Solar wind by IPS observations at decameter wavelengths

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Corona and Solar Wind

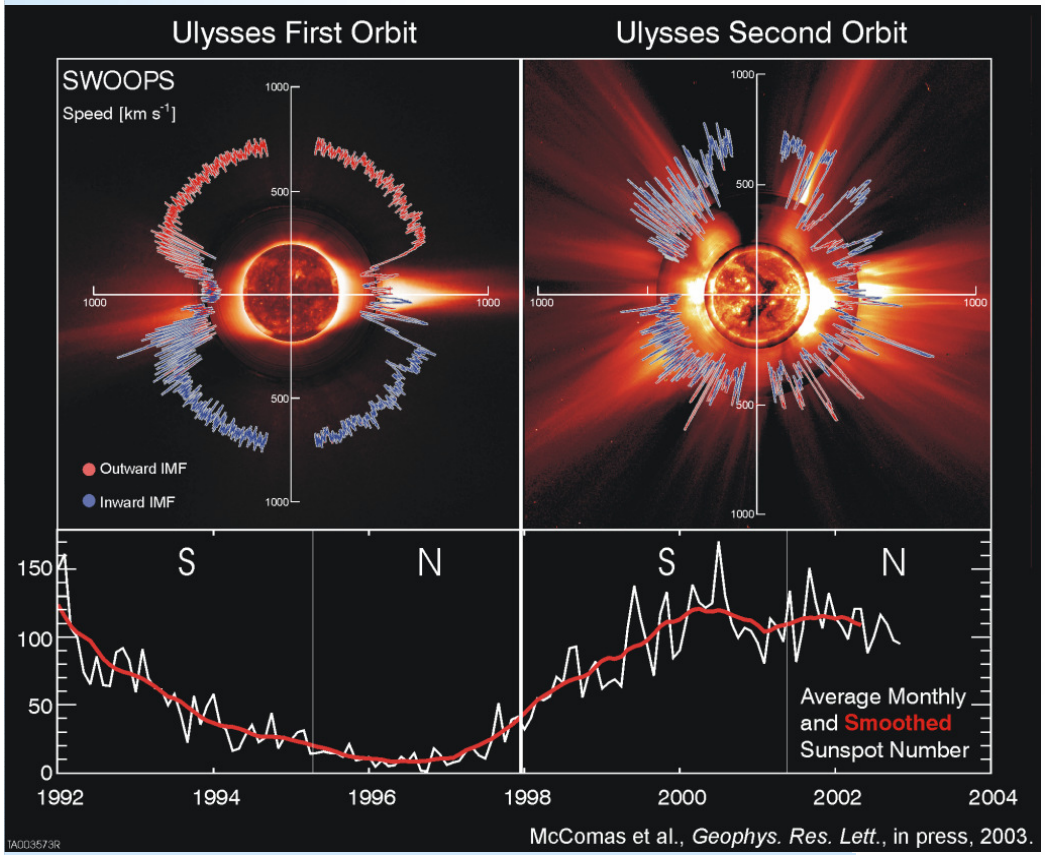
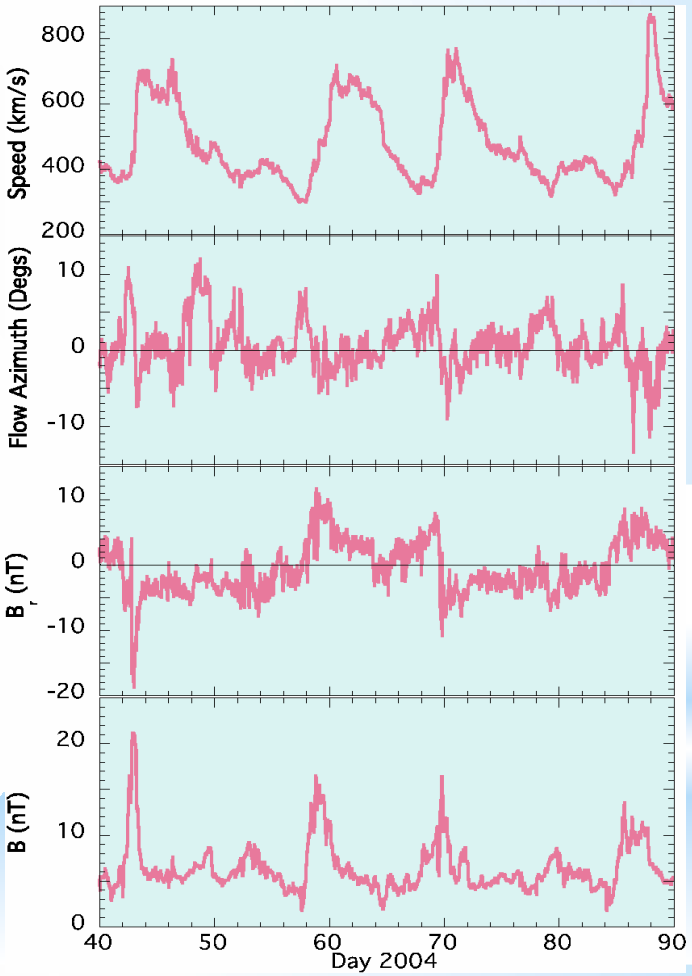


