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DATA PROCESSING IN MULTI-ELEMENT RADIO INTERFEROMETER

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One of the important problems in radio astronomy is to restore as faithfully as possible the true brightness distribution of the radio sources in the sky. As a high-resolution antenna necessary to solve this problem, multi-element interferometer has been used especially for solar studies, and the resolution of less than one minute of arc has been successfully obtained which can hardly be attained with a single giant dish even in centimeter-wave region.

For this kind of interferometer, however, it is difficult to keep the system in a well adjusted condition.

Owing to the progress in antenna array theory and the electronic computer, this difficulty can be overcome by combining antenna with data processing. Indeed, the interferometer system cannot be completed without this combination. At Toyokawa, two series of one-dimensional high-resolution interferometers with HPBW of 0!38 have been in operation on wavelengths of 8 and 3 cm, and two-dimensional interferometer, or radioheliograph, on 3cm has also been in operation. General view of these interferometers are shown in Fig. 1. and Fig. 2..

Inspite of the extensive progress in antenna theory, it has not been sufficiently applied to the actual routine observations. We have established the data processing scheme, where the phase of each antenna is corrected as much as possible and the noise spectra beyond the theoretical limit is removed. The detailed theory of phase error correction is shown in Ref. (1) and Ref. (2).

References

(1) Ishiguro, M. ; Image Correction in High-Resolution Radio Interferometer, Proc. Res. Inst. Atmospherics, Nagoya Univ., 18, 73 (1971)

(2) Arisawa, M. ; Improved Radio Mapping of the Sun, ibid, 18, 89 (1971)

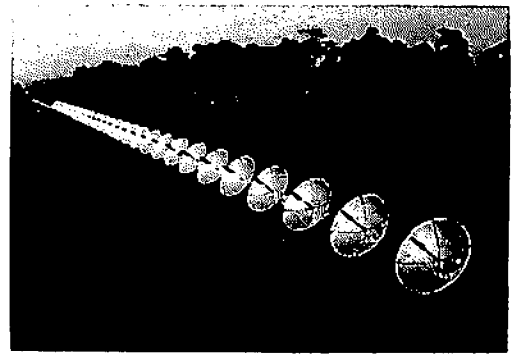

Fig. 1. General view of 8cm (32+2)-element compound interferometer.

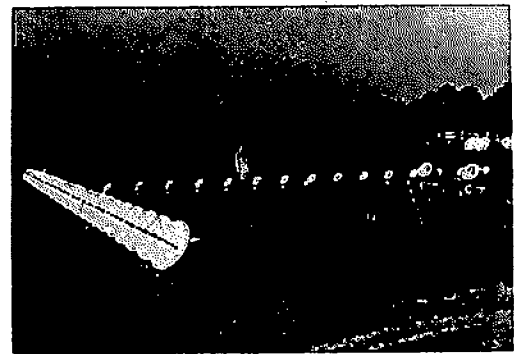

Fig. 2. General view of 3cm (32+2)-element compound interferometer and (32+16)-element T-shaped interferometer.

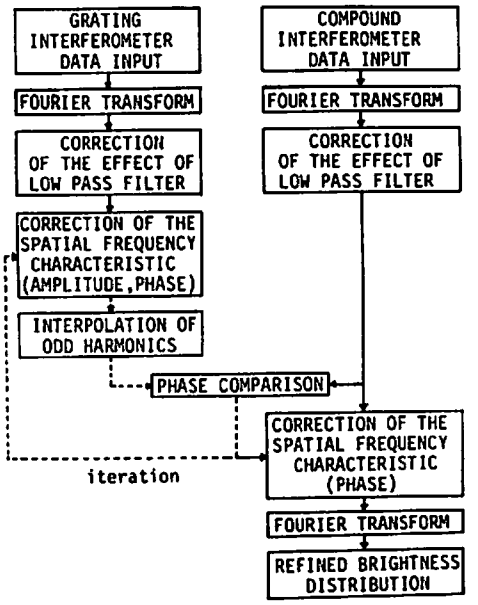

Fig. 3. Flow-chart of data processing. (FORTRAN program length is about 16K words.)

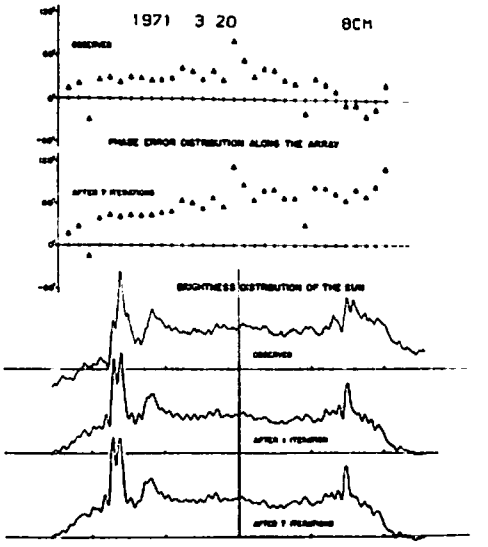

Fig. 4. Estimated phase error distribution along the array and the result of phase correction for the brightness distribution of the sun observed with 8 cm compound interferometer. (Usually phase error estimation is converged after 7 to 10 iterations.)

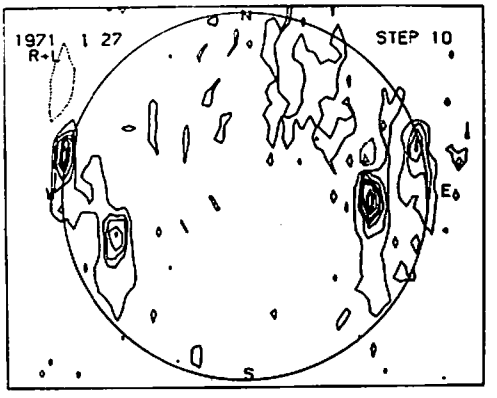

Fig. 5. Unprocessed contour map of the brightness of the sun observed with 3 cm T-shaped interferometer.

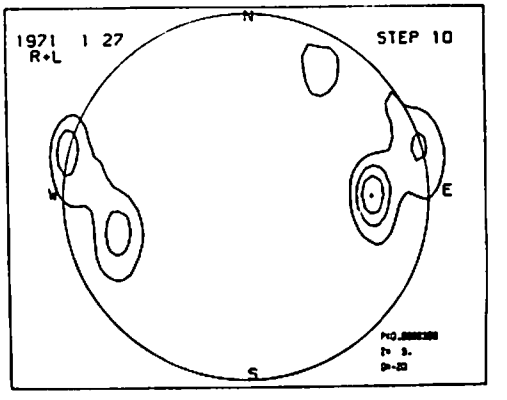

Fig. 6. Processed contour map of the brightness of the sun. (after filtering and phase correction.)