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The error analysis between the measurement and original solar radio polarization degree

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Abstract

The MingantU SpEctral Radioheliograph(MUSER)is comprised of 100 antennas, which is a solar-dedicated radio interferometric array in centimetric and decimetric wave range. This radio heliograph will be optimized to carry out imaging spectroscopy of the Sun with high spatial resolution, high time resolution and high frequency resolution simultaneously. We use MUSER-I and MUSER-II to observe the Sun and get the right and left circularly polarized signal, then calculate the polarization degree of the source. The relationship between the original polarization degree of the Sun and the observed polarization degree is drawn in this paper. The error is less than 10%. So we can use the measured data of the observed polarization degree to represent the original polarization degree of the Sun.

1 Introduction

The MingantU SpEctral Radioheliograph(MUSER) [1]was developed to image solar radio bursts over a wide range of frequencies with high frequency resolution. It provides a new tool for observing solar radio emissions including radio bursts from the primary energy release sites of solar energetic events such as flares and coronal mass ejections (CMEs). The MUSER, as shown in Figure 1, consists of two interferometer arrays, MUSER-I and MUSER-II. The MUSER-I array is comprised of 40 reflector antennas with 4.5-m dishes and covers a frequency range from 0.4-2 GHz. The MUSER-II array is comprised of 60 reflector antennas with 2-m dishes and covers a frequency range from 2-15 GHz. All 100 antennas are placed along 3 spiral arms with a maximum baseline of 3 km and surrounded by small hills . MUSER will make full solar disk radio images at multiple frequency channels with a time resolution down to 3 ms.

2 Measurement of the solar radio signal

MUSER observes the Sun every day and the polarization degree measurement is relevant to the signals of different channles[2]. The observed solar radio results could give the magnetic field above the corona clearly, so scientists may analize these data. In order to determine completely the polarization state of a radio signal, it is necessary to measure four independent quantities. The output of MUSER are left and right circularly polarized signals. So the quanties measured the signal intensity Ir and Il using right hand and left

Figure 1. The photograph of MUSER

hand circularly polarized antennas. In radio astronomy, circular polarization of the incident wave is said to be RH if the field vector rotates clockwise when viewed in the direction of propagation. This is the standard radio engineering convention, the polarization degree is often expressed as a percentage and when this is down, it should be called the percentage polarization rather than the degree of polarization. We should know that the degree of polarization obtained shows only the apparent or average polarization state of the total received signal. When mutiple sources are presented at the Sun, the global polarization does not reflect the intrinsic polarization of the individual sources. For instance, even if the polarimeter shows 50% polarization we can't simply conclude that there is a single partly polarized source on the Sun, we can't distinguish there possibilities with polarimeter observations alone. After MUSER is established in Inner Mogolia, We want to konw the ability of the this instrument so we choose two antennas from MUSER-I and MUSER-II and test them. The test results are shown in figure 2, figure 3, figure 4, figure 5 for low frequency antenna.The measured results of MUSER-II antenna are shown in Figures 6, figure 7, figure 8, figure 9, the horizental line is frequency band and the vertical line is polarization degree. Here, I just give a few test results of the MUSER antenna. Then we draw the error between the original solar radio signal and the observed solar radio signal, the measured frequencies are 412.5MHz, 612.5MHz,962.5MHz, the results shown in Figures 10, figure 11, figure 12. The error between the original and the observed polarization degree at 2GHz,10GHz,15GHz are shown in Figure 13, figure 14, figure 15, figure 9 From these results, we could see that if we assume the original polarization degree is increased, the error is decreased, we

