Detection of Faint Radio Sources by Using an Optical Fiber Connected VLBI Array

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In VLBI (Very Long Baseline Interferometer) observation, radio signals received by two or more radio telescopes are recorded on magnetic tapes in a digital form. The tapes are shipped to a correlation station to have interferometer fringes. The recording speed on the tape has been a bottleneck of having higher data acquisition rate for better sensitivity. Recent growth of fiber communication technology makes it possible to transfer the data at a speed of a few gigabits per second or higher. In Japan the 'Super SINET' network started the service in 2000. This network connects universities and research institutions for academic purposes with fiber links at a gigabit rate. Forming a fiber-connected radio telescope array is one of important applications of the network. Now the Usuda 64-m radio telescope of the Institute of Space and Aeronautical Sciences, the Tsukuba 32-m radio telescope of the Geographical Survey Institute and the Gifu 11-m radio telescope of the Gifu University are connected with fiber communication links at the rate of 2.5 Gbps each. The network is extended to about 300-km around the Tokyo metropolitan area and larger than the MERLIN network, England, extending over about 200-km. By a full usage of two-way communication capability, data reception and correlation processing is performed at the telescope site in parallel with data acquisition and shipping to other telescope sites. In this way, the total aggregated observation rate of 4.096 Gbps is achieved on a single 2.048-Gbps communication link, which is 16 times faster than the nominal tape recording speed. The observation rate gives 4 times higher sensitivity than the currently working VLBI observation. The high data acquisition rate and a pair of large telescopes produces extremely fine fringes of very high signal-to-noise ratio and are expected to work in the detection of continuum emission from very faint stellar objects.

In the presentation, the authors show the technical details of the high-speed sampling at the rate of 2.048 Gbps on a single channel, data transmission via the SDH/OC48 communication link, and real-time correlation processing at the both sites of radio telescopes. Also scientific results of trial observations on the P Cygni, the first radio detected single star of the class of the blue super giants. The source flux density is estimated to be about 1 mJy or less. In the observation, a technique of phase reference switching is attempted, which enable us to make long integration by tracking spontaneous phase changes caused by the atmospheric path instability in referencing the phase changes to the fringe phases of a nearby strong quasar. The improvement of the signal-to-noise ratio by the long integration is also presented.