Neutral Line Associated Sources in sympathetic flare on 23 March, 2024

Kudriavtseva Anastasiia[1], Myshyakov Ivan[1], Anfinogentov Sergey[1], Dashinimaeva Saruyna[2]

[1] Institute of solar-terrestrial physics, SB RAS

[2] Irkutsk State University

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What is the Neutral Line associated Sources?

Neutral Line associated Sources (NLS) – are compact microwave sources projected onto vicinities of the neutral line of the photospheric magnetic field. There are often appears in active region structure before powerful solar flares.

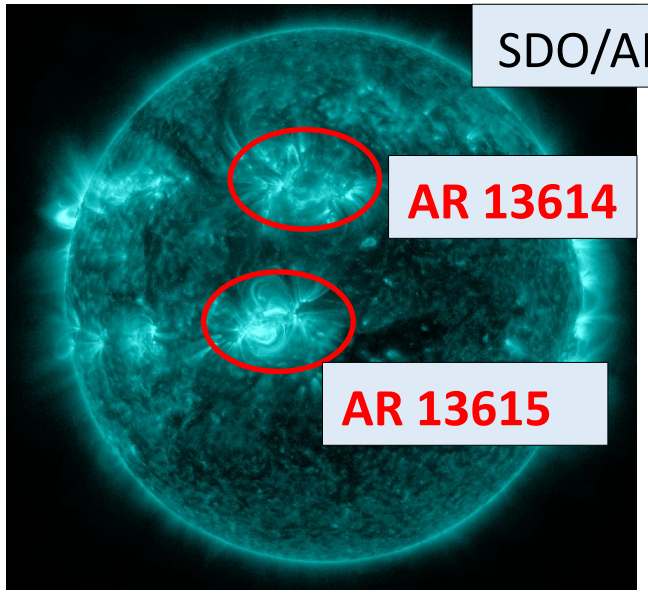
How we can identify it?

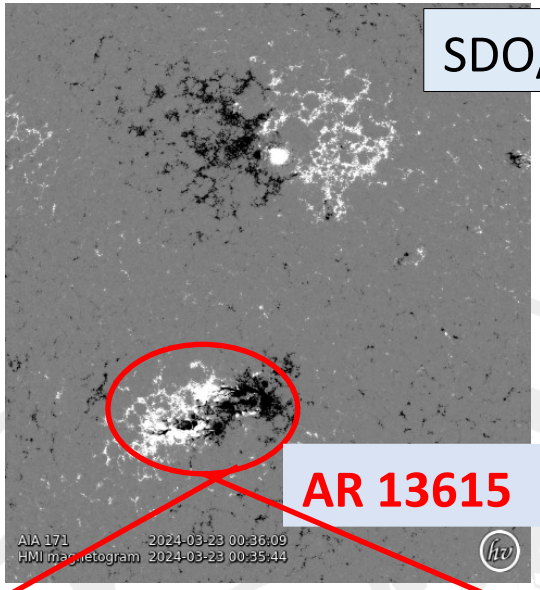
First step to detect NLS – direct superposition radio images with distribution of the line-of-sight magnetogram. Brightness centers of the sources in intensity are located in the vicinity of the zero line of magnetic field. Based on these facts, microwave source can be tentatively identified as an NLS.

Second step – comparison radio images with the spatial distribution of the magnetic field calculated at a height *h* above the photosphere.