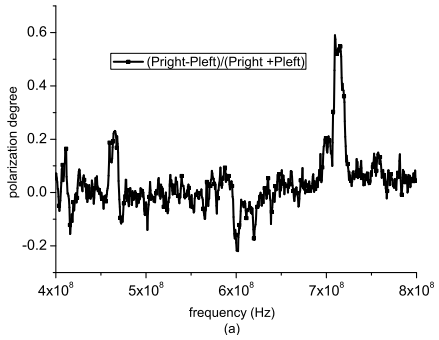

Figure 2. The polarization degree calculation of IC1 antenna in 0.4-0.8GHz

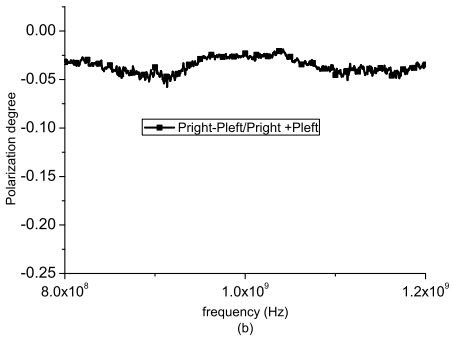

Figure 3. The polarization degree calculation of IC1 antenna in 0.8-1.2GHz

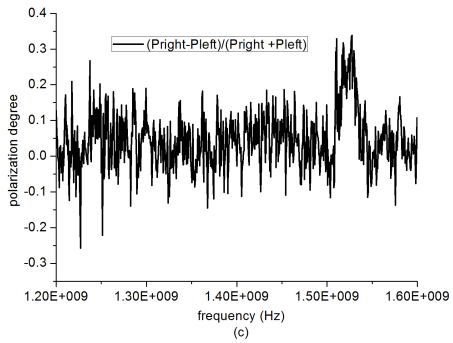

Figure 4. The polarization degree calculation of IC1 antenna in 1.2-1.6GHz

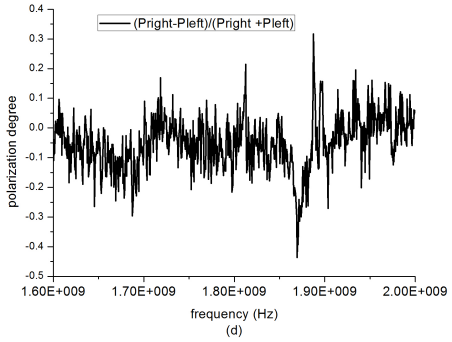

Figure 5. The polarization degree calculation of IC1 antenna in 1.6-2GHz

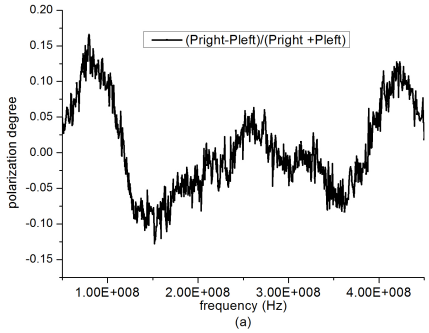

Figure 6. The polarization degree calculation of HC3 antenna in 5th frequency band

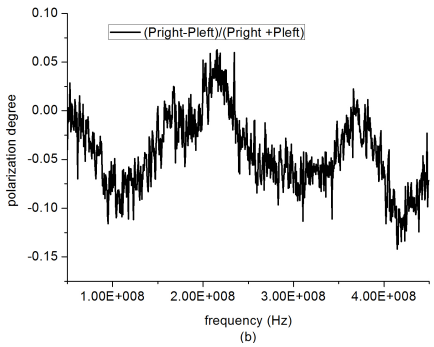

Figure 7. The polarization degree calculation of HC3 antenna in 9th frequency band

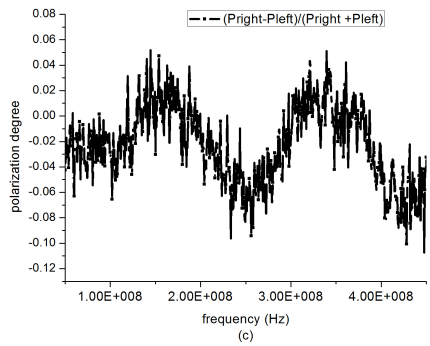

Figure 8. The polarization degree calculation of HC3 antenna in 17th frequency band

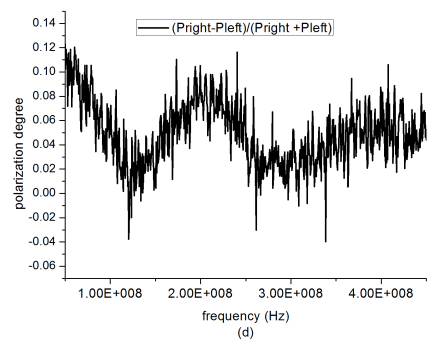

Figure 9. The polarization degree calculation of HC3 antenna in 29th frequency band

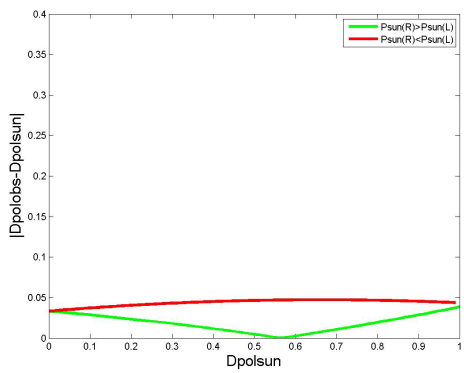

Figure 10. The error between the original and the observed polarization degree at 412.5MHz