Fig. 1, 2



The method of the observations of the interplanetary scintillations (IPS)

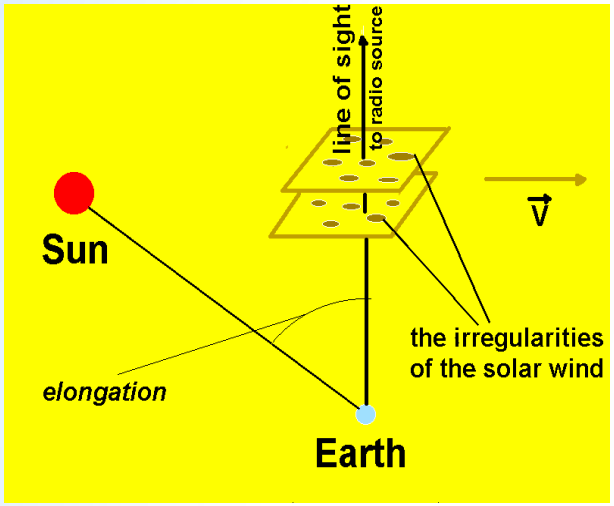


Fig. 3. Interplanetary scintillations (IPS) technique

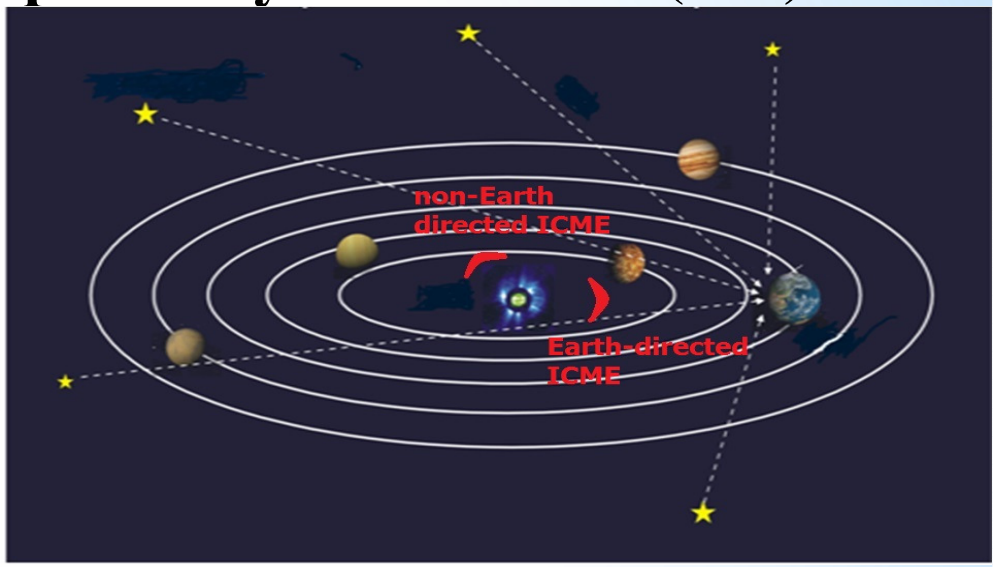


Fig. 4. Whole heliosphere monitoring with using Ukrainian radio telescopes

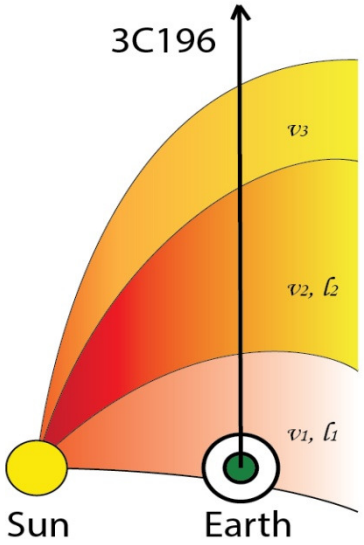


Fig. 6. Founding and tracking of geoeffective ICMEs and CIRs by using IPS data from Ukrainian radio telescopes