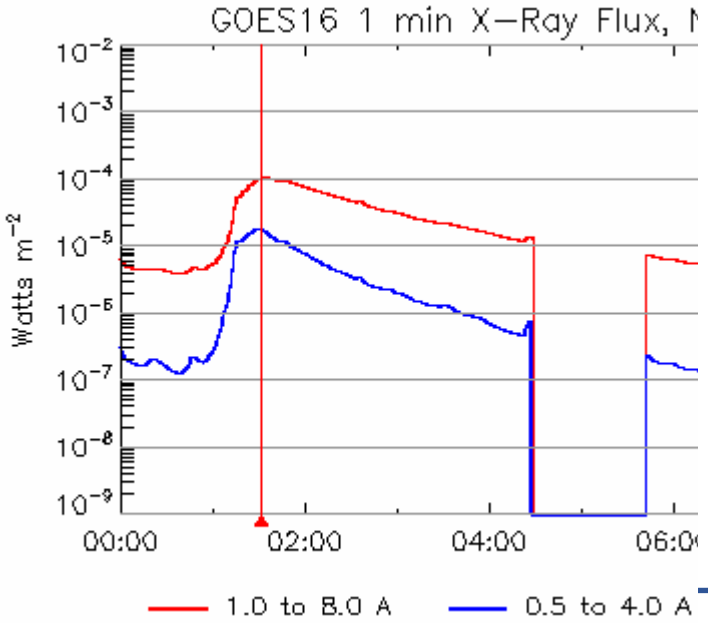
Flare X1.1 on 23 March 2024

AR: 13615 + 13614
GOES class: X1.1
Time start: 00:58 UT
Time peak: 01:33 UT

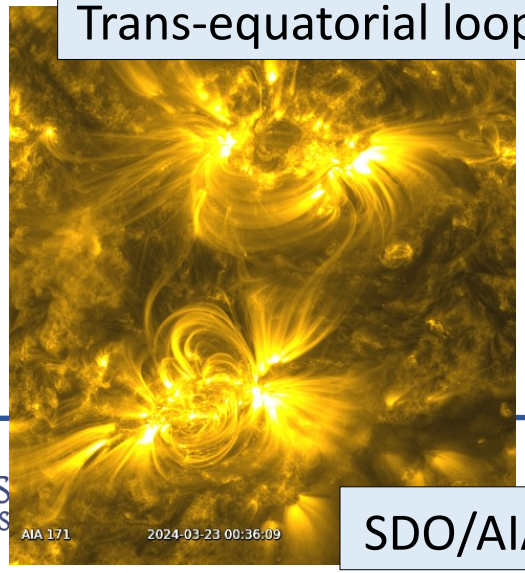




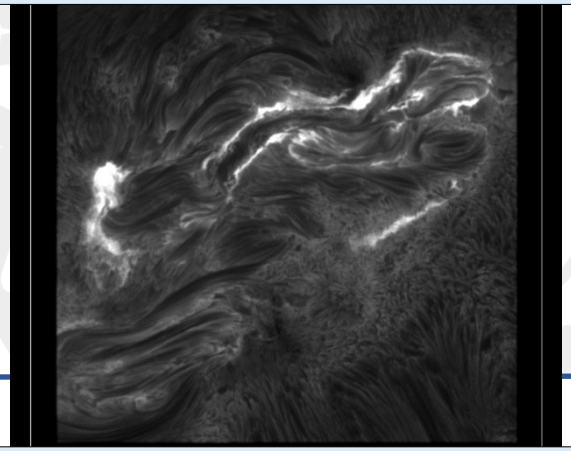
Complex magnetic structure AR 13615



Trans-equatorial loop

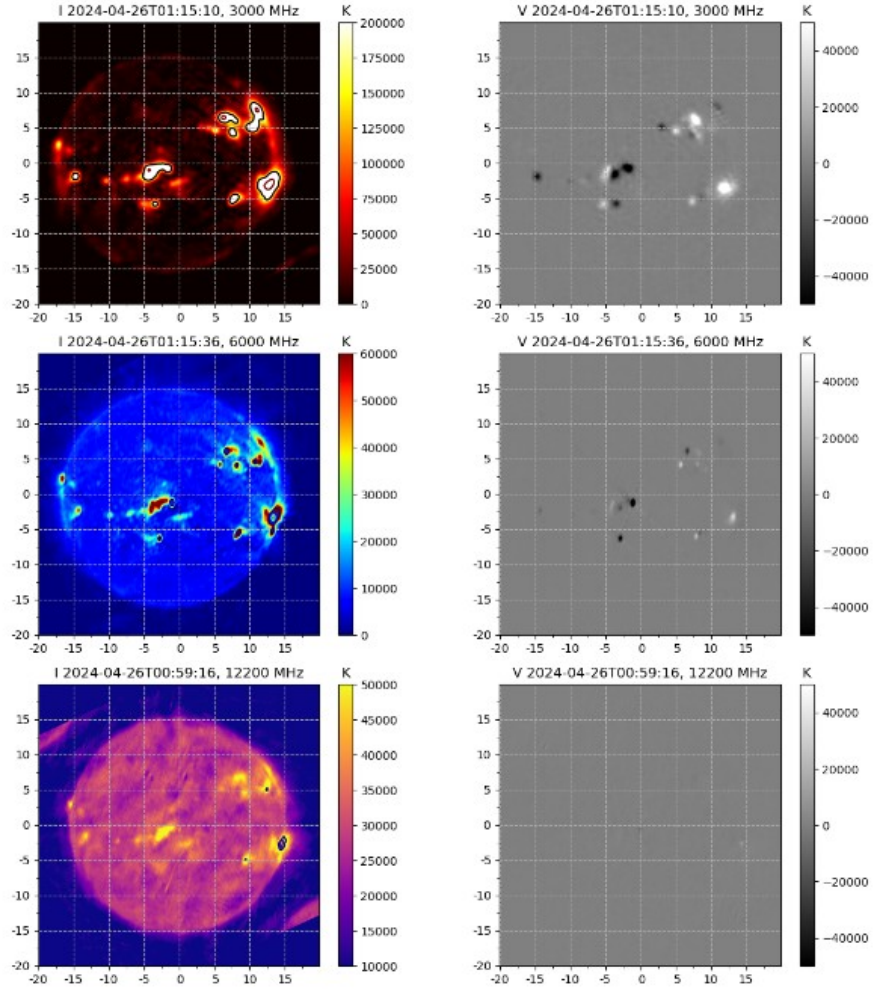


SDO/AIA(171 Å)



