XXX IAU General Assembly, Division E: Sun and Heliosphere

August 20-31, 2018, Vienna, Austria

MUSER: on the way to fundamental and applied problems of solar physics

Victor Melnikov[1,2] and Yihua Yan[2]

(e-mail: v.melnikov@gaoran.ru, yyh@nao.cas.cn)

[1] Pulkovo Observatory of RAS, Saint Petersburg, Russia

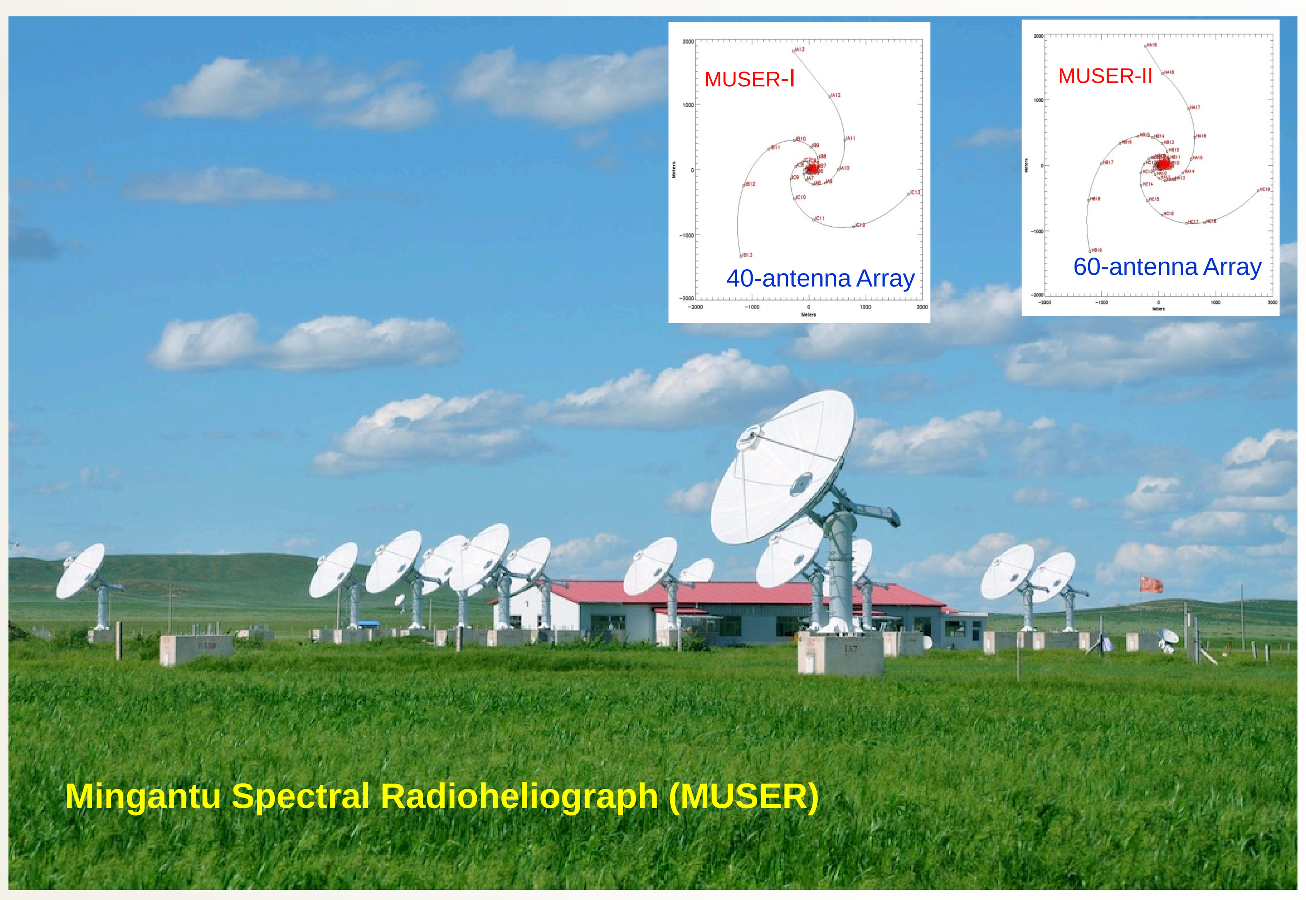
[2] National Astronomical Observatories of CAS, Beijing, China

INTRODUCTION

Chinese spectral radioheliograph MUSER, a radio synthesis imaging telescope dedicated to observe the Sun, operates on multiple frequencies in dm to cm range (Yan et al. 2012). Its characteristics (see in the table below) allow MUSER to be used in solving the fundamental problems of physics of solar flares and CMEs, the heating of the solar corona, as well as in solving some applied problems of physics of solar-terrestrial relationships. Recently developed methods of radio physics allow us to obtain information that is unattainable in other areas of the electromagnetic spectrum.

