FULL TITLE
ASP Conference Series, Vol. **VOLUME**, **YEAR OF PUBLICATION**
NAMES OF EDITORS

Results of SPARO 2003: A Search for Systematic Errors

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Introduction

The Submillimeter Polarimeter for Antarctic Remote Observations (SPARO) is used together with the Viper telescope at the Amundsen-Scott South Pole Station to measure linear polarization at 450μm on large angular scales (Novak et al. 2003; Renbarger et al. 2004). During April through July of 2003, we obtained new observations of four star-forming Giant Molecular Clouds: Carina, NGC6334, G331.5-0.1, and G333.6-0.2. The data analysis method is described by Li et al. (these proceedings), who also show some of the resulting polarization data. Here we describe the results of tests for systematic errors.

Procedure

A polarimetric *file* is obtained by taking photometric observations at each of six half-wave plate (hwp) angles. The photometric observations consist of rapid "chopping" of one telescope mirror combined with slower "nodding" of the telescope. A *set* consists of nine consecutive polarimetric files and lasts about one hour.

We calculate various *data quality parameters* for each set, including sky noise number, mean tau (atmospheric opacity), tau range, signal level, and pointing errors. We then make cuts on the data, eliminating those sets with quality parameters that lie outside predetermined limits.

To determine the sky noise number for each file, we look at the center pixel of each nine-pixel array. From the raw data values, we subtract off the source signal to create a plot of the noise. We then take the Fourier Transform (FT) of this noise signal. The left side of Figure 1 shows raw data (top row), noise (middle row), and the noise Fourier Transform (bottom row) for three different sky noise values. The low-frequency contribution of the FT corresponds to the sky noise.

The sky noise number for each file is defined by averaging over the first and last 50 points of the FT and subtracting. The sky noise number for the entire set is the average over the nine files.

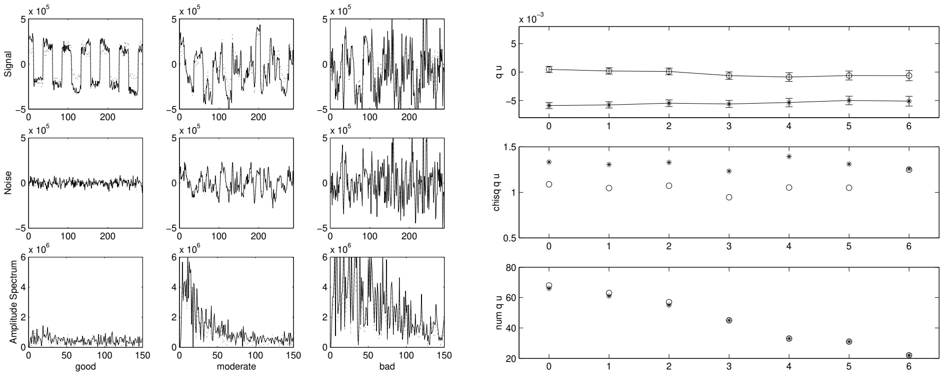

Figure 1. At left we show the skynoise analysis process for three values of the skynoise data quality parameter (G333.6MAX). The top row shows the demodulated raw data for orthogonal polarizations versus sample number. The second and third rows show the sky noise analysis process as discussed in the text. At right are typical results of the sky noise cuts. The plots show polarization, reduced chi-squared, and number of surviving sets as a function of cut severity (G331.5MAX). Stars and circles signify the (normalized) Stokes parameters q and u, respectively.

Our goal is to determine whether or not our data is affected by systematic error. This is accomplished by seeing 1) if there is a dependence of polarization on the various data quality parameters and 2) whether cutting on these parameters lowers the value of the reduced chi-squared.

Results

Out of 26 fields observed, two were chosen for this study: G331.5MAX and carinaSE. These two fields represent extremes in the range of source brightness. A series of 25 cuts was performed on each field. These cuts were divided into five groups of cuts, one for each of the data quality parameters. Within a group, cuts were made to varying degrees of severity.

The right side of Figure 1 shows the values of the Stokes parameters q and u, their corresponding reduced chi-squared values, and the surviving number of sets plotted with respect to the degree of severity of the cut. We found that no single parameter seemed to affect the polarization measurements, nor did any of the cuts affect the reduced the chi-squared. The only possible exception was a downward trend in polarization for skynoise cuts on the faintest pixel in carinaSE. However, this trend was within the errors of the measurements, and was not correlated with any other pixel in the array.

So far, our results do not appear to be significantly affected by systematic error. In the future, we will examine the polarization effects of snow accumulation on the telescope mirrors.

References

Novak, G., et al. 2003, ApJ, 583, L83
Renbarger, T., et al. 2004, PASP, 116, 415