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

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By
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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.

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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.

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