

High Time Resolution Astronomical Polarimetry with GASP

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Abstract. The Galway Astronomical Stokes Polarimeter (GASP) is a high time resolution, full-Stokes imaging polarimeter which utilises a Fresnel rhomb prism as a beam-splitter and quarter wave retarder. The ability to perform optical photometry and polarimetry at high frame rates enables more detailed studies of a multitude of compact objects including; optical pulsars, magnetars and Active Galactic Nuclei (AGN). We present a brief discussion of the instruments' current capabilities and hardware design. GASP is currently configured with two Electron Multiplying Charge-Coupled Devices (EMCCDs), which offer sub-millisecond frame readout speeds over a defined region of interest on the sensor. We will report results from an observational campaign at the William Herschel Telescope (WHT) in December, 2015. During this campaign GASP was used to study the Crab Pulsar, V404 Cygni and polarisation standards. As a subset of our analysis we have identified a significant contribution from the Interstellar Medium (ISM) and the interaction of a varying polarised source with the ISM, the subsequent conversion of linearly polarised light to circular, and its dependence on the angle of the source emission electric field orientation. Further to the presentation of results we will discuss future observational work, which is planned for September 2017 and subsequent improvements to increase the temporal resolution of the detectors.

Keywords. instrumentation: polarimeters, techniques: polarimetric, instrumentation: detectors.

1. Introduction

The polarisation state of the Crab Pulsar and its surrounding nebula has been studied for almost fifty years. The linear polarisation of the Crab Pulsar was first discovered in 1969 by Warner *et al.* (1969) and first presented by Wampler *et al.* (1969). Shown below (Figure 1) is historical data with a specific focus on the mean position angle of the electric field vector measured for the Crab Pulsar and the background effect on this measurement which is primarily due to the background subtraction method.

2. Observations and Results

The data for this analysis was obtained at the WHT in December 2015 and analysed using our own data analysis pipeline which involves an instrument-specific calibration routine and gain analysis on the electron multiplication from both cameras used in the GASP instrument. The Galway Astronomical Stokes Polarimeter (GASP), as a 2D-imaging polarimeter, allows for the selection of varied apertures and background subtraction methodologies. We have demonstrated the effect on the measurements of the pulsar's position angle with respect to the aperture selected and the background

subtraction method employed for both phase-resolved and integrated data. For the first two measurements we have shown how GASP measurements match previous observations when the same aperture extraction and background subtraction methods are applied and we are continuing this work further.

Table 1: Crab pulsar and nebula. Polarimetry since 1969.

Observation Dates	Position Angle	Aperture (")	Reference
40296	107 ± 6	5.5" 9.4"	Wampler <i>et al.</i> (1969)
40292	89	6.8" 8.1"	Cocke <i>et al.</i> (1969)
40512	89	3"	Cocke <i>et al.</i> (1970)
40518	98		Kristian <i>et al.</i> (1970)
40260, 40451-2, 40513 40558	160	*	Visvanathan(1971)
40918-9,40972,40975	117		Cocke <i>et al.</i> (1973)
41650-3	118	5" 7"	Ferguson <i>et al.</i> (1974)
44261-2	118	2"	Jones <i>et al.</i> (1981)
46409	130	2"	Smith <i>et al.</i> (1988)
52966-71	109.5	2.35"	Śłowikowska <i>et al.</i> (2009)
53619-718 (53668)	105	0.25"	Moran <i>et al.</i> (2013)
56243	85	1.6" *	Moran <i>et al.</i> (2016)
57359	128	2.1"	This work

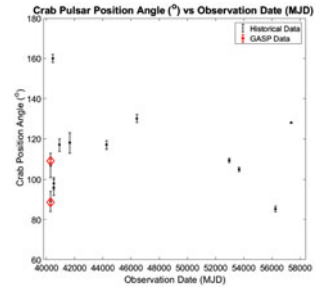


Figure 1: Table 1 data (black point) with GASP data (red diamond)

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