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Section 3. Radio Astronomy

Contribution is made to the Solar Maximum Year (SMY) Program by issuing Atlas of Solar Radio Bursts for 1980 and Atlas of Solar Radio Bursts for Post SMY Period, May and June 1981, both of which consist of computer plots of 10-second average records of Fully-Automatic Radiopolarimeters at Toyokawa and tables of outstanding events. These Atlases are distributed among active scientists in the world strongly associated with SMY Program (Enome et al., 1981).

The λ 8-cm radioheliograph at Toyokawa has been improved in performance of phase stability and sensitivity with an introduction of a low-noise frontend receiver for each antenna and of coaxial cable for the transmission of reference frequency and IF signals. The total system of the radioheliograph, thus, becomes complex and is distributed along arrays; a central control system is developed. This system consists of two microprocessors, one of which is used for the backend receivers, and the other for the 2nd IF and frontend receivers respectively. Main tasks of this system are routine control and monitoring of the total system, and to execute simple test jobs such as phase calibration of each antenna, etc. Maintenance, modification, and extension of the system are easily done in both software and hardware aspects because of standardization of interfaces (Kobayashi and Takata, 1982).

A project is proposed to improve the time resolution and the dynamic range of the λ 8-cm radioheliograph system at Toyokawa. The main purpose of this project is to replace the backend of the present λ 8-cm radioheliograph with a digital correlator backend. By this improvement, a maximum time resolution of 0.1 sec/image with a minimum detectable flux of about 0.5 s.f.u. is expected. A design study of the digital correlator backend is undertaken. From the study and some experiments using a one-bit correlator, it was clarified that a one-bit correlator is suitable for the digital correlator backend (Nishio et al., 1982).

An optimization method is studied for the 5-element 10-m diameter super-synthesis array at Nobeyama Radio Observatory, Tokyo Astronomical Observatory, Univeristy of Tokyo (Morita and Ishiguro, 1982). In this paper an optimization method is proposed in which 'number of weighted holes' are used as criterion for the evaluation of the array configuration, and it is shown that under an appropriate condition it becomes a good index of the peak sidelobe level of the synthesized beam. The performance of the array configuration determined by this method is evaluated through a simulation test of the super-synthesis by using model brightness distribution.

Several cooperative studies are made and in progress as contributions to the SMY Program and related satellite data analyses combined with ground-based observations. K. Shibasaki worked on Westerbork Synthesis Radio Telescope for one year and half during SMY period. One of the results obtained will appear as a joint paper, which deals with an active region AR 2490. The Solar Maximum Mission Satellite, the Sacramento Peak Vacuum Tower Telescope, the Very Large Array and the Westerbork Synthesis Radio Telescope have been used to observe the region on two consecutive days at soft X-ray, ultraviolet, optical and radio wavelengths (2cm, 6 cm and 20 cm), with comparable angular resolution (2 to 15 arc seconds) and field of view (4 arc minutes X 4 arc minutes). The radio emissions at wavelengths 6 cm and 20 cm show a double structure in which one component is associated with bright H-alpha palge, C IV and soft X-ray emission, and the other component is associated only with sunspot. No radiation at wavelength 2 cm is detected in this latter component. Coronal temperature and emission measure derived from X-ray lines indicate that the dominant radiation mechanism of the plage-associated component is due to thermal bremsstrahlung while the gyroresonance absorption coefficient must be invoked to account for the high brightness temperature (T_b = 2 X 10^6 K) observed in the sunspot associated compoent. The high magnetic field strength needed (600 G at a level where T = 2 X 10^6 K) is explained assuming a thin transition zone, in order to reach a high electron temperature close to the sunspot, where the magnetic fields are stronger. A higher temperature gradient above sunspots is also consistent with the absence of detectable C IV emission (Chiuderi-Drago et al., 1982).

Acceleration and confinement of energetic electrons in June 7, 1980 solar flare is discussed (Kane et al., 1982), which had well-defined quasi-periodic oscillations of large amplitude in hard X-ray and microwave radio emissions observed with the International Sun Earth Explorer-3 (ISEE-3) spacecraft and the ground-based radio observatories respectively. Its observational characteristics are summarized as follows: The event has a total of seven well defined peaks with an average separation of about 8 sec; There is a general similarity between the time intensity profiles of 26 - 398 keV X-rays and 9.4 - 17 GHz radio emission, the similarity decreases with decreasing frequency below 9.4 GHz; In the X-ray emission above 20 keV there is no indication of a fine time sturcture with a time constant of 0.032 sec; The logarithmic amplitude of the variations is much smaller for X-rays of about 43 keV than that for higher energy X-rays; The polarization of 17 GHz emission is smaller (5 - 10 %) at intensity peaks and relatively larger (10 - 20 %) at intensity valleys; The spectrum of X-rays above 20 keV hardens with time during the initial increase of the X-ray emission, then hardens at the intensity peaks and softens at the intensity valleys; The spectrum of the microwave radio emission is relatively steep at the intensity peaks and the turnover frequencies are above 17 GHz. AT the valleys the spectrum is relatively less steep and the turnover frequencies are around 17 GHz; For both peaks and valleys, the turnover frequencies and the steepness of the spectrum decreases systematically with time; The size of the radio source at 17 GHz is about 5 arc seconds. Both the size and the position of the source did not change significantly during the event; Interpretation and discussions are given for the above observed features.

