Spectral System of the Urumqi Telescope and Water Maser Studies*

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Abstract For spectral line observations in short centimeter wavelength, a new system was installed in the 25 m telescope of Urumqi Station of NAOC. The receiver is a cryogenically cooled HEMT receiving system with a 2 GHz wide band, a 20 K working temperature and an average noise temperature of 50 K. The back end is SAW chirp-transform spectrum analyzing system with a total bandwidth of 40 MHz and a frequency resolution of 40 kHz. Many known H_2O maser sources were observed. A new digital correlation spectrometer will be installed at the end of this year. The site and new facilities at Urumqi Astronomical Station provide excellent conditions for the spectral line observations in centimeter wavelength region. A frontier subject in astrophysics, studying for water masers and star formation was designed.

Key words astronomical technique-spectrometer, ISM: masers, stars: formation

1 The Spectral Systerm

The 25-meter radio telescope of Urumqi Astronomical Station of NAOC, is located at Nanshan Mountain near the sourth suburb of Urumqi city, Xinjiang province. It situates 2080 m above the sea level, a very dry site for the short centimeter observations. The telescope is mainly used as a VLBI station. It has receiving systerms for even bands: 1.3 cm, 3.6/13 cm, 6 cm, 18 cm, 49 cm and 92 cm.

To investigate large-scale structure of the Milky Way and dynamical properties of the 22 GHz water maser emission, the 1.3 cm spectral line receiving system was built. The receiver is a cryogenically cooled HEMT amplifier. Its major parts are designed and developed for the VLBI projects (Ma et al. 1999). A slight modification was made and a second mixer with a reference frequency synthesizer was added in order to compensate the Doppler shift due to the motions of the sources. This generates a fixed output at the 529 MHz central frequency. The SAW CZT-based spectrometer consists of three parts (Chen et al. 1990). Pre-amplifiers and mixers constitutes the first stage with two highly stable L.O. (F_1=710 MHz,F_2=690 MHz). Part II is the SAW CZT processor containing four parallel CZT subsystems. Each subsystem operates in a bandwidth 20 MHz with 50% working duty cycle and a frequency resolution 39 kHz. The SAW CZT processor, therefore, has a bandwidth of 40 MHz and 100% duty cycle. The equivalent transformation rate is greater than 1024 points/66.6 μs. Part III is a digital processor to carry out the A/D conversion and digital integration. The longest integration is about 300 ms(Zheng et al. 1999).

The spectrometer, synthesizer, antenna controlling computer and noise source are operated by observing computer. The diagram of the system is shown in Fig.1.

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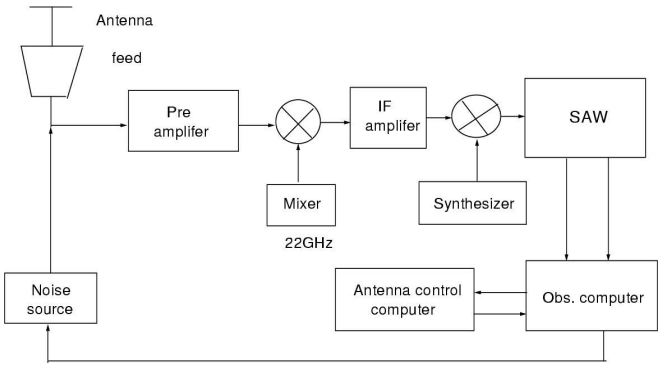

Fig. 1 The diagram of the 13mm water maser spectral system

2 Observational Tests

With the SAW CZT-based spectrometer the early experimental observations were carried out at 13.7 m radio telescope at Qinghai Station of the Purple Mountain Astronomical Observatory. Since then the digital processor in the spectrometer has been improved(Zheng et al. 1996; Chen et al. 1991). The 13 mm spectral receiving system on the 25 m radio telescope at Urumqi was experimentally used to observe water masers to test the properties of the system and site of the Urumqi Station for short centimeter astronomical observations. Water vapor maser emission from a number of Galactic sources were observed. Observations were made in position-switching mode and a 31 K state noise was used as a second calibrator. The system temperature at zenith was 180 K. The absolute calibration of flux density was about 20%. The measured lines from some known sources, such as W3(OH), ON1 are shown in Fig.2. The results present the feasibility of the receiving system and the excellent meteorological conditions of the Urumqi Station for short centimeter wavelength band.

