Development of tools for SALT/RSS spectropolarimetry reduction: application to the blazar 3C 279

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Introduction

Active Galactic Nuclei (AGN) are the centres of galaxies powered by accretion onto a super-massive black hole. The accretion can power relativistic jets which produce non-thermal emission over multiple wavelengths [1]. Blazars are a subclass of AGN where the direction of the jet lies very close to our line of sight. The highly Doppler boosted emission from the jet results in high apparent luminosities.

At optical wavelengths the observed emission is a superposition of polarized non-thermal synchrotron emission, arising from the jet, and unpolarized thermal emission, arising from the disc, broad line region, torus, and host galaxy [2].

The RSS spectrographs [3] on the Southern African Large Telescope (SALT) can operate in spectropolarimetry mode and has been used to observe blazars in various states of polarization. In order to streamline the data reduction for these programmes we present additional tools, to work in conjunction with the existing reduction software package, *polsalt* [4]. We present the overview of this pipeline and demonstrate its application to observations of 3C279 over the course of 2017. The pipeline is currently being applied to other observations as well (see Barnard et al. presentation at this conference).

Pipeline Overview

RSS spectropolarimetry data is currently reduced with the polsalt package. This package allows for a full reduction from pre-reduction to extracted spectrum, and measured polarization. However, the package does not allow flexibility, nor provide a tool to confirm that the wavelength calibration of the O & E beams are identical. The tools developed here work in conjunction with the existing pipeline and provide a method to perform the wavelength calibrations using conventional IRAF methods.

The updated work flow is as follows:

- Pre-reductions are performed using polsalt
- The O & E beams are split into to separate FITS files and cropped to remove any data-less rows, into the format required by IRAF
- Wavelength calibrations are performed in IRAF
- The wavelength solution for the O & E beams are compared, highlighting any variations in the individual wavelength solutions
- The O & E beam FITS files are recombined into a single file, the header and extensions are updated for polsalt, and cosmic-ray cleaning is performed with the lacosmic package [5].
- Spectral extraction and polarization calculations are performed with polsalt
- Flux calibration is performed using the astropy and scipy packages.

Discussion & Conclusions

Creating an independent 2D wavelength solution for the O & E beams allows for more flexibility in obtaining the wavelength solutions and provides a tool to directly compare the O & E beam solutions. This is useful for difficult cases, such as arc line identification for the PG0300 spectral grating, because there are fewer arc lines in some parts of the spectra and it is more complicated to create a consistent solution across the full wavelength range covered.

Relative flux calibrations using spectropolarimetric standards were reduced alongside the data, up to and including spectral extraction. Scipy packages were then used to calculate the response function and to apply it to the target.

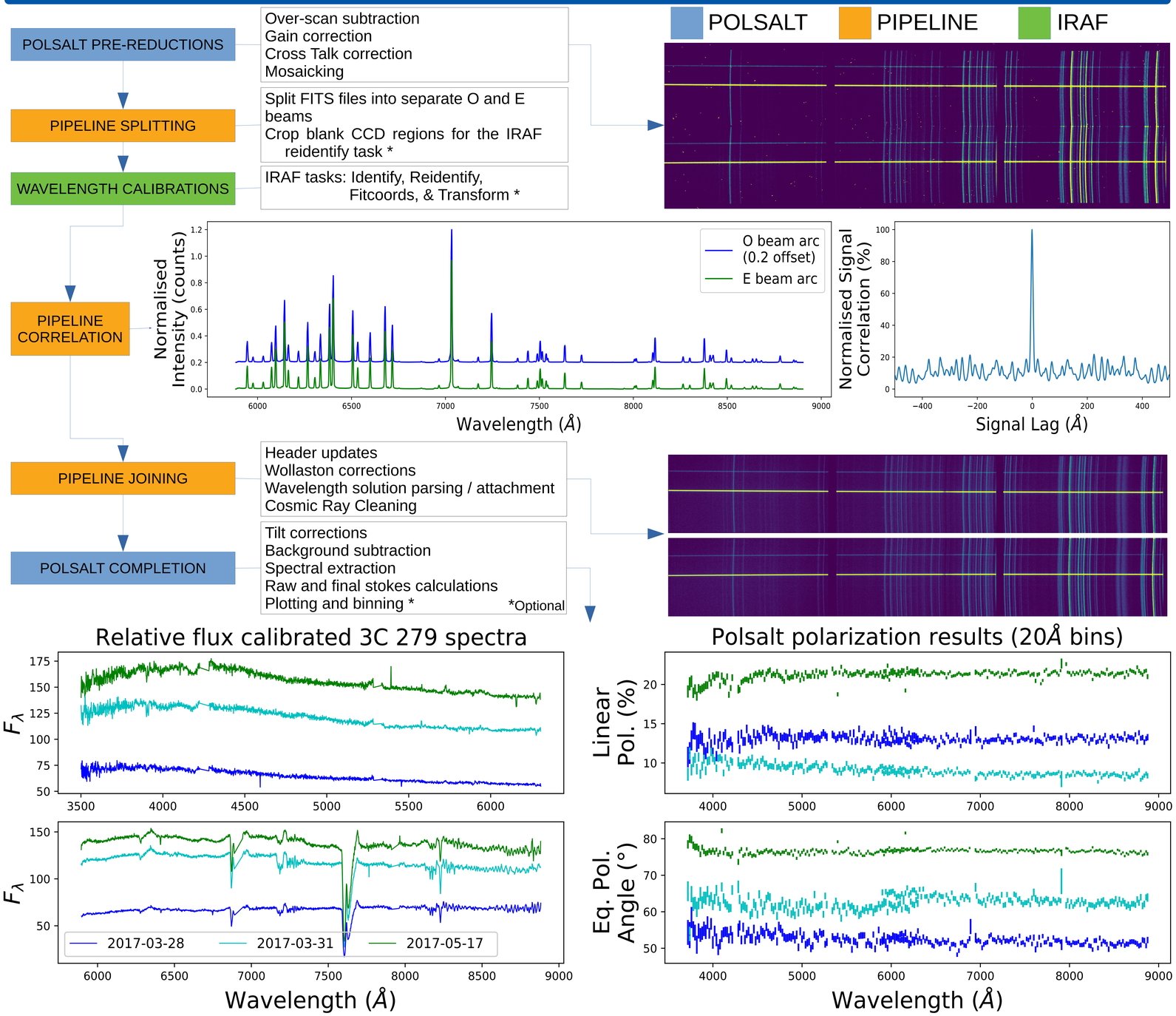
3C 279 was observed over the course of 2017/2018 with spectropolarimetric standards available for 2017. It was observed in linear polarization mode with Hiltner 600 used as the standard star for flux calibrations.

The observations show a clear change in the degree of polarisation and the polarisation angle. The observations were taken using PG0900 with two different grating angles and the polarisation measurements are in good agreement where the observations overlap.

References

1. Urry et. al., 1995, PASP, 107, 803
2. Böttcher et. al, 2017, Galaxies, 5(3), 52
3. Burgh et al., 2003, SPIE 4841, 1463
4. github.com/saltastro/polsalt
5. Dokkum et. al., 2001, PASP 113, 1420

Results



Relative flux calibrated 3C 279 spectra

Polsalt polarization results (20Å bins)