Studies of the relative timing of solar flare emission at different wavelengths can provide valuable insights into the associated particle acceleration mechanisms. In general microwave and hard X-ray emissions give the time history of the interaction of energetic electrons with the solar plasma and magnetic fields, whereas gamma ray emissions reflect the corresponding behavior of energetic protons and ions. A report is made on the observations of significant systematic differences between the times of occurrence of the peak intensities of the three kinds of flare emission in two major solar flares at 0312 UT on June 7 and at 0118 UT on June 21, 1980 respectively. A possible mechanism is given and discussed for these new observations (Nakajima et al., 1982).

Another interpretation is proposed to account for time profiles of hard X-rays, microwaves and nuclear de-excitation gamma ray line emission from these impulsive and other extended bursts in terms of nonthermal, thick-target, trap model with simultaneous acceleration and injection of electrons and protons. The gamma ray line delays with respect to hard X-ray emissions are explained by greater relaxation time of accelerated protons than that of nonthermal electrons. The delay time will be then inversely proportional to the ambient density with estimated values of 5 X 10^{11} for an impulsive case and 2 X 10^{10} for an extended case (Enome, 1982).

K. Shibasaki has returned from Dwingeloo Observatory, the Netherlands. During his stay in the Netherlands he attended the SMY Workshop at Goddard in February, 1981 and Third European Solar Meeting at Oxford in April, 1981.

S. Enome attended the SMY Workshop at Annecy in October, 1981.

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- Shinzo ENOME -

Publications

Chiuderi-Drago, F., Bandiera, R., Falciani, R., Antonucci, E., Lang, K., Willson, R. F., Shibasaki, K., and Slottje, C.: Multiple Wavelength Observations of a Solar Active Region, Solar Phys. in press, 1982.

Enome, S., Shibasaki, K., Takayanagi, T., and Takata, S.: Atlas of Solar Radio Bursts for 1980, IMS/SMY, WDC-C2 Toyokawa, 1981.

Enome, S., Shibasaki, K., Takayanagi, T., and Takata, S.: Atlas of Solar Radio Bursts for Post SMY Period, May and June 1981, WDC-C2 Toyokawa, 1981.

Enome, S.: Impulsive and Extended Bursts, Proc. 'Hinotori' Symposium, Inst. for Space Astronaut. Sci., Tokyo, in press, 1982.

Kane, S. R., Landecker, P. B., McKenzie, D. L., Kai, K., Nakajima, H., Kosugi, T., and Enome, S.: Acceleration and Confinement of Energetic Electrons in 7 June, 1980 Solar Flare, Ap. J. Letters, submitted, 1982.

Kobayashi, S. and Takata, S.: A Control System of the 8-cm Radioheliograph at Toyokawa, Proc. Res. Inst. Atmospherics, Nagoya Univ., Vol. 29, in this issue, 1982.

Monthly Report of Solar Radio Emission, Toyokawa Observatory, January - December, 1981.

Morita, K.-I. and Ishiguro, M.: An Optimization Method of Super-Synthesis Observation by 'Number of Weighted Holes', Trans. Inst. Electronics and Comm. Eng., Japan, submitted, 1982.

Nakajima, H., Kosugi, T., Kai, K., Enome, S., and chupp, E. L.: Relative Timing of Microwave, X-ray and Gamma Ray Emissions in the Impulsive Solar Flares on 1980 June 7 and 1980 June 21, Proc.

'Hinotori' Symposium, Inst. for Space Astronaut. Sci., Tokyo, in press, 1982.

Nishio, M., Tsukiji, Y., Enome, S., Shibasaki, K., and K.-I. Morita: A Design Study and Some Experiments of Degital Correlator Backend for λ 8-cm Radioheliograph at Toyokawa, Proc. Res. Inst. Atmospherics, Nagoya Univ., Vol. 29, in this issue, 1982.