3 Digital Correlation Spectrometer

Though the SAW CZT spectrometer can be used in astronomical observations, it was designed in 1983. Its band width and resolution are difficult to meet the further requests of astronomical measurements.

At present, digital auto-correlation is used as spectrum analyzing systems for radio astronomy. The digital auto-correlation spectrometer provides a flexible selection of bandwidth and high resolutions and convenient digital components.

For improving the resolution and stability of the equipment, a new digital correlation spectrometer, as a back end will be installed to the spectral system of the telescope at the end of this year. The S80S4096 digital correlation spectrometer has 4096 frequency channels with the maximum analog bandwith ranging from 0.5MHz to 80MHz. At the maximum signal bandwith of 80MHz the frequency resolution is 19.53KHz. The bandwidth and the frequency resolution can be changed by selecting the appropriate clock frequency.

4 Project

(1). Search new water masers. Select IRAS sources with high color index without 6 cm

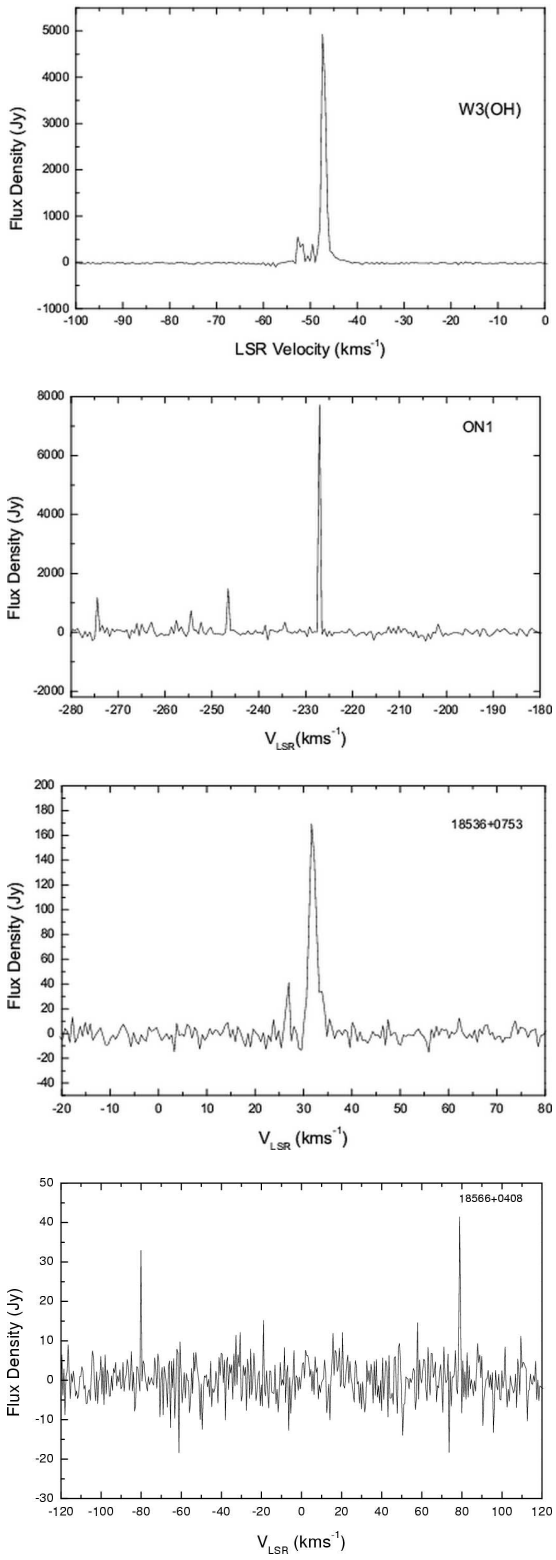

Fig. 2 Observed results of water maser emission

radiation as samples. Such objects may be at early stages of young stellar objects and are important for study initial conditions of star formation.

(2). Investigate water maser emissions of different stages of star formation, to obtain the correlation of the water maser emissions and the star forming and early evolution activities.

(3). Select masers of different star formation stages to monitor their time variation and to examine the affect of the maser environment.

(4). We will cooperate with NAOC and select masers of different star formation stages to observe the infrared emission with 1.26 m telescope at the same time to investigate pumping mechanism.

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