RADIO ASTRONOMY IN CHINA, 1999-2001

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Local Observatories (including Beijing, Purple Mountain, Shanghai, Yunnan and Urumqi observatories) attached at the Chinese Academy of Sciences have been reformed as an united observatory named as National Astronomical Observatories of China (NAOC), Chinese Academy of Sciences in the Summer of 2000. All research groups both at the observatories (BAO, PMO, SAO, YAO, UAO) and universities (PU, BNU, NU) on radio astronomy have also been reorganized to match with requirements of contract and innovation in research of radio astronomy in China. The report will summarize research and development conducted by these groups.

1. DEVELOPMENT AND STATUS OF INSTRUMENTS

1.1 The FAST Project

FAST means Five-hundreds-meters Aperture Spherical Telescope that has been proposed as an element pilot of SKA project to be built at one of Karst depressions in Guizhou province. Preliminary funds was provided to support preresearch of some key techniques in the project by the Chinese Academy of Sciences and the Ministry of Science and Technology since 1999. The schemes for segmenting the main reflector, for adjusting the reflector panels by computer-control actuators, for driving the focus cabin by computer-controlled cables and for real-time measurements and some kinds of control, such as ADRC, Lonwork bus, closed loop and differential controls have been studied and scaled-model tested. The results are encouraging, that could basically show feasibility of the project. Tentative Scheme and layout of the feeds and receivers have been discussed and proposed by Sino-Anglo scientists and engineers. Meanwhile some efforts have been put on studies of further enlarging sky coverage, improving the structure and expected performance of the FAST. Further funds are applied to begin devices design, further R&D and construction of the telescope.

1.2 The 34m Full Tracking Radio Telescope (Proposal)

A 34m full tracking radio telescope has been proposed by SAO. It will be operated up to Ku band and used for both radio astronomy and space exploration. Necessary funds for building this telescope would probably be provided by both Chinese Academy of Sciences and Shanghai Government, if the final scheme was demonstrated and passed.

1.3 Millimeter Wavelength Heliography

It is proposed by the radio solar community and now is under preliminary R&D at PMO and NAO.

1.4 Submillimeter Wave Telescope

A 600-720 GHz SIS mixer has been developed at PMO in cooperation with ASIAA and NRO. Joint collaboration in the project SMA and planning to build a portable submillimeter telescope are under way.

1.5 The 50m Decimetric-wave Telescope at Miyun (Planned)

A 50m S-band radio telescope has been proposed by Miyun group of NAOC. Exploration of gravity wave and pulsars would be one of its main subjects. It could also be used to study some molecular clouds and measure space explorers in the future. At present, antenna scheme studies and funds application are under way.

1.6 Existing Instruments

1.6.1 25m VLBI Telescopes at Shanghai And Urumqi

1.5GHz de-dispersion pulsar-timing observation system has been built and installed on the 25m radio telescope at UAO. The telescope is also equipped with wide-band high-resolution self-correlation spectrometer. It can be used to observe the molecular lines such as that from ammonia (NH_3), water (H_2O), methanol (CHOH_3), and hydroxyl (OH). Ammonia emits thermal in lines the other three in non-thermal lines, with a frequency range of 2-23 GHz.

In 1999, the VLBI terminals were upgraded to the MKV systems from MKIII and VLBA at SAO. Now Shanghai station becomes an important station for VSOP observation.

1.6.2 The 13.7m Millimeter-wave Telescope at Delinha

A broad-band tunerless SIS receiver was built and installed on the telescope, that has been under routine operation at 3 mm band since 1999. A multi-line backend has been designed and set up for observing simultaneously CO (J=1-0) and its isotopic lines at this band. The performance of the telescope has been improved due to upgrading the LO locked phase system and compressor for cryogenics.

1.6.3 Solar Radio Telescopes

The Chinese solar radio astronomy community started to establish a braodband (0.7-7.6 GHz) Solar Radio Dynamic Spectrometer System with high temporal (~1ms) and high frequency (~10 MHz) resolutions from 1994. The system is divided into 5 separate parts: 0.7-1.5 GHz (YAO), 1-2 GHz (BAO), 2.6-3.8 GHz (BAO), 4.5-7.5 GHz (PMO) and 5.2-7.6 GHz (BAO) spectrometers, which are located at 3 different sites. The 1-2 GHz and 2.6-3.8 GHz and 5.2-7.6 GHz spectrometers were successively put into operation at BAO in 1994, 1996 and 1999, Meanwhile, the 4.5-7.5 GHz spectrometer at PMO and 0.7-1.5 GHz spectrometer at YAO were finished and began test operation in 1999 and 2000 respectively. The whole system passed the official evaluation examined by Chinese Academy of Sciences in 2001.