Fuxian Solar Observatory/NVST (Hα)

Siberian Radioheliograph



Data:

- ✓Two-dimensional
- ✓Multi-wavelength
- ✓Stokes I, V

Frequencies: 3-24 GHz

Time resolution: 2-3 s

Spatial resolution:7-30″

Observation interval:

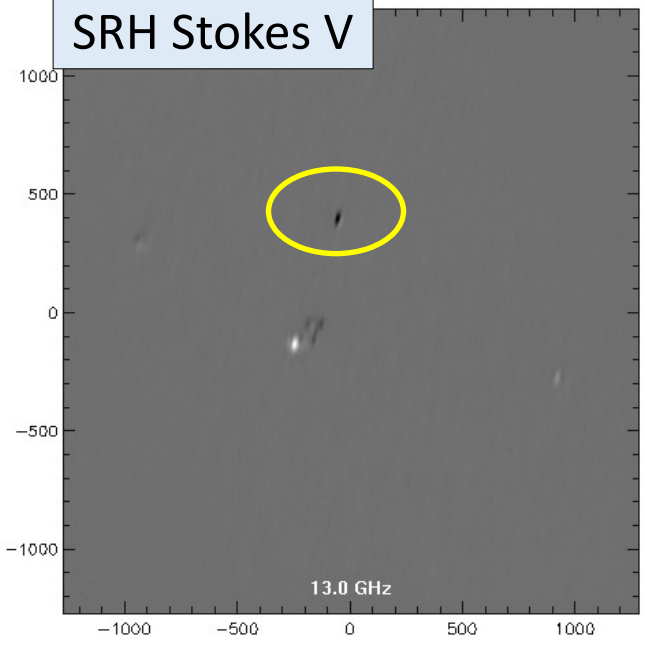
Summer: 23.00 — 10.00 UT (11 hours)

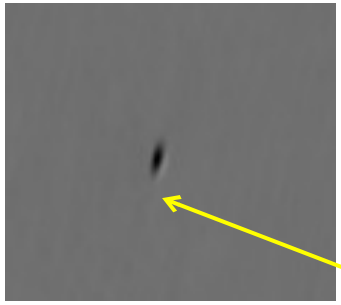
Winter: 02.00 — 08.00 UT (6 hours)