MUSER specifications

Frequency Range	0.4 – 15 GHz （λ: 75 –2 cm）
Frequency Resolution	64 channels (I: 0.4 - 2 GHz)
	520 channels (II: 2 - 15 GHz)
Spatial Resolution	1.3”– 50”
Temporal Resolution	I: 25 ms
	II: 206 ms
Dynamic Range	25 db (snapshot)
Polarizations	Dual circular L, R
Arrays	I: 40×4.5m parabolic antennas
	II: 60×2m parabolic antennas
Maximum baseline	3 km
Field of view	0.6°– 7°



The ability of MUSER to get images and measure Stokes I and V parameters simultaneously at many frequencies in a wide band is of fundamental importance. It allows to approach/solve such important problems as

- Measuring the strength, geometry and dynamics of magnetic field at coronal heights;

- Identification of triggers of solar flares and CMEs;

- Selection of the most appropriate mechanism/model of electron acceleration in solar flares.

Here we consider some of the recently developed radio physics methods to be used for solving the problems.

NEW METHODS OF RADIO DIAGNOSTICS

Automated forward fitting method for diagnostics of magnetic field strength, direction, and their dynamics at every point of a flare coronal loop, as well as the number and energy spectrum of accelerated mildly relativistic electrons (Fleishman et al. 2009; Morgachev et al. 2014).

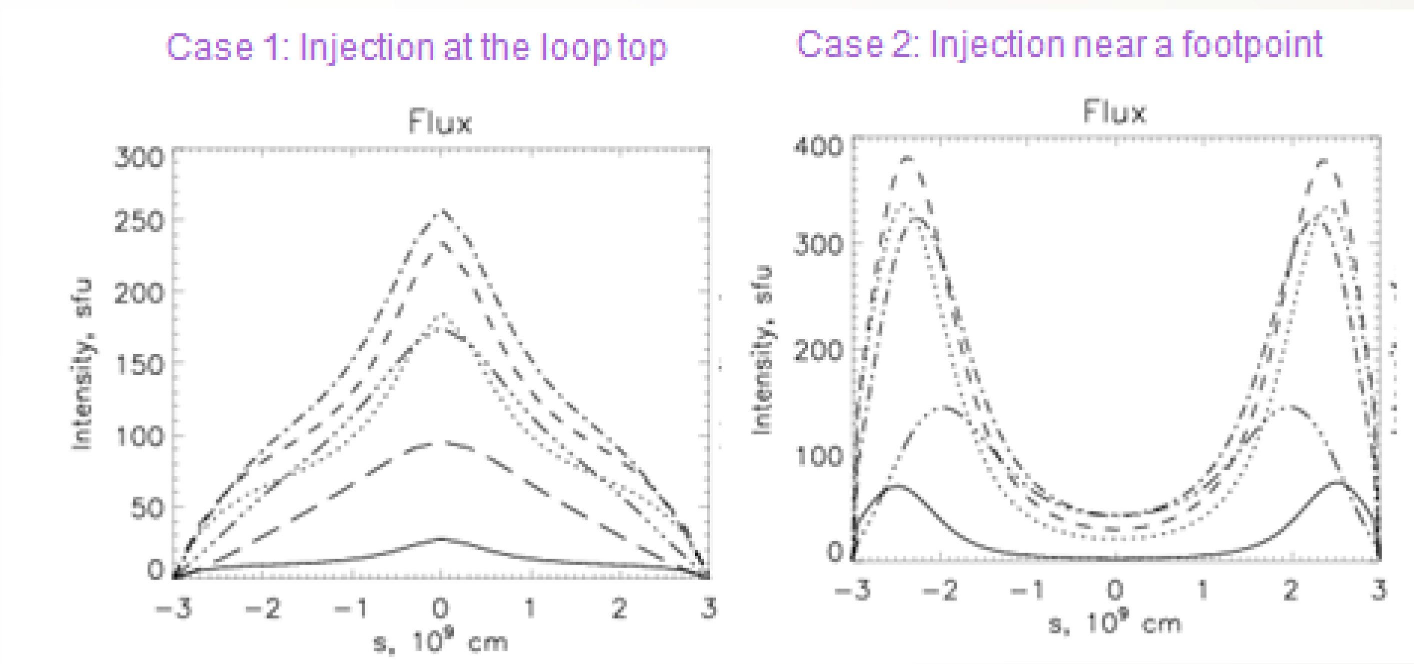
$$\begin{cases} |J_{f1}(x1,x2...xn)-J_{obsev}(f1)| \longrightarrow \min \\ |J_{f2}(x1,x2...xn)-J_{obsev}(f2)| \longrightarrow \min \\ \dots\dots\dots\dots\dots\dots \\ |J_{fn}(x1,x2...xn)-J_{obsev}(fn)| \longrightarrow \min \end{cases}$$

