TIME-DISTANCE MEASUREMENTS OF LARGE-SCALE FLOWS IN THE SOLAR CONVECTION ZONE

A DISSERTATION
SUBMITTED TO THE DEPARTMENT OF APPLIED PHYSICS
AND THE COMMITTEE ON GRADUATE STUDIES
OF STANFORD UNIVERSITY
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

By
Peter M. Giles
December 1999

I certify that I have read this dissertation and that in my opinion it is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Phil Scherrer
(Principal Advisor)

I certify that I have read this dissertation and that in my opinion it is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Peter Sturrock

I certify that I have read this dissertation and that in my opinion it is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Arthur B. C. Walker

Approved for the University Committee on Graduate Studies:

Abstract

Helioseismology has been a powerful tool for measuring the structure and rotation of the solar interior. However, there are still many aspects of the Sun's dynamics which are not well understood. This thesis uses the recently developed method of time-distance helioseismology, closely analogous to seismic exploration in geophysics, to search for large-scale flows in the interior of the Sun. With this technique, data from the Michelson Doppler Imager (MDI) have been used to measure the meridional circulation deep in the solar convection zone for the first time. The results show that the measurements are consistent with a meridional circulation which is 20 m/s poleward at the solar surface, and roughly 3 m/s equatorward at the base of the convection zone. The turnover point is just below $r = 0.80\mathrm{R}_\odot$. The meridional circulation is also observed to be varying with time, with the possible appearance of an equatorward surface flow at high latitudes during the rising phase of the solar magnetic cycle. In addition to these important results, the measurements have yielded interesting results for the solar differential rotation, including the possible detection of a highly localized asymmetric feature with an amplitude of 200 m/s.

All of these measurements illustrate the unique capabilities of the time-distance technique for looking at the solar interior in a new way. Furthermore, these results will have a bearing on our understanding of solar dynamics, particularly the solar cycle and the maintenance of the rotation profile.

Acknowledgements

There are many people who need to be mentioned and acknowledged, either for the part they played in this work, or just for being good friends during the last six years.

First of all, I would be remiss if I did not mention that SOHO is a project of international cooperation between ESA and NASA, and that my research was supported by NASA contract NAG5-3077 at Stanford University.

Second, there is a long list of people at Stanford who have contributed to this work in one way or another. From a scientific standpoint, Tom Duvall, Jr., was the guidance and the inspiration for the work, the inventor of the tools, and the Master to the apprentice. I have Phil Scherrer to thank for many of the ideas contained in this thesis and for his ability to ask the big questions. Alexander Kosovichev has also been an inspiration, and a teacher. Jesper Schou and Rasmus Munk Larsen provided the measurements of the internal rotation rate which I have used as a reference, and have also been helpful when I was drowning in an ocean of linear algebra. Also, the new measurements of the Carrington elements in appendix A were inspired by comments and suggestions made by Jesper. Rick Bogart wrote and maintained the remapping software used in the analysis. John Beck, Laurent Gizon, and Aaron Birch have also made contributions which appear in these pages. Also, a special thanks to Margie Stehle for keeping all the details in order, and especially for all her help during the last few weeks.

There is an even longer list of people who have made the last six years not only intellectually challenging but just plain fun. Out of the many friends I have made during this six years, I would like to especially thank Russ, Duncan and Julie, Adrian, Chris, Andreas and Eileen, and Brian, for making this six years into much more than just work. My life will be better for knowing them. Jesper Schou makes this list also, for the four peaks we have stood on together: Mount Whitney, Mount Williamson, Mount Tyndall, and Mount Fuji. I spent many more weekends reaching some smaller summits with Jesper and Brian Roberts as well. Thank you also to everybody who helped me take out my frustrations with a hockey stick. Finally, let me recall an afternoon spent at Candlestick Park in late summer of 1997, with Rick and Tom, a bases-loaded double play and an extra-inning home run to beat the Dodgers.

Thank you also to my family; Mom and Dad, Kristina, and Steve and Angela. It has been a long time and I have been far away, and I have missed you all.

And of course, I wouldn't have done any of this without Kate's love, understanding, and support. The four years that we spent apart have made these last two even more wondrous. Truly she deserves an epic poem or a great novel; for now she will have to settle for the rest of these pages. I hope they will make her proud.

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