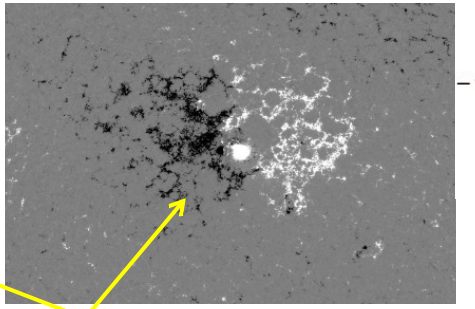
https://badary.iszf.irk.ru/srhDaily.php

AR 13614

SRH Stokes V

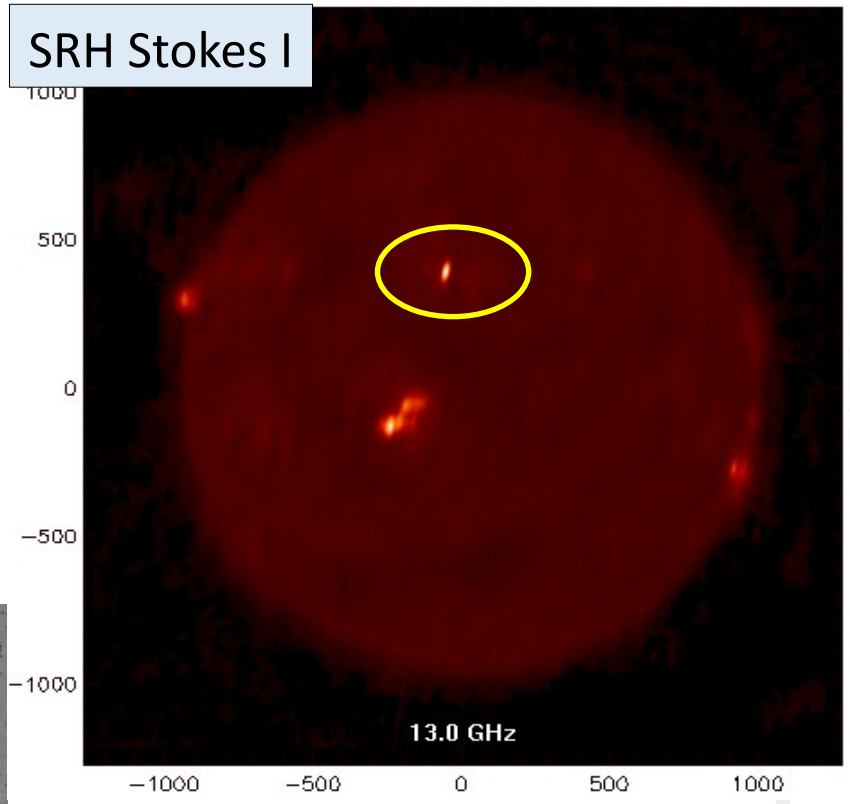


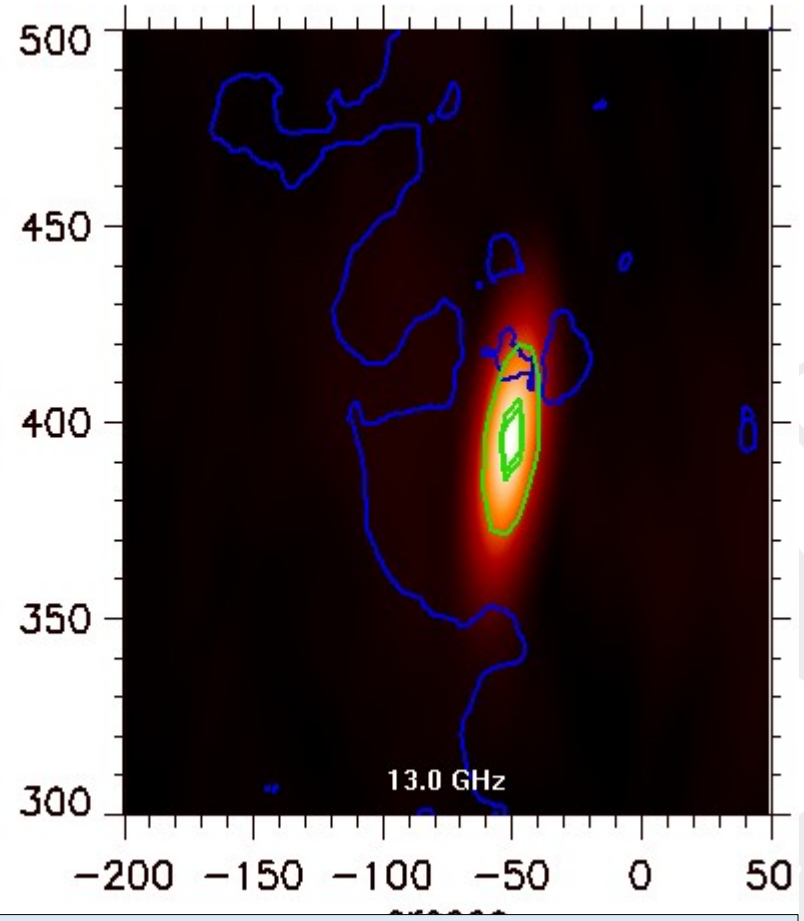




Inversion of sunspot polarization?