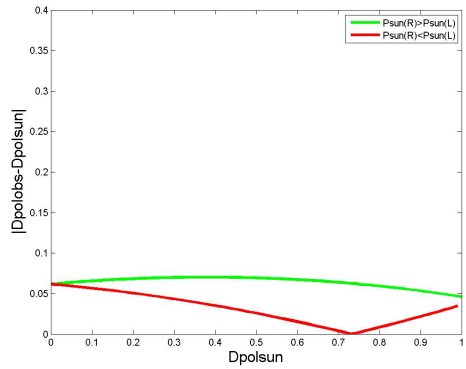

Figure 11. The error between the original and the observed polarization degree at 612.5MHz

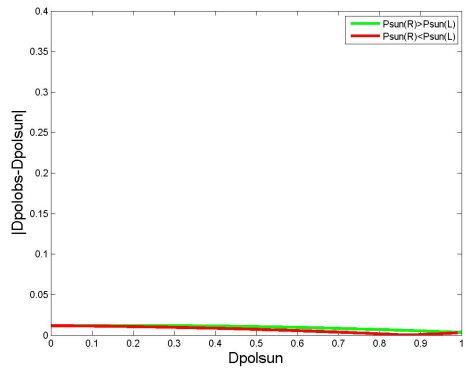

Figure 12. The error between the original and the observed polarization degree at 962.5MHz

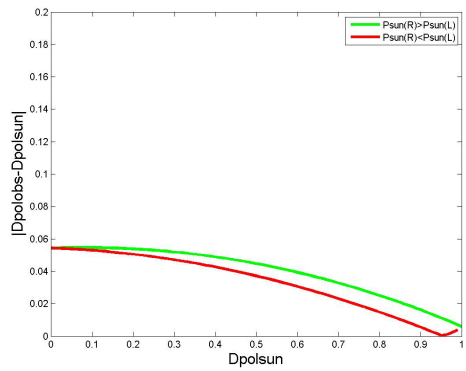

Figure 13. The error between the original and the observed polarization degree at 2GHz

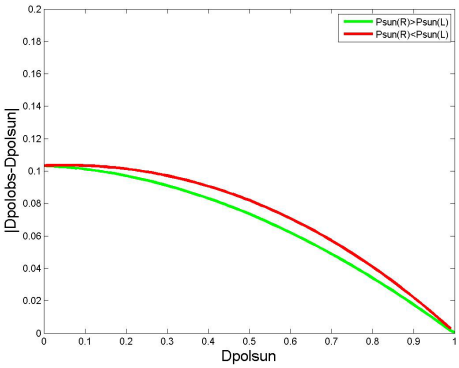

Figure 14. The error between the original and the observed polarization degree at 10GHz

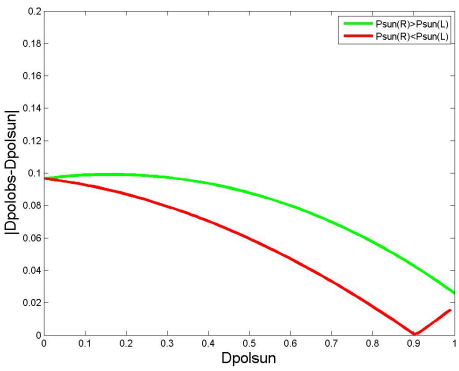

Figure 15. The error between the original and the observed polarization degree at 15GHz

could use the measured results to substitute the original one.

3 summary

The result of the poalrization degree mesurement is given in this paper, at the same time, the presence of background components is problem that associated with the observation of polarization in solar emission, such as receiver noise and all received emissions other than the solar event. If we calculate the polarization degree using the raw observed value, it is generally not equal to the polarization degree of the event. In order to obtain a meaningful value, the next work is subtracting the bakground components from the raw data.

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References

[1] Yan, Y. and Zhang, J. and Wang, W. and Liu, F. and Chen, Z. and Ji, G., "The Chinese Spectral Radioheliograph—CSRH ," *Earth, Moon, and Planets*, **11**, 104, 2008, pp. 97-100, doi:10.1007/s11038-008-9254-y.

[2] Bhatnagar, S.and Nityananda, R, "Solving for closure errors due to polarization leakage in radio interferometry of unpolarized sources," *Astronomy and Astrophysics*, **51**, 375, August,2008 pp. 344-350, doi: 10.1051/0004-6361:20010799.