1.6.4 Miyun Synthesis Radio Telescope (MSRT)

After a general survey using MSRT was completed in 1997, some technical developments have been conducted at Miyun, Beijing. A limited delay tracking system has been installed on the system. So at present it can be operated as a compound interferometer as well. New developments of MSRT have provided new working modes: one-dimensional radio heliograph and IPS telescope in addition to original aperture synthesis mode. Radio observations at 232 MHz and multi-frequency spectral studies of the SNR HB21, studies of IPS and high-resolution radio solar have been conducted with this system. Protruding structure buried in radio survey map was studied by using wavelet method. If some more funds and manpower could be put into the development, the system would be remade as tied array to be used in VLBI observation in the future.

2. SOLAR RADIO ASTRONOMY

With the help of new braodband (0.7-7.6 GHz) Solar Radio Dynamic Spectrometer System, many fine structure of solar radio bursts have been observed in very high temporal and spectral resolutions. For instance, the bi-directional type-III bursts in microwave, the microwave type-U bursts in sub-second time duration, microwave type-M bursts, evolving emission lines (EEL) in microwave and the multiple twisted type-U bursts have been firstly observed in such high frequency range. It is expected that these new instruments may play an important role in studies in the 23rd solar cycle maximum.

3. MOLECULAR RADIO ASTRONOMY

CO (1-0) line emission observations of bright IRAS sources (e.g. NGC1333) have been conducted by BNU group. They have studied magnetic field dissipation in dense molecular clouds and acceleration by magnetic mirrors and Alfven waves in molecular outflows. New detected CO (1-0) emission from planetary nebulae and temperature rise at the edges of dark molecular clouds were found by this group.

Several items associated with star-formation research such as the dense cores of molecular clouds, the interaction between young stars and circumstellar environment, a large- scale survey or partial survey of the Galactic plane in Ammonia lines, search for new methanol masers for the establishment of a complete sample are undertaken by the NU group.

A number of observing programs, mostly in CO and its isotopic lines, have been carried out using the 13.7m mm-wave telescope at Delingha. For instance, samples of IRAS sources, massive dense cores, protoplanetary nebulae, and high-velocity gas associated H_2O masers have been studied by different groups (NU, PMO, PU, BNU). Studies on OH masers and associated magnetic field, H_2O masers and their variation have been also conducted by NU and BNU groups.

4. RADIO SOURCES IN THE GALAXY

Investigation of massive cores where massive stars may be in forming process and activities of massive young stellar objects have been made with multiple wavebands. For instance, the ^{13}CO and $C^{18}O$ emissions, the ^{13}CO image and the high-speed out flows have been observed in selected samples.

The simultaneous de-dispersion system at 2.3 and 8.4 GHZ and the simultaneous single-channel system at 0.327 and 0.61MHz were successfully developed on the 25m telescope at UAO. So the timing, the glitch, the model changing, inter-stellar scintillation and the spectra of sampling pulsars have been obtained by using these equipments.

The spectral flatening towards the edge of supernova remnant HB21/HB9 has been found from multiple-frequency spectrum observations. It should be caused by interaction between the SNR and the ISM. Some results have been achieved from ISP observations made with the MSRT.

5. OBSERVATION AND STUDIES ON EXTRAGALACTIC RADIO SOURCES

A sub-sample of EGRET, active galactic nucleus (AGN) samples have been multi-band and multi-epochs observed and studied successively with EVN, VLA, WSRT and VLBA by VLBI group at SAO. They have also observed and investigated some quasars and BL Lac objects by using VLBI technique at 6 and 18cm wavelengths. Some statistical and theoretical results have been achieved from the research.

BAO group has obtained 8-epoch polarization images of a gravitational lens PKS1830-211 by using VLBA. They have also got a space-VLBI image of the IDV 2007+777. A pair of Seyferts has been identified from a ROSAT bright source. Some 90 extragalactic compact radio sources have been observed with VLBA. About 11 AGNs have been VLBI-polarization imaged by the group. In copperation with German and Dutch radio astronomers, the flux, polarization or intraday variations of some quasars (e.g. 0235+164, 0917+624, 0420-014) have been observed and studied by using VLBI. The giant radio galaxies 3C 236 has been observed by using VLBI, MERLIN and HST together. An association between radio light variation and VLBI structure variation of 0420-014 has been found by SAO group. Visually superluminal speeds of 4 AGNs have been measured with VLBI by the group.