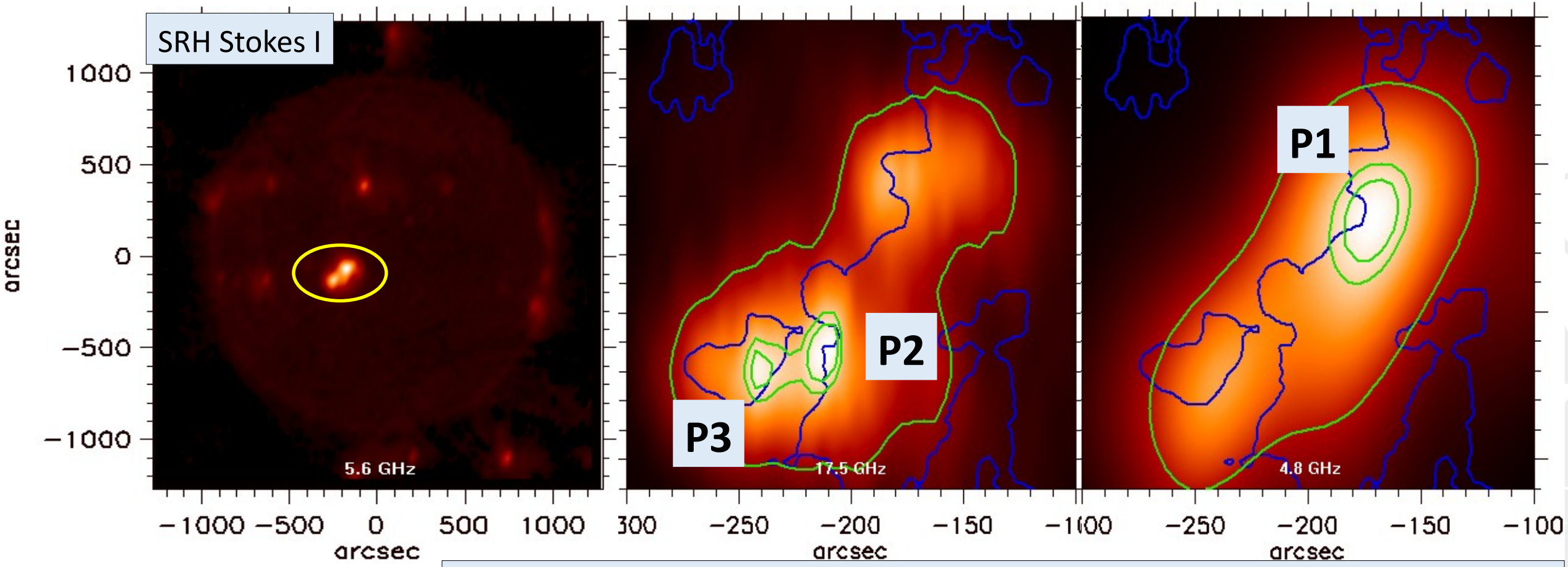
SRH Stokes I





Background – SRH (I); green lines – SRH (I) contours; blue lines – zero line of magnetic field

