CALIBRATION OF THE SOHO/LASCO C3 WHITE LIGHT CORONAGRAPH

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Abstract. We present a detailed review of the calibration of the LASCO C3 coronagraph on the SOHO satellite. Most of the calibration has been in place since early in the mission and has been utilized to varying degrees as required by specific analysis efforts. However, using observational data from the nearly decade-long database of LASCO images, we have re-evaluated and improved many aspects of the calibration. This includes the photometric calibration, vignetting function, geometric distortion, stray light, and exposure and observation times. Using this comprehensive set of corrections

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we have generated and made available a set of calibrated coronal images along with a set of periodic background images to ease the accessibility and use of the LASCO database.

1. Introduction

In this paper, we present a comprehensive review of the LASCO C3 calibration. For the most part this calibration has been in place since launch. During the course of the SOHO mission further information, much of it derived from star observations, has allowed us to refine the details of this calibration. As a result, corrections to the photometric calibrations, the vignetting function, geometric distortion effects, stray light, and exposure and observation times have all been optimized. Using these recent refinements we have generated a Level-1 data set so that a majority of the C3 data set is available without need of further correction.

A broad definition of calibration is the conversion of instrumental observations from engineering units to scientific units. The corrections that must be applied vary with the instrument but often this is a vital step in the derivation of new knowledge from scientific observations. Indeed, the quality of such scientific conclusions is generally limited by the quality of the calibration applied to the basic observations. This problem is especially unique for satellite based instruments where post-launch calibration may be difficult and the observer often has fewer controls over the instrument than before launch. Care must be taken so that adequate flexibility and resources are available to ensure calibration quality both before launch and over the extended period associated with space missions.

For the LASCO C3 coronagraph, the pre-flight calibration was performed at the Naval Research Laboratory (NRL) and has proved adequate to support the many scientific analysis that have used LASCO data. It is important to note that different studies require the application of different instrumental corrections. For example, determination of CME velocities and acceleration do require corrections for geometric distortion but do not require photometric calibration. On the other hand, photometric calibrations are essential to studies that examine CME mass and energetics. The application of the relevant calibrations has been done at the discretion of the user and with advice and support from LASCO team members. During the course of the SOHO mission as the quantity of data has grown it has become possible to make improvements to the pre-flight calibration. In this paper, we present a comprehensive review of pre-flight and in-flight calibrations. This does not include polarization which is the subject of a separate paper currently in preparation. Since C3 observations have generally been made without the polarizer filters the following discussion applies to most of the C3 data set (≈93%).

Although we have re-evaluated all aspects of the pre-flight calibration a number of the calibrations have been re-examined in detail. These include the vignetting function, the geometric distortion, and correction of the reported exposure time. In addition, a detailed re-evaluation of the photometric sensitivity of the various