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Section 3. Radio Astronomy

The two year project of a multi-correlator backend system for the λ 8-cm Radioheliograph, RSIP for Real-time Solar Image Processor, is completed last year in its hardware system. By the introduction of RSIP, the λ 8-cm radioheliograph is converted from the swept-lobe to the multi-correlator type. RSIP can synthesize two-dimensional and one-dimensional images of the radio Sun at a rate of 0.1 s/image and display them in real time. During the past one year we have spent most of time in tuning up the hardware system, in particular, of the correlator sub-system, A/D converter and the third IF amplifier. Development of software to display real-time data is finished with the help of software engineers from NEC, Nippon Electric Company. Very recently we have succeeded to display images in real-time and on offline basis in a limited performance compared with the designed goal. An example of the image obtained on offline data processing is shown in this volume, which is dedicated to the late Professor Haruo Tanaka for his pioneering works in radio astronomy in Japan and also for his constant encouragement and interest in this project. The dynamic range of images currently available on offline is estimated better than 20:1 without any image processing such as CLEAN or SELF-CAL. At present dominant source of noise which deteriorates the signal-to-noise ratio is internal spikes, which originate in the correlator sub-system. Reduction of these spike-like noises is our main focus of tuning up. If this reduction of noise is attained, we will operate the radioheliograph during night for a survey of cosmic transient sources. The minimum detectable flux density is estimated to be as low as 10 Jy (=3 times sigma) with an integration time of 10 sec. A proposal is presented for the fiscal year 1986 to replace the front-end amplifiers to better ones with noise temperature as low as 70 K. If this is realized, the total receiver noise temperature will be less than 200 K and the minimum detectable flux density will be 2 Jy in 10 sec integration time.

K. Shibasaki organized a small workshop on "Brightness distribu-

tion of the quiet Sun at mm wavelengths" at Nobeyama Radio Observatory with M. Ishiguro of NRO, Tokyo Astronomical Observatory. Main goal of the workshop was to obtain a coherent understanding on the excess brightness in mm-wave intensity at pole regions and at coronal hole regions on the Sun, detected with the 45-m radio telescope at NRO. A close relation between unipolar strong magnetic field and mm-wave excess was pointed out, and two interpretations are considered. One is due to large emission measure at higher altitude, and the other is due to the presence of magnetic field. Both interpretations require larger optical depth at higher altitude or at higher temperature. The latter interpretation can be verified by circular polarization observations.

He has been also working on the vector magnetogram obtained at Okayama Astrophysical Observatory with M. Makita's group at Tokyo Astronomical Observatory. The magnetogram data are collection of Stokes parameters of magnetically sensitive line wing at each pixel point on the Sun. There are crucial problems associated with the conversion of Stokes parameters to magnetic field strength and direction. For example theoretical calculation of a conversion table always shows saturation effect where magnetic field is strong. It is revealed, however, that there is no such effect detected in those magnetograms observed at Okayama. In the mean time, comparisons are in progress of magnetogram data obtained at Okayama Astrophysical Observatory and Sayan Mountain Observatory of SibIZMIR, U.S.S.R. Provisonal results show very good agreement on the distribution of polarization degrees between the two data sets.

Calculations are made of distribution of the current in active regions, on the basis of magnetogram data, in its transverse component. Examples are found that certain current distribution is associatd with temporal changes in sunspot structures and/or H-alpha filament structures, which support the model calculations proposed by Y. Nakagawa of Chiba Institute of Technology. Preparation for publication is in its final stage.

Related to the next satellite for solar flare observations, currently called HESP or SOLAR-A, which is scheduled to be launched in the next solar maximum, he have studied the performance of multi pitch modulation collimator, which will be used as a hard X-ray imaging telescope. This collimator was proposed by T. Kosugi of Nobeyama Solar Radio Observatory. Based on his idea, computer simulation was performed for image synthesis making use of Maximum Entropy Method and CLEAN Method. The results of simulation will be employed in the

decision of the design goal of the hard X-ray imaging telescope with respect to the number of modulation collimators and the size of each detector.

A plan to construct a large radio heliograph in the next solar maximum has made a large step in its design study by the two solar radio astronomy groups, one at Nobeyama Solar Radio Observatory and the other at Toyokawa Observatory. Main performance specifications are 10 arcsec or higher spatial resolution, 1 sec or higher temporal resolution, and full Sun field of view at a microwave frequency. In the past one year or so extensive studies were done with intense effort into the detail of antenna system, which includes element antennas, mounting, driving and control sub-systems etc., receiver system, composed of frontend receivers, IF receivers, local oscillator sub-system etc, digital correlator system, cable system for signal transmission and for control, and computer system, consisting of online, control, and offline data processing computer sub-systems. Several companies are involved in those feasibility studies, results of which will hopefully come out very soon in the form of detailed proposals for the large radio heliograph system and/or its sub-systems.

M. Nishio attended the second VLA tutorial workshop on VLA system held at Soccoro, NM, U.S.A. in August, 1985. He also attended the International Symposium on Antennas and Propagation held in Kyoto in August, 1985, where he made a report on the Real-time Solar Image Processor.

K. Shibasaki attended the SMY Workshop at Irkutsk, U.S.S.R. in June 1985, where he made a report on spectra of S-component and active region magnetic fields.

S. Enome attended the SMM Workshop held at Lanham, MD, U.S.A. on Rapid Fluctuations in Solar Flares, where he made reports on the association of narrow-band decimeter bursts and X-ray bursts, and a Japanese plan for a large radio heliograph in the next solar maximum.

Emeritus Professor Haruo Tanaka of Nagoya University died in October, 1985 as described in the Obituary in this issue. The funeral ceremony was performed in November, 1985, where many scientists, engineers, and related persons gathered together to mourn his death from very wide field of radio sciences, astronomy, space sciences, and etc. Telegrams of condolence were also received from world-wide scientists.

March 6, 1986 - Shinzo Enome -

Publications

Atlas of Solar Radio Bursts for 1984 and 1985, Toyokawa Observatory, WDC-C2 Toyokawa (1986).

Enome, S. and L. E. Orwig:Relation between Solar Narrow-Band Decimeter Wave Bursts and Associated X-Ray Bursts, submitted to Nature (1986).

Kosugi, T., M. Ishiguro, and K. Shibasaki:Polar-Cap and Coronal-Hole-Associated Brightening of the Sun at Millimeter Wavelengths, Publ. Astron. Soc. Japan, **38** (1986).

Monthly Report of Solar Radio Emissions, Toyokawa Observatory, January - December (1985).

Nishio, M., and K. Shibasaki:A Modified Self-Calibration Method of the Gain and the Phase of the Radio Interferometer, Trans. Inst. Electr. Comm. Eng. Japan, **J68-B**, 523-530 (1985), (in Japanese).

Nishio, M., Y. Tsukiji, S. Kobayashi, K. Shibasaki, and S. Enome:Real-Time Solar Image Processor (RSIP) for the λ 8-cm radioheliograph at Toyokawa, Proc. 1985 Interntl. Symp. Antenna and Propagation, Vol. II, 651-654 (1985).

Quarterly Bulletin on Solar Activity (Radio Part) for 1980, Tokyo Astronomical Observatory, University of Tokyo, **23** (1985).

Quarterly Bulletin on Solar Activity (Radio Part) for 1981, Tokyo Astronomical Observatory, University of Tokyo, **24** (1985).

Shibasaki, K.:Spectrum of S-component Flux and Active Region Magnetic Field, Proc. Res. Inst. Atmospherics, Nagoya Univ., **32**, 1-9 (1985).