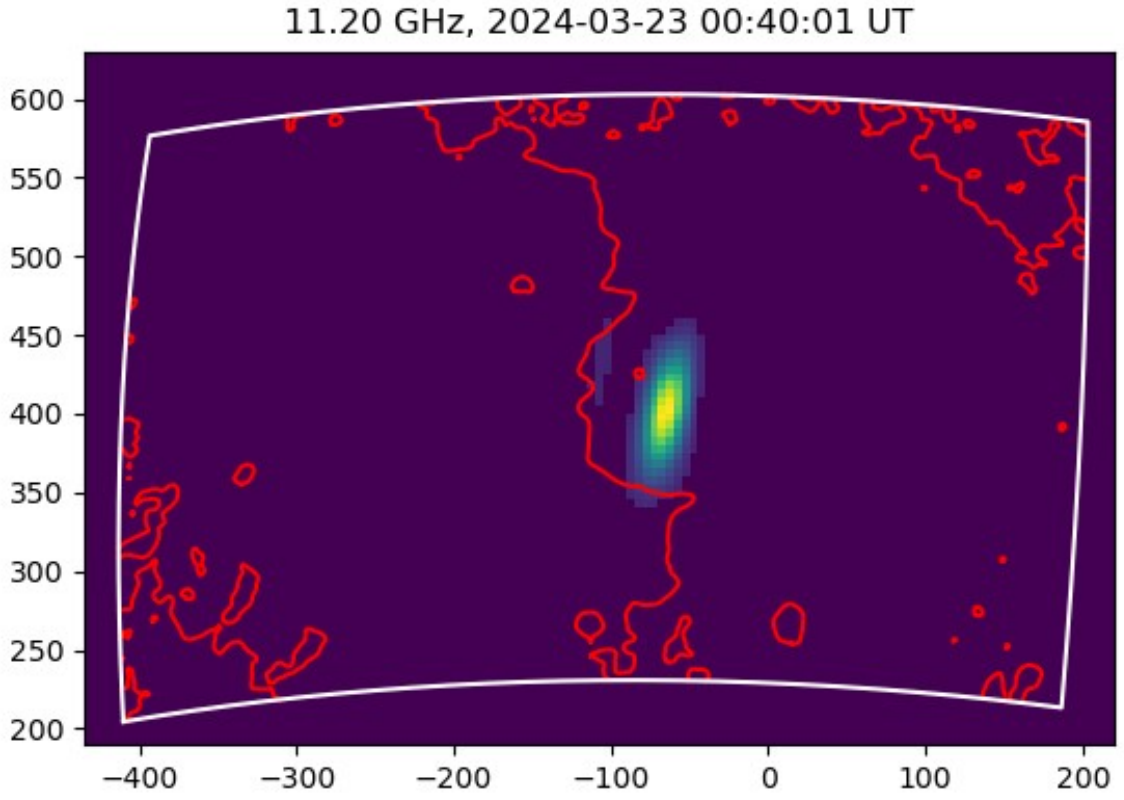
AR 13615



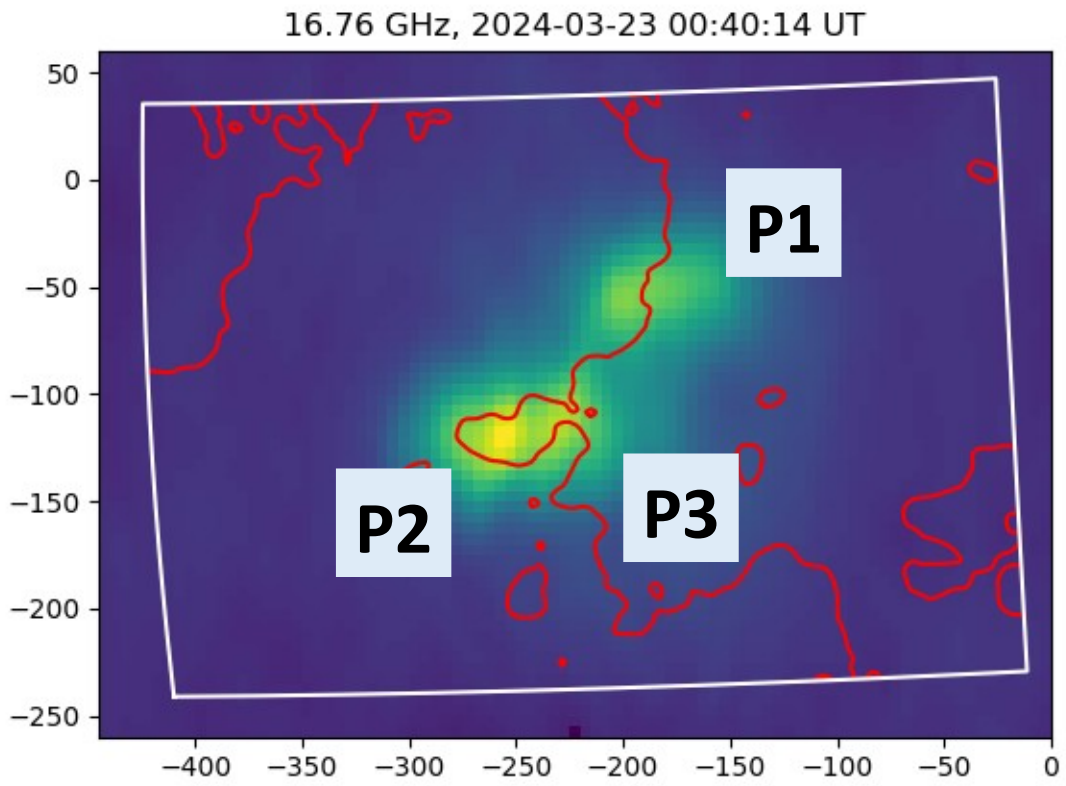
Background – SRH (I); green lines – SRH (I) contours;
blue lines – zero line of magnetic field

