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VII. INSTRUMENTATION FOR THE STUDY OF SOLAR RADIATION AND STRUCTURE

(J. Harvey)

This report complements the report on solar instrumentation presented by Commission 10 in that subjects treated there are not repeated here. Both reports taken together should give a fair, though necessarily incomplete, idea of solar instrumentation activity during the period June 1984 through June 1987.

A. Absolute Spectral Radiometry

Broad-band radiometers on the Solar Maximum Mission and Nimbus-7 satellites continue to operate and have revealed interesting changes in solar irradiance. Radiometers have been flown on Spacelabs 1 and 2 with good results (Crommelynck et al., 1986; Labs et al., 1987; Van Hoosier et al., 1986). The difficult region between 5 and 57 nm has been investigated by Carlson et al. (1984). A long term program, using modern equipment and techniques, to measure solar irradiance from the ground has started (Palmer et al. 1983).

B. Spectro- and Differential Photometry

One of the most active research areas during the past three years has been precision differential photometry, often directed toward limb observations. Most of these instruments involve rapid scanning of the image with detector arrays to reduce atmospheric noise. Seykora (1985) uses low amplitude, high frequency chopping to detect tiny intensity variations. Rösch and Yerle (1984), Hirayama et al. (1985a), Dicke et al. (1986) and Herzog et al. (1986) scan parallel to the solar limb to measure facular contrast and image geometry. Limb-to-limb scanning is employed by Chapman et al. (1986). A unique instrument to measure solar diameter fluctuations, the solar disk sextant, has recently been ground tested by Sofia and his colleagues.

Ultraviolet spectrometers and results have been described by Samain and Lemaire (1985), Hirayama et al. (1985b), Parkinson and Gabriel (1986) and Epstein et al. (1987). A 1024-element, linear array detector has been added to the spectrograph at Purple Mountain Observatory (Wang et al., 1987). At the Crimean Astrophysical Observatory, an ingenious spectrometer using a Michelson interferometer and lazer stabilization, has been used for precise Doppler shift measurements (Didkovsky et al. 1986).

C. Polarimetry

Careful design has allowed Henson and Kemp (1984) to achieve broadband circular polarization measurements to one part per million. New Stokes polarimeters are under construction by the High Altitude Observatory and the Applied Physics Laboratory of Johns Hopkins University for installation at the National Solar Observatory. The high sensitivity video magnetograph of the Big Bear Solar Observatory is described by Wang et al. (1985) and the video Solar Magnetic Field Telescope of the Beijng Observatory has been described in great detail (Beijng, 1986). Video techniques are also used in a spectromagnetograph being built at the National Solar Observatory (Jones, 1987). Markov (1985) present the characteristics of the 1024-element magnetograph operated by SibIZMIR.

D. High Angular Resolution

The flight of Spacelab 2 in the summer of 1985 at last provided extended periods of solar observations with sub-arc-second resolution and no atmospheric distortion. The visible and ultraviolet instruments and preliminary results are described by Title et al. (1986) and Brueckner et al. (1986) respectively. Rocket flights, though brief, continue to be an important method for obtaining high resolution observations. The Transition Region Camera was flown in 1985 (Damé et al., 1986) and first experimental flights of normal incidence X-ray telescopes have been conducted by groups from the Center for Astrophysics (Golub et al., 1985), Lockheed and Stanford. On the ground, speckle imaging techniques have at last been developed into a practical tool for achieving nearly diffraction-limited, white-light images of small solar structures (Laville Conde et al., 1986). Adaptive optics experiments continue at the National Solar Observatory by groups headed by R. Smithson and J. Beckers. The MSDP spectrograph at Pic du Midi has been improved and now delivers half-arc-second, two-dimensional spectroscopy (INSU), 1986).

E. Infrared Instrumentation

Using equipment designed for stellar observations, remarkable far-infrared observations of the solar limb structure, limb darkening and oscillations have been made both from high-altitude aircraft (Lindsey et al., 1984) and from the ground (Lindsey and Kaminsky, 1984). Balloons have been used to observe the thermal emission of dust near the sun (Mizutani et al., 1984), and for mapping the disk at 4.6 and 18 micrometers (Zou, 1984) and 50, 80 and 200 micrometers (Degiacomi et al., 1985). Excellent spectra were obtained by a Fourier transform spectrometer flown on Spacelab 3 and a Michelson interferometer flown on a balloon (Boreiko and Clark, 1986). Two-dimensional arrays of sensitive infrared detectors are becoming available for use in solar observations (Graves et al., 1987) and a remarkable new pair of photographic emulsions have been produced that are sensitive as far as 1.4 micrometers (Shcherbakova et al. 1985).

F. Radio Instrumentation and Techniques

Frequency agile receiving equipment has become a popular addition to solar radio telescopes (Hurford et al., 1984; White et al. 1986). Earth rotation image synthesis has been employed by Alissandrakis et al. (1985) to obtain solar images at 169 MHz and by a group at SibIZMIR to obtain microwave images (Smolkov et al., 1986). Very long baseline interferometry of solar features has been attempted by Tapping (1986) as a way of obtaining very high resolution. A fast 2.8 GHz receiver was described by Jin et al. (1986) and a sensitive 80 GHz whole sun radiometer and polarimeter have been developed by Nakajima et al. (1985). The outer corona is observed by the low frequency image synthesis telescope at Clark Lake (Kundu et al., 1987) and the magnetic field is probed using Faraday rotation of Helios transmissions (Pätzold et al., 1987).

G. Helioseismology

A new generation of instruments is under development to make observations of solar velocity oscillations. Magneto-optic filters that use resonance absorption effects in atomic vapor to reveal Doppler shifts have been developed by Cacciani and Rhodes (1984), Appourchaux (1987) and Koyama (1986). A laser-stabilized, electrically-tunable, Fabry-Perot filter has been developed by Rust et al. (1986). A birefringent filter is used by Libbrecht and Zirin (1986) to observe degrees > 4. Glenar et al. (1986) have shown that laser heterodyne spectroscopy is an effective way of measuring solar velocity oscillations. Michelson interferometers continue to be developed for Doppler shift measurements (GONG, 1987). A classical spectrograph has been equipped with three linear diode arrays to obtain phase shift measurements of oscillations (Staiger, 1987).

Equipment to measure solar intensity oscillations has been described by Duvall et al. (1986), Didkovsky and Kotov (1986), Kotov et al. (1985), Didkovsky

(1985), Jimenez et al. (1987) and Nishikawa et al. (1986).

Networks of oscillation observing equipment have been or are being established at numerous sites around the world to provide continuous observations until suitable space experiments can be conducted. A group from Birmingham has stations in operation in Australia, the Canary Islands and Hawaii to obtain low-degree observations. The IRIS project based in Nice has placed one low-degree instrument at La Silla and plans additional instruments at Stanford and Tashkent (INSU, 1986). The GONG project based in Tucson plans to install six instruments for degrees up to about 300 at sites that are currently being investigated. A prototype instrument is under construction (GONG, 1987).

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