Imaging Spectroscopic Analysis of Solar Radio Spikes with Quasi-Periodic Pulsations Observed by MUSER

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Solar radio fine structure bursts are manifestations of kinetic processes that take place in the solar atmosphere. The radio imaging-spectroscopic facilities are very important tools for advancing our knowledge of the dynamic processes, magnetic fields and the atmospheric structures above the solar surface. The Mingantu Spectral Radioheliograph (MUSER), located in Inner Mongolia of China, is a solar-dedicatedd facility with three arrays covering 30-400 MHz, 400MHz-2GHz and 2-15 GHz frequency ranges designed with characteristics to perform high-quality imaging spectroscopy of the Sun [1]. The main observational results observed by MUSER from 2014 to 2019 before the COVID-19 pandemic when MUSER indoor devices were disassembled and moved into the new operating room, including the quiet Sun and 94 solar radio burst events were statistically studied in [2], which priovide a useful database for futher investigations. MUSER and its upgrades are now recovered to normal observations. Due to the calibration difficulties, there were only images at a few frequencies demonstrated in [2]. After investigations of MUSER data calibrations over many years, a novel calibration method has been developed so that the position of any point-like calibrator can be determined within the frame work of the aperture synthesis theory [3]. The method also applies to general radio interferometry and synthesis problems. With this new calibration method, the MUSER data have been calibrated to achieve images at multiple freqeuncies before the large calibration antennas are put into use. On 2015 June 21, many radio fine structures were observed by MUSER-I array in the long-duration burst event from 1:17:27 to 6:13:04 UT accompanying two (M2.0 and M2.6) flares. Among these fine structures, the groups of spikes in 0.6–2 GHz range showing very interesting features, i.e., each group of spikes were co-occurred on the strips or quasi-periodic pulsations (QPPs), as shown in Figrue 1. We present the imaging-spectroscopic analysis for this event so as to understand the physic processes of these fine structures.

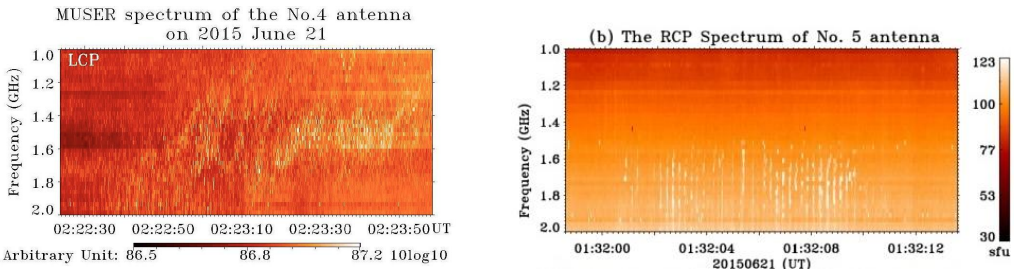

Figure 1. The special spikes co-occurred on the strips (left panel) or QPPs (right panel) in the dynamic spectra.

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2. Minghui Zhang, Yin Zhang, Yihua Yan, Wei Wang, Linjie Chen, Chengming Tan, *et al.*,"Observational Results of MUSER during 2014–2019," *Res. Astron. Astrophys.*, **21**, December 2021, 284 (12pp), doi.org/10.1088/1674-4527/21/11/284

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