Magnetic field extrapolation

AR 13614

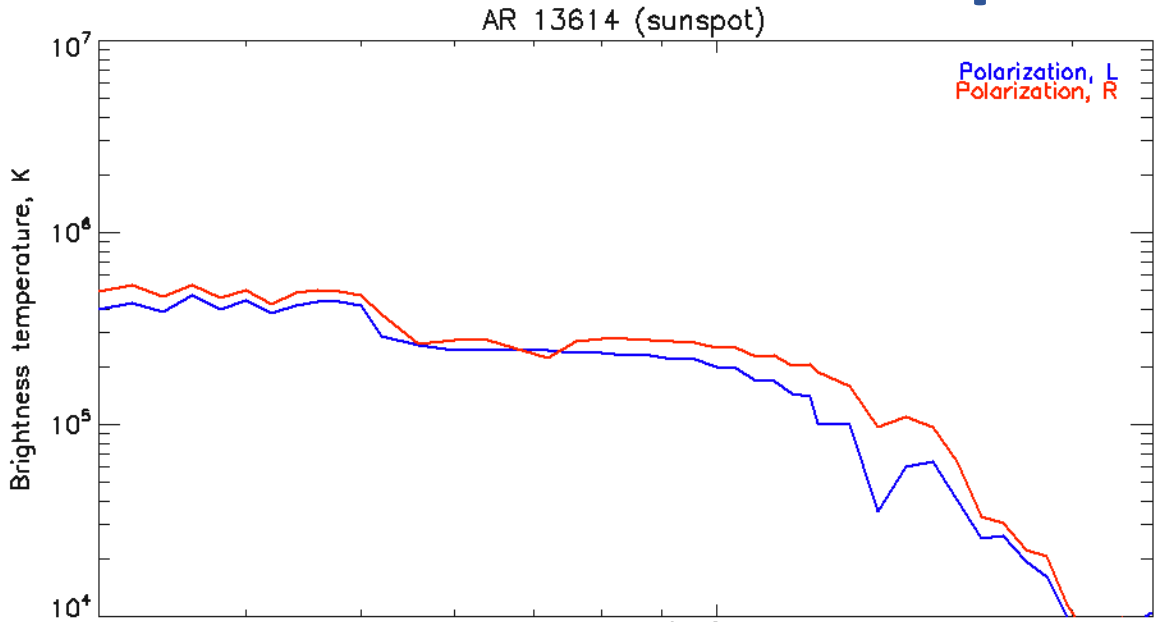


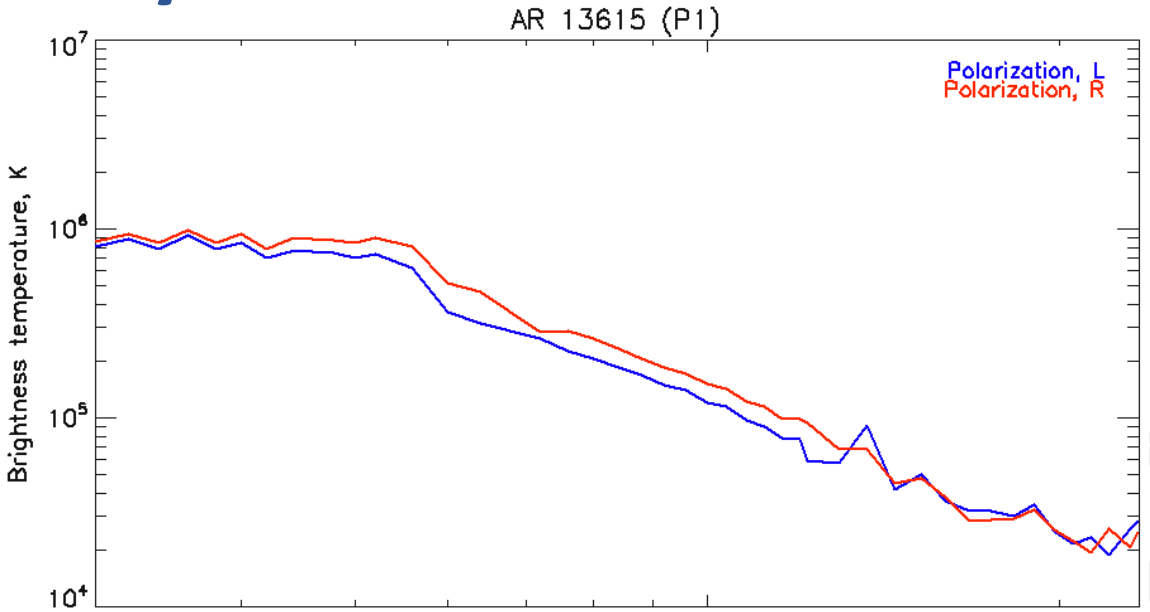
AR 13615

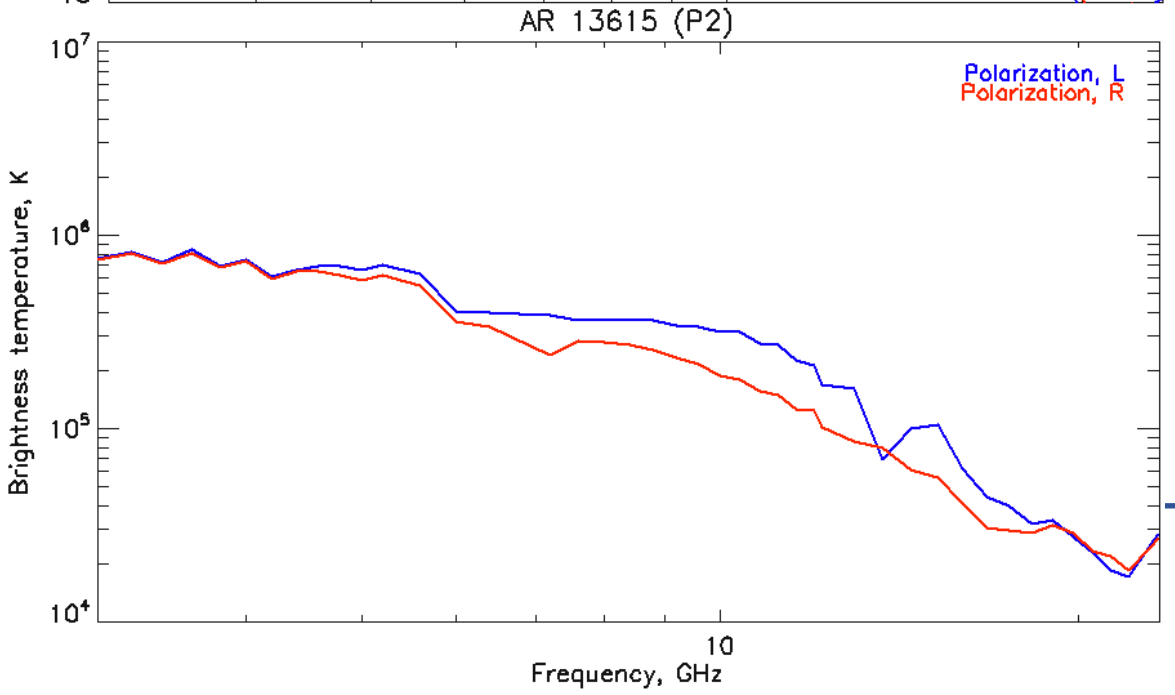


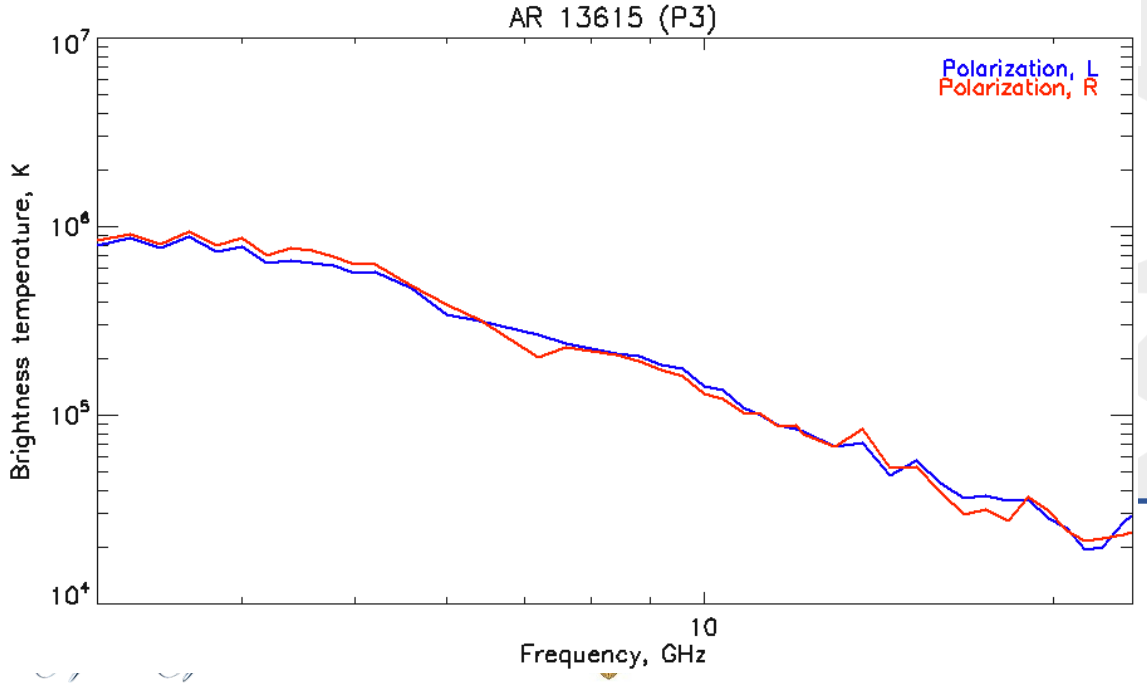
Background – SRH (I); red lines – zero line of magnetic field for height *h* above the photosphere

Spectral analysis









Summary

- We investigated the solar flare X1.1 on 23 March 2024 by microwave data by the Siberian Radioheliograph in the wide range from 3 to 24 GHz.
- We carried out spectral analysis for all radio sources in both active regions.
- Two candidates to NLS were found in the active region AR 13615.

Thanks for your attention!