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**SEISMIC STUDY OF THE SUBSURFACE STRUCTURE AND DYNAMICS OF  
THE SOLAR INTERIOR FROM HIGH SPATIAL RESOLUTION OBSERVATIONS**

NASA Grant NAGW-2983

Final Report

For the period 1 January 1992 through 30 September 1997

Principal Investigator

Dr. Sylvain G. Korzennik

September 1997

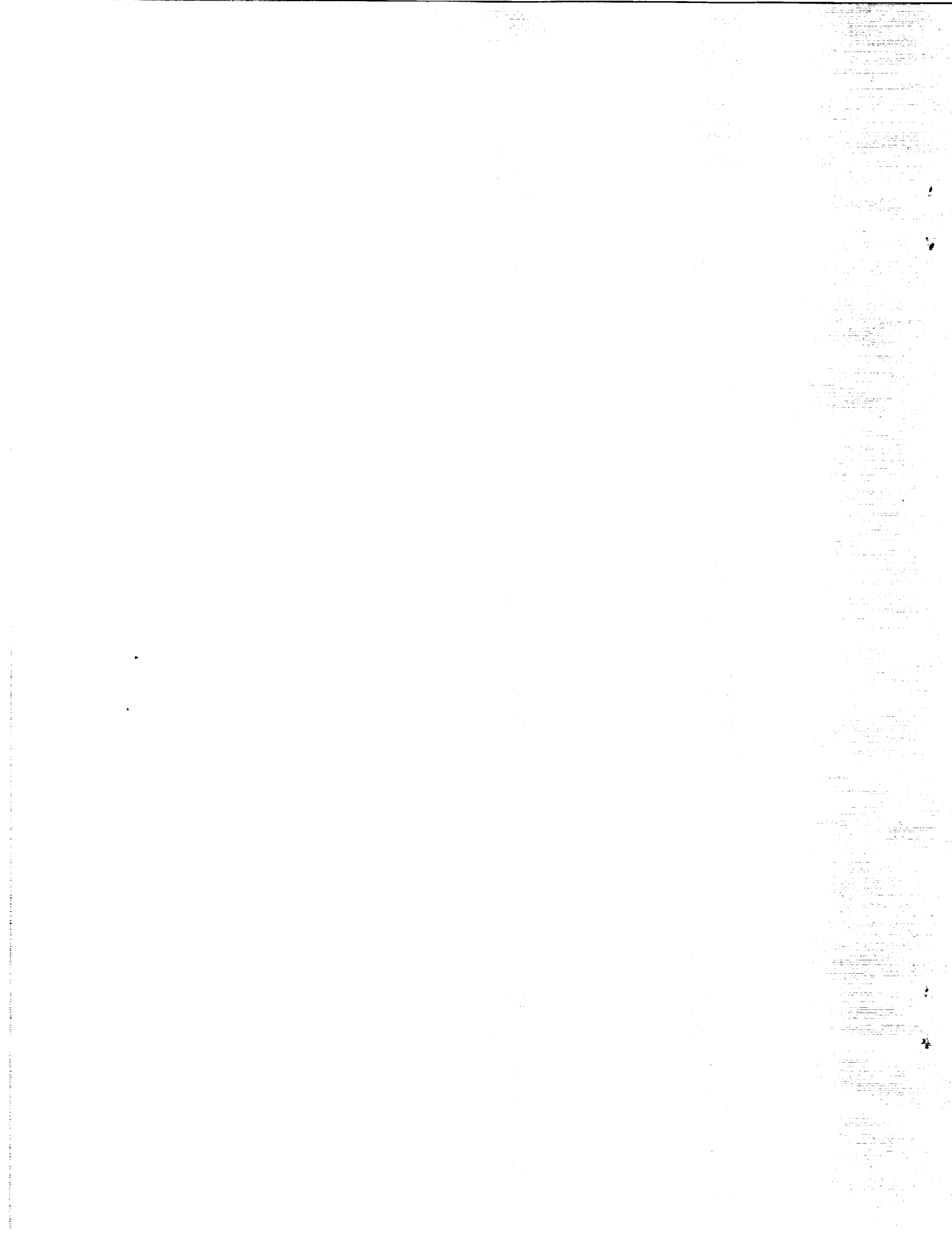
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# Seismic Study of the Subsurface Structure and Dynamics of the Solar Interior from High Spatial Resolution Observations

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## Development of Human Resources

Mr. Ziskin, worked for a year as a research assistant (08/93 – 07/94), and was mostly supported by this grant. He left the project to go to graduate school, as anticipated when he was hired.

Mr. Aguirre, a Harvard graduate student in Astronomy who deferred his admission for a year, was hired as a research assistant for a six months period (06/95 – 12/95), and supported by this grant.

Dr. Eff-Darwich, a post-doctoral fellow who joined our group in May 1996, has contributed to this program in his area of expertise; Dr. Baudin, a post-doctoral fellow who joined our group in June 1997, will also carry on some aspect of the work develop under this program (*i.e.* time-distance work) to the SOI/MDI data set.

## Global Helioseismology

We have carried out the data reduction and analysis of Mt. Wilson 60' solar tower high spatial resolution observations. The reduction of the 100-day-long summer of 1990 observation campaign in terms of rotational splittings was completed leading to an excess of 600,000 splittings. The analysis of these splittings lead to a new inference of the solar internal

rotation rate as a function of depth and latitude. This work was presented at an invited review talk given at the GONG '94 meeting (Los Angeles, July 1994).

More recent Mt. Wilson data have been reduced and analyzed to be compared to the first GONG network results. A 36-day-long period, contemporary to GONG month #4, was reduced and analyzed in term of mode frequencies. The comparison of the two data set indicates a very good agreement, at the level of 1 part in  $10^5$ , which corresponds to a fraction of the mode uncertainties. This comparison also showed systematic differences, that can be traced to the different analysis methods, and give us a better estimate of the nature and amplitude of such systematic errors.

With the addition of Dr. Eff-Darwich to our group, we have further contributed to the determination of the solar internal rotation rate as a function of depth and latitude. Using two distinctive inversion methods (*i.e.* a SOLA method and a modified RLS, aka OMD method), and the first SOI/MDI available rotational splittings, we have actively participated to the SOI/MDI rotation inversion team activities.

## **Velocity-Intensity Phase Relation of the P-Mode Oscillations**

We extended our analysis of the phase relation between the velocity and intensity fluctuations induced by the solar 5-min oscillations. The study based on five consecutive days of GONG *breadboard* data (taken in June of 1991) was repeated using seven days of GONG 3-site network data (obtained in May of 1995). While the comparison between the results from the two epochs (which roughly correspond to active versus quite sun) is consistent with the expected migration of magnetic fields towards the equator, the magnitude of the variation of the phase has not decreased, leaving the interpretation of the results open to debate.

## **Local Helioseismology: Time-Distance Diagrams**

Several analysis of Mt. Wilson dopplergrams in term of time-distance diagrams were carried out. A first comparison of travel times estimated using quiet and active sun proved to be inconclusive, and was presented at a poster paper at GONG 94 meeting (Los Angeles, July 1994). Since, we have developed a forward modeling of the travel-time, that includes the effect of the dispersion relation. We have also continued to refine our analysis methods, and applied them to GONG and SOI/MDI data.