HARVARD RADIO ASTRONOMY STATION

FORT DAVIS, TEXAS 79734

Final Report
to
NASA
on Grant NSG-7391

EXPERIMENTAL SOLAR RADIO SPECTRUM ANALYZER (50-100 MHz)

Principal Investigator: Alan Maxwell

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ABSTRACT

This report summarizes work carried out under NASA Grant NSG-7391, for $8,000, covering the period 15 October 1977 to 14 January 1978. The Grant provided funds for the acquisition of an experimental radio spectrum analyzer covering the band 50-100 MHz, for use in a program of a solar radio observations. Components for the experimental analyzer were duly obtained, and the system was assembled, checked, and put into operation at the Harvard Radio Astronomy Station, Fort Davis, Texas, in early February 1978. The analyzer is working in an entirely satisfactory manner and, from the time that it has been put into operation, it has played an important part in the on-going research programs in solar radio astronomy being conducted at the Harvard Station.

WORK CARRIED OUT UNDER THE GRANT

NASA Grant NSG-7391, in the amount of $8,000, covering the period 15 October 1977 to 4 January 1978, was made to Alan Maxwell, Harvard College Observatory, for the acquisition of an "Experimental Solar Radio Spectrum Analyzer (50-100 MHz)".

Immediately after the above grant was awarded, an order was written for the purchase of the principal components of the spectrum analyzer: namely, Hewlett-Packard components consisting of an RF section, an IF section, a Main Frame, and a Display Unit for a spectrum analyzer that would cover the band 50-100 MHz. As the noise figure for the H-P equipment was approximately 23 dB, it was necessary to obtain a broad-band preamplifier of high sensitivity, to be inserted in front of the H-P components. For this purpose a Watkins-Johnson low-noise preamplifier was purchased (with funds from other sources); when coupled in front of the H-P equipment, the overall system noise figure was reduced to 4.5 dB.

The Hewlett-Packard and Watkins-Johnson components were delivered to the Harvard Radio Astronomy Station, at Fort Davis, Texas, in January 1978. The components were assembled together, checked out, coupled to a suitable antenna, and put into operation in the solar radio program at Fort Davis early in February 1978.

The acquisition of this experimental analyzer, for the band 50-100 MHz, formed the first step in replacing five obsolescent analyzers, covering the bands 25-50, 50-100, 100-180, 180-320, and 320-580 MHz, which are currently being used for the

solar radio programs at the Harvard Station. The old analyzers use obsolete technology, in the form of vacuum tubes, rotating capacitors, and the like. They require excessive maintenance and are rapidly wearing out. Originally, it had been anticipated that it would be necessary to replace these five obsolescent analyzers with new, custom-built equipment. However, with the rapid advance of standard, commercial technology it seemed possible to replace the old analyzers with off-the-shelf components, obtainable from manufacturers of high-quality electronic equipment. The cost of standard commercial equipment was also estimated at being as less than half the cost of custom-built equipment. However, since the technology of the catalog items was relatively new to the technicians and scientists at the Harvard Station it was deemed prudent to assemble one analyzer on an experimental basis.

In point of fact, the experimental analyzer was assembled with a minimum of trouble and has performed entirely up to expectations. It therefore seems entirely feasible to replace the other four obsolescent spectrum analyzers at the Harvard Station with standard commercial equipment -- as soon as appropriate funds can be obtained.

The new experimental analyzer is already forming an integral part of the on-going research programs in solar radio astronomy at the Harvard Station. For example, it operates in a frequency band that provides vital information about the occurrence of solar radio bursts of spectral type II. These bursts form

an important initial diagnostic for the investigation of shock waves, generated by intense solar flares, as they propagate outward through the solar corona and thence into the interplanetary plasma. An analysis of the velocities of the shock waves causing type II radio bursts, and the relation of these derived velocities predicted by computer models for the passage of fast-mode MHD shocks through the solar corona, is at present being carried out by the Principal Investigator in conjunction with scientists at the NOAA laboratories in Boulder, Colorado. This work will eventually be extended to include data on the passage of flare-generated shocks through the interplanetary plasma, as determined by equipment on satellites such as Helios, ISEE, and Voyager.

The new spectrum analyzer also provides vital information on the initial characteristics of groups of type III radio bursts generated by the passage of superthermal electron jets. Type III bursts and their associated electron jets are also often detected by equipment on satellites deployed through the interplanetary plasma.