Deducing the Three Dimensional Structure of the Corona from STEREO/COR1 Coronagraph Observations

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INTRODUCTION

With the launch of the STEREO mission coronagraph images from two viewpoints will be routinely available. SECCHI, the remote sensing suite, contains a nested set of coronagraphs imaging the Thomson scattered corona from 1.3 Rsun to beyond 1 AU.

It is generally accepted that these images will allow the determination of the 3D nature of streamers, CMEs and other coronal structures. In spite of this expectation, it is not clear what the best method to use the available data to obtain the 3D density distribution.

In this paper we begin to consider the 3D reconstruction process for coronagraph images. The models presented here were developed with COR1 images in mind, but it is believed that the algorithms developed will be useful for COR2 and possibly HI as well.

INSTRUMENT DESCRIPTION

Figure 1 – Opto-mechanical layout of the COR1 Instrument

COR1 is an internally occulting coronagraph providing images with an annular field of view extending from 1.32-4 Rsun. A second coronagraph, COR2, will image the K-corona from 2.5-15 Rsun.

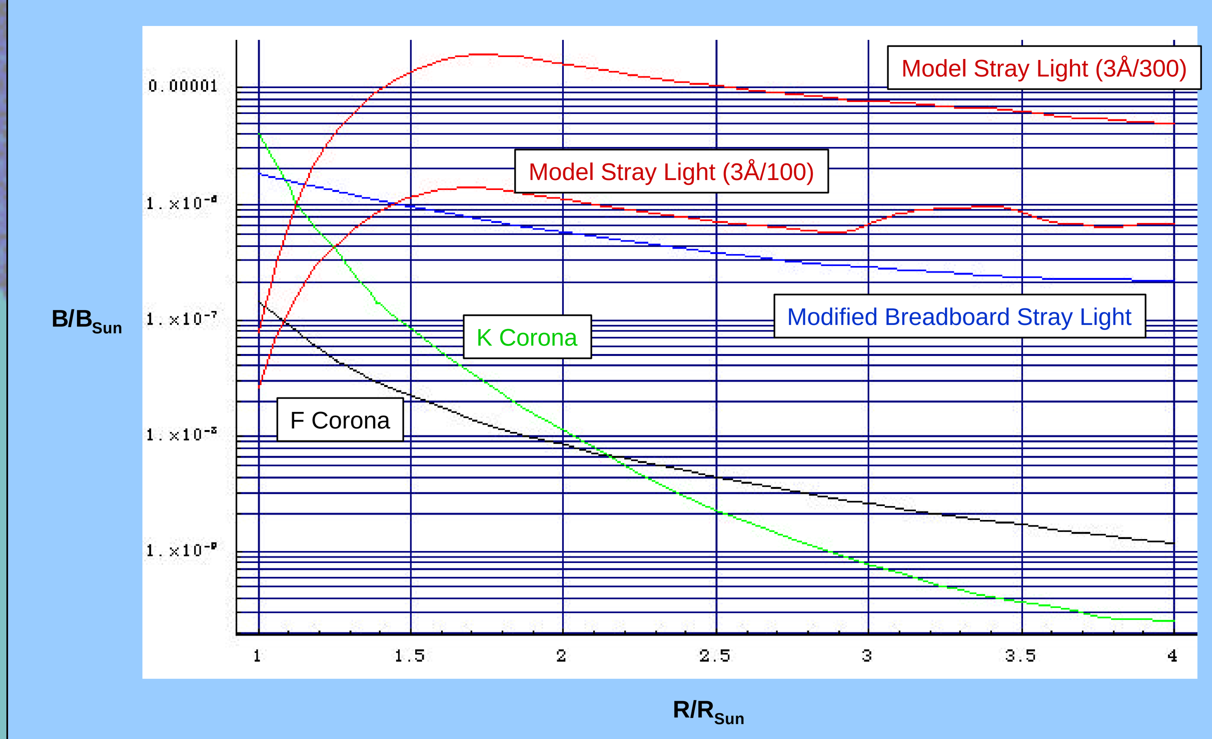

Figure 2 – Plots showing the relative intensity of the K-corona, F-corona and scattered light within the COR1 instrument

DISCUSSION

Two views are NOT sufficient for the unique determination of 3D density distribution of a coronal streamer or CME. This can be proven conclusively by considering the imaging process in Fourier space.