$J_{obs}(f1)$, …, $J_{obs}(fn)$ – observed characteristics of emission at multiple frequencies $f1$, …, fn; $J_{fi}(x1,x2,\dots,xn)$ – theoretically calculated characteristics; $(x1,x2,\dots,xn)$ – source parameters.

Different existing mechanisms and models of electron acceleration predict different positions of the acceleration site in a flaring magnetic loop, as well as different types of energetic electrons’ pitch-angle distribution. Only observations can help us choosing the best model.

Method of finding the electrons’ acceleration/injection site

Microwave brightness distribution

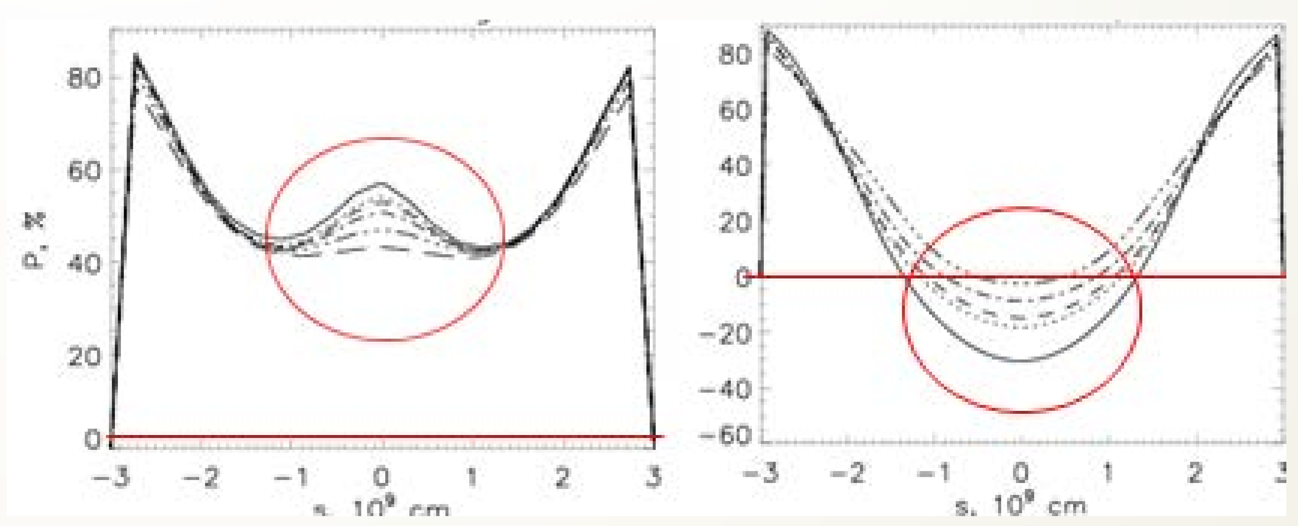


Clear difference in microwave brightness distributions along a flaring loop (Melnikov et al. 2002; Reznikova et al. 2010).

Method of finding the type of pitch-angle distribution of accelerated electrons

Polarization distribution

Case 1. Perpendicular anisotropy Case 2. Longitudinal anisotropy



Difference in microwave circular polarization distributions along a flaring loop (Melnikov et al. 2012; Morgachev et al. 2015).

Polarization changes its sign from extraordinary to ordinary mode in case of longitudinal anisotropy of mildly relativistic electrons propagating in a flare loop.

MUSER was supported as National Major Scientific Research Facility R&D Program (ZDYZ2009-3)