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POLARIMETRIC CALIBRATION FOR LARGE TELESCOPES

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One of the calibration problems posed by the new generation of mid-infrared instrumentation on 8–10 m class telescopes is that of polarimetric calibration. To be able to calibrate polarimetric data reliably it is necessary to be able to measure both the instrumental polarization and the efficiency of detection of polarization with a high degree of accuracy. In many senses the problems are less difficult than for spectrophotometric calibration, but still need to be defined and overcome. In this article we discuss the polarization calibration problems relevant to the mid infrared that are applicable to infrared instruments as the CC-Pol module of CanariCam—the mid-infrared imaging spectrograph for the GTC—which will cover the range from 8 to 24 μm. It is a part of the photometric, spectrophotometric, and polarimetric calibration for the CanariCam project (Martín-Luis et al. 2001).

1. THE PROBLEM TO SOLVE

When we do polarimetry, from the calibration view point, we have two problems:

1) The presence of mirrors and the instrumental optics introduces an instrumental polarization component (IP). Typically, a 45 degree reflection, as occurs with a Nasmyth focus produces a linear polarization of 5% in the visible, 0.5% in the NIR and less in the MIR. It is important to quantify the degree of IP and its orientation. Futhermore, it is necessary to measure the zero of position angle.

2) The efficiency of detection, which is usually corrected by using standard polarized stars or an instrumental calibrator. The latter is preferable because the standard stars have generally a low degree of polarization (<5% at V and smaller at longer wavelengths, and many highly polarized stars are also variables (Whittet et al. 1992).

2. WHAT IS AVAILABLE

At present, the most complete network of low polarization stars (LPSs) is that elaborated by Gehrels (1974). Although this list is widely used, its spatial density is low (only 30 stars) and inhomogeneous so

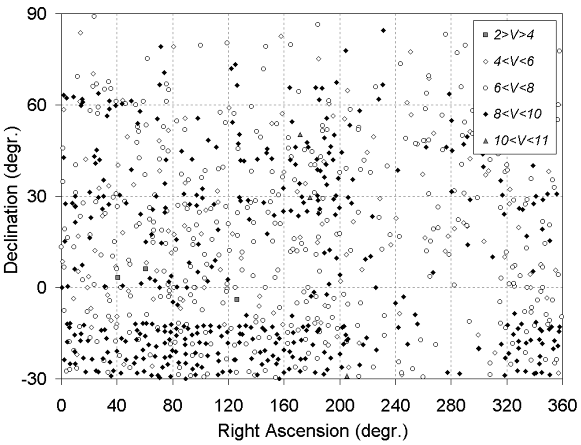

Fig. 1. Sky distribution for CC-pol LPSs by magnitude.

the sky coverage is very uneven. Furthermore, 50% of the stars have $V < +5$ so they may be unacceptably bright for a telescope such as the GTC.

There are polarized standards (Whittet at al. 1992) available at wavelengths between 0.3 and 2.5 μm, but at longer wavelengths their degrees of polarization are generally small. There are sources with infrared polarization but they may be variable and so are not useful. Stars such as red giants are strongly polarized in the visible but their polarization is variable and drops rapidly in the near infrared.

3. THE AIMS OF THIS PROJECT

1) To develop a network of suitable LPSs with a homogeneous and acceptable sky distribution (several stars should be visible to the telescope at any one time and large slews should be avoided), and with an adequate flux distribution for our telescope + instrument system.

2) To study different options for measuring the efficiency of detection of polarization.

4. RESULTS

Zero Polarization Standards As polarization is almost always induced by the interstellar medium (ISM) and is rarely intrinsic to a star (except in very cool stars), any main sequence star in the solar neighborhood should be unpolarized unless it is located in a region of particularly high density of

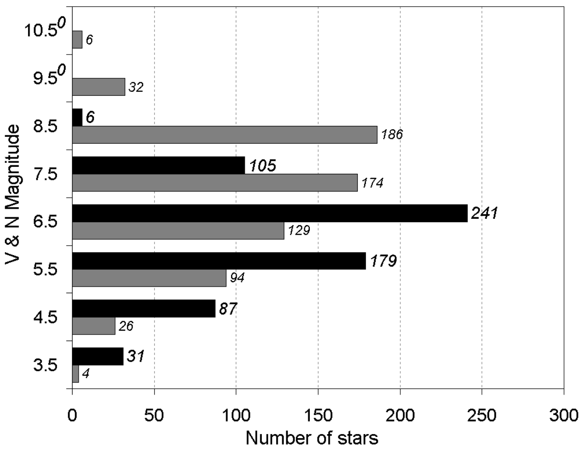

Fig. 2. V and N magnitude distribution for CC-Pol LPSs.

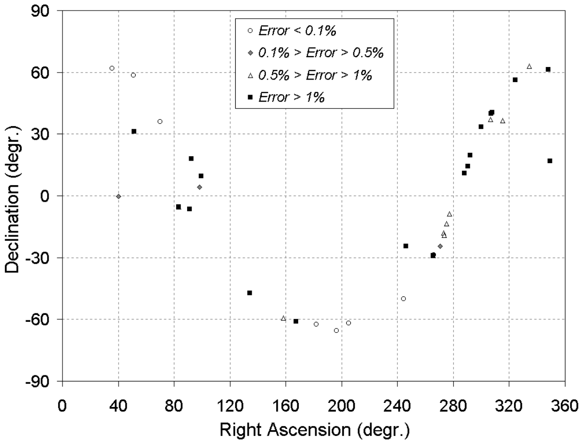

Fig. 3. Sky distribution of measured HPSs.

the local ISM or deeply embedded in dust. Thus it is usually sufficient to select high proper motion stars as potential zero polarization stars. We have selected main sequence stars with $A_V < 0.1$ and a spectral type no later than K3 V, by using a complete search of the SIMBAD database and a color excess criterion to eliminate the stars with high extinction. After selection, 651 "normal" stars remain with a good distribution on the sky (see Figure 1). The correspondent magnitude distribution is shown Figure 2. We will carry out polarimetric observations of a sample of stars in order to verify the method.

High Polarization Standards Although the polarization detection efficiency can be measured easily in the laboratory, it is convenient to check the polarization efficiency at the telescope nightly using high polarization sources (HPSs). Smith et al. (2000) present the best measurements to date of spectropolarimetry of 55 MIR high polarization sources (see Figure 3). Some of them have an extended polarization component from surrounding nebulosity. Others may be variable and should also be excluded. There are only three sources with very high precision measurements that are visible over the GTC horizon. We conclude that the simplest solution is to use principally an instrumental calibrator such as a wire grid and rely on astronomical calibration only as a secondary method.

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