There are three properties that can be observed that related

- Parallax derived from the two views
- Temporal changes due to rotation
- Polarization information

The best method for the combination of this information is not known. However, the problem is similar to the problem of binocular robotic vision.

In this paper we begin the discussion which, we expect, will lead to an algorithm for the determination of streamer structure.

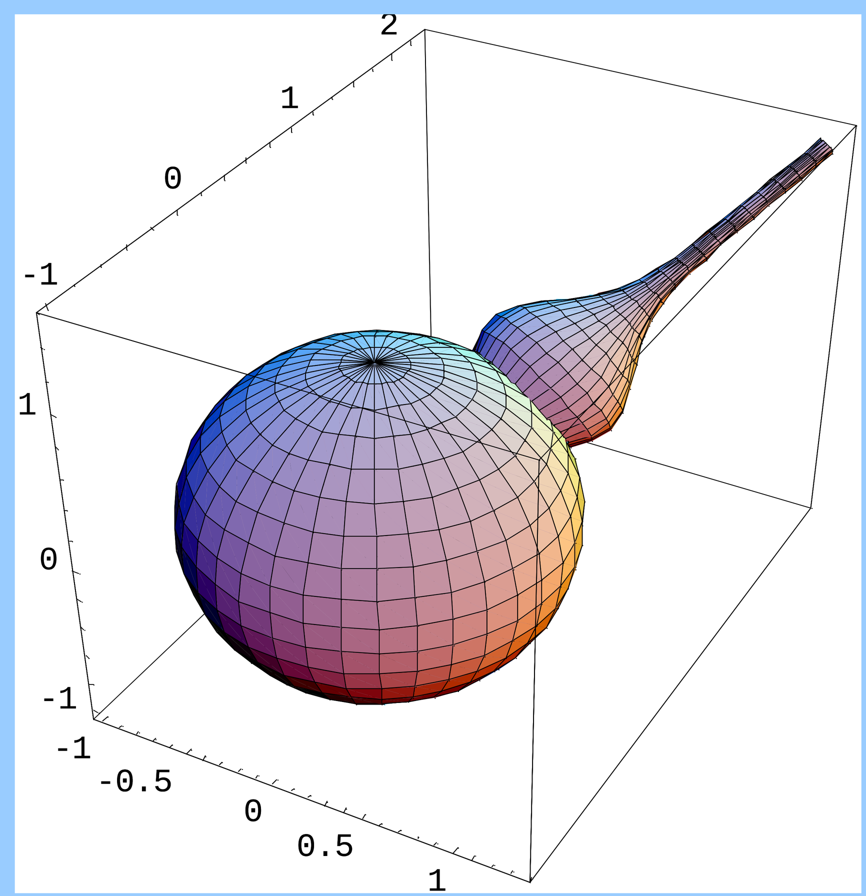

Figure 3 – Model streamer used to develop the results below.

