New details of interstellar medium revealed by the FAST Galactic Plane Snapshot survey

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Many aspects of the interstellar medium in our Milky Way galaxy has not yet revealed clearly. Sensitive radio observations can detect the neutron and ionized hydrogen through spectral line observations, and probe magneto-ionized gas through the polarization observations of polarized radio sources such as pulsars and background radio sources. Radio images can also show the shocked gas by supernova remnants. The Five-hundred-meter Aperture Spherical Telescope (FAST) built by China has a 300 m illumination aperture, and is the most sensitive single-dish radio telescope in the world because it is equipped with a highly sensitive L-band 19-beam cryogenic receiver hat has a system temperature of 22 K. It is an excellent instrument for hunting pulsars and exploring the Galactic interstellar medium.

We started the FAST Galactic Plane Pulsar Snapshot (GPPS) survey[1] at the beginning of 2020, and plan to cover the Galactic plane in the Galactic latitude of ±10° in the visible sky by FAST (zenith angle less than 28.5°) with a huge number of 3' beams in the L-band, each has an integration time of 5 minutes. Up to now, we has successfully discovered more than 600 pulsars (see *http://zmtt.bao.ac.cn/GPPS/*). During the pulsar survey observations, the piggyback spectral line data in the L band of 1000— 1500 MHz are recorded simultaneously with the digital spectroscopy backends connected to the *L*-band 19-beam receiver.

The Galactic magnetic fields which permeate the interstellar medium of the whole galaxy are extremely difficult to measure. Rested on the high sensitivity of FAST, we measure polarization and Faraday rotation of previously known pulsars and newly discovered pulsars, we get magnetic field strength in the Galactic halo as being about 2μG[2] . Newly determined Faraday rotation measures of pulsars by FAST gives evidence for the magnetic field reversals along the spiral arms in farther regions of the first quadrant in the Milky Way.

By processing the piggyback spectral line data, we get the sky distribution of neutral hydrogen (HI) gas[3] in 88 square degrees between the Galactic longitude of 33°to 55°and within the Galactic latitude of ±2°. Though the fine calibration is still under way, the results available are already the most sensitive for detection of HI gas clouds to date, showing unprecedented detail about the distribution of HI gas.

The ionized gas of interstellar space is the last major component of the Milky Way that remains unexplored in detail. We processed the hydrogen radio recombination lines (RRL) in the GPPS spectral line data in the same sky area as the HI data[4] , revealing luminous regions ionized by bright stars and diffuse ionized gas (DIG) of unknown origin. The data are indispensable for the studies of the ecological cycle of gas and star formation in the Milky Way. The results will be introduced by L.H. Hou in the next talk.

In addition, we tested the scanning observations by FAST for radio continuum radiation of our Galaxy. The results in a sky area of 5°×7° confirm that two large faint radio emission structures (G203.1+6.6 and G206.7+5.9) as being nearby shell-type supernova remnants[5], one of which is produced by supernova explosion very close to the Sun at only about 1,400 light-years.

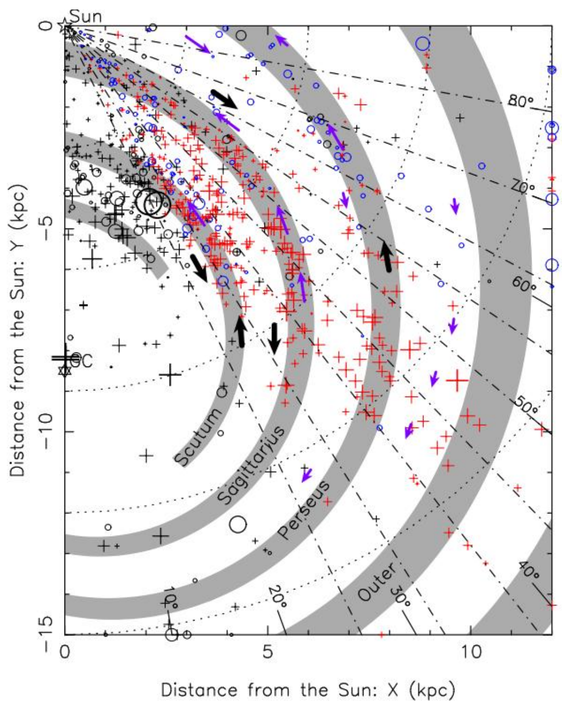

Figure: The magnetic field structure in a much large region in the Galactic disk revealed by the new measurements (color symbols) of pulsar Faraday effect by the FAST.

References

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