polarimetric and photometric modes, and automatically analyzing data from all four channels. It also includes a configuration file for SPARC4-pipeline execution parameters, where reduction settings can be adjusted according to specific science needs. Reduce images by utilizing keywords in their headers to guide the process. The reduction is performed by day, by channel, and the resulting products are saved separately for each channel.

The reduction process begins with classifying the images as bias, flat, or science images. It then calculates a master bias and master flat, which are used to correct the science images. Finally, the SPARC4-pipeline computes the desired products, such as magnitude, polarization, and polarization angle. Additionally, it can perform time series analysis for multiple images taken over time.

Once the reduction is complete and the results are generated by the SPARC4-pipeline, a script will be developed to gather all the products and save them in a spreadsheet. This spreadsheet will be the core of the database that will compose the website back-end, which will be released in a front-end that will be the interface between the users and the catalog..

4. The site

Once all data are organized, corrected, and reduced, we can process the results and prepare them for delivery on a website that will be made available to the community.

The goal is to ensure that this information is VO-compliant, meaning it will be provided in a format that adheres to the standards defined by the Virtual Observatory (VO) framework.

Finally, a website will be created to make these results accessible. It will allow users to download the necessary products and perform cross-referenced searches. The relevant quantities that will be made available include the following:

- RA and DEC of the sources;
- Linear Polarization;
- Linear Polarization error;
- Position angle of the linear polarization;
- Error of the linear polarization angle;
- Magnitude;
- Magnitude error;
- Date of observation;
- Telescope;
- Flags.

5. Development Status

The project is in its initial development phase, but some of the steps mentioned above have already been completed. Below, we provide a description of the progress made so far.
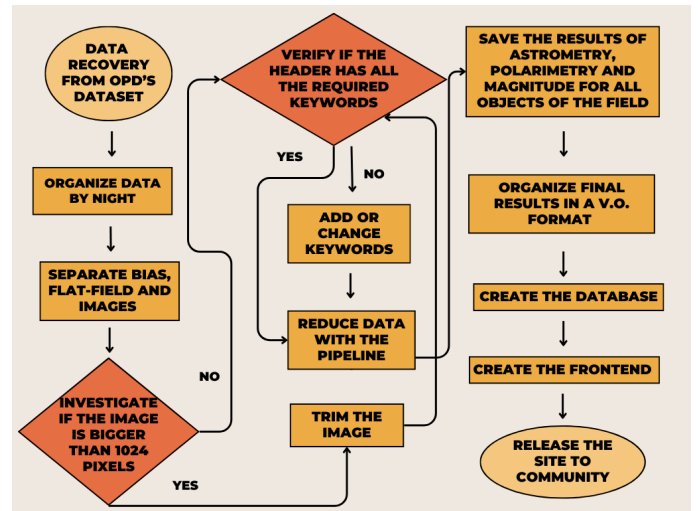

Figure 1. Polarimetric catalog workflow

The data prototype was filtered and recovered from the OPD dataset. A script was developed to organize the data by night and to separate the bias, flat, and science images in the format required for SPARC4-pipeline identification. Another script was created to verify the size of the images and trim them if they are too large, ensuring they meet the correct dimensions for SPARC4-pipeline compatibility.

A script is currently being developed to check the image headers and verify that all standard keywords required by the SPARC4-pipeline are present. If any keywords is missing or incorrectly formatted, the script will add or modify it. It will also correct parameters that are not written in the required format.

An investigation of the OPD dataset was conducted to determine how the prototype data should be filtered. It was decided that filtering can be done using keywords in the OPD data registration that indicate polarimetric observations. A total of 98 such keywords have already been identified, and their corresponding dates are being defined to facilitate recovery from the OPD dataset.

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