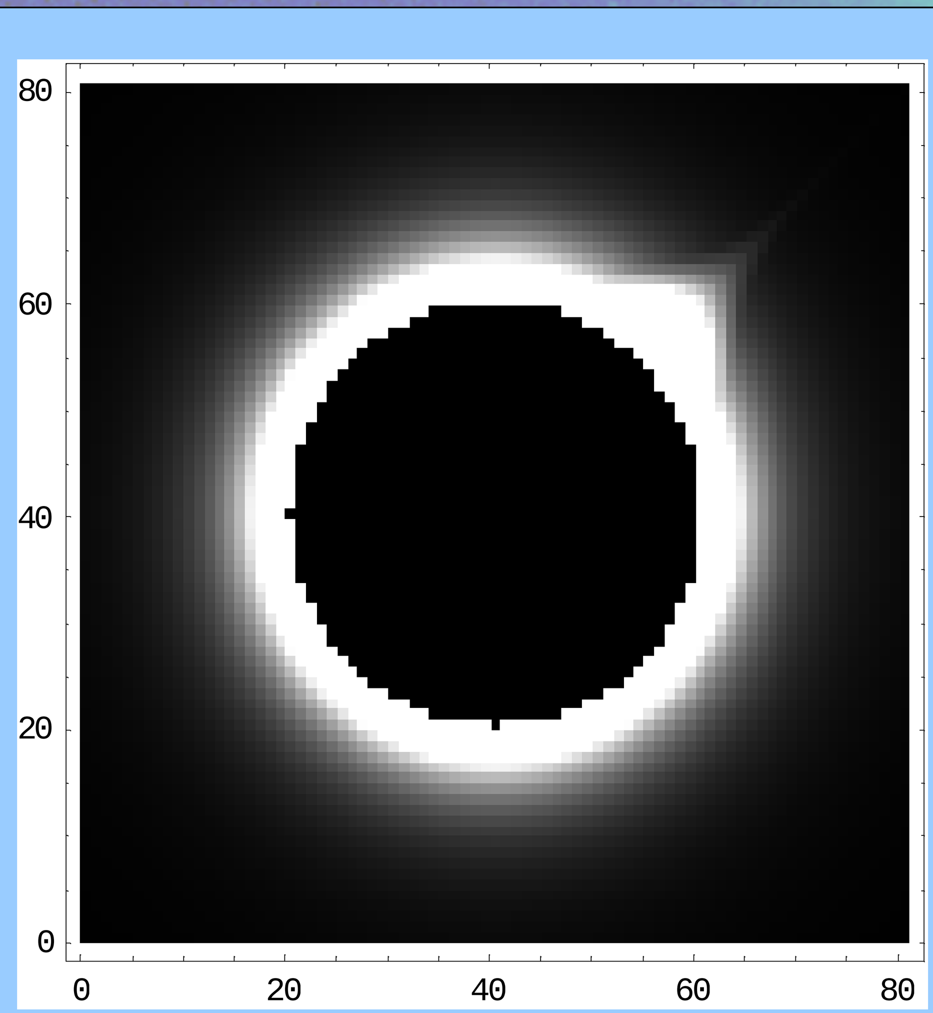

Figure 4 – Synthetic pB Image of Quiet Sun Corona and a Streamer

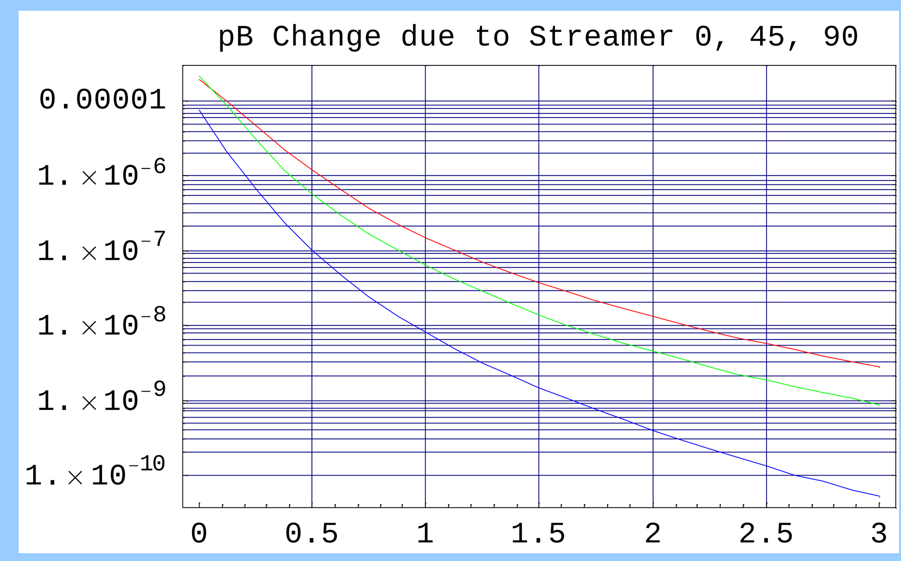

Figure 5 – Radial variation of polarized brightness for a model streamer at 0, 45, and 90 degree angular position

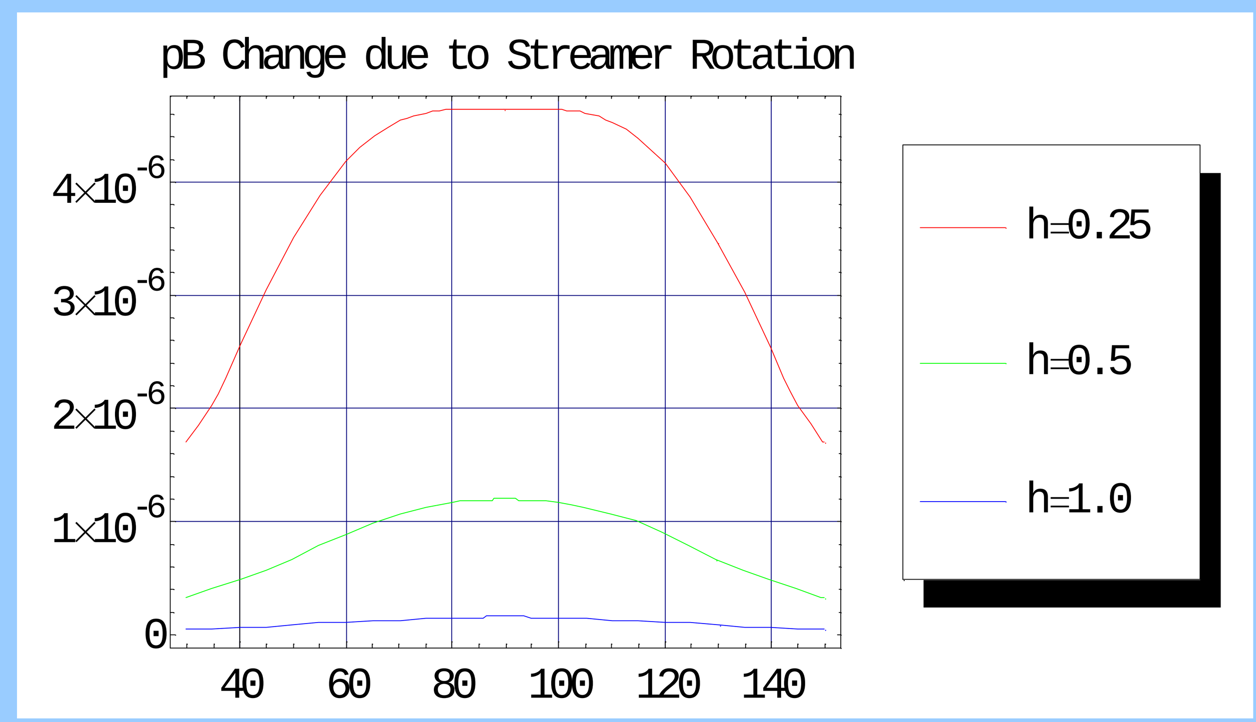

Figure 6 – Streamer contribution to the line of sight integral of polarized brightness for various streamer angular positions

CONCLUSIONS

- **Simple intensity images from two viewpoints is not sufficient to unambiguously determine the structure of the 3D corona**
- **However, other information relating to the 3D structure is available**
  - **Polarization**
  - **Temporal variation**
- **These data for an inhomogeneous data set which bound any reconstruction attempt**
- **The optimum algorithm for combining these different type of data is not known**
- **This problem is very similar to the problem of binocular vision in robots. It is hoped that some of the lessons learned there can be applied to the solar problem. The major difference is that robotic vision deals with optically thick sources, and the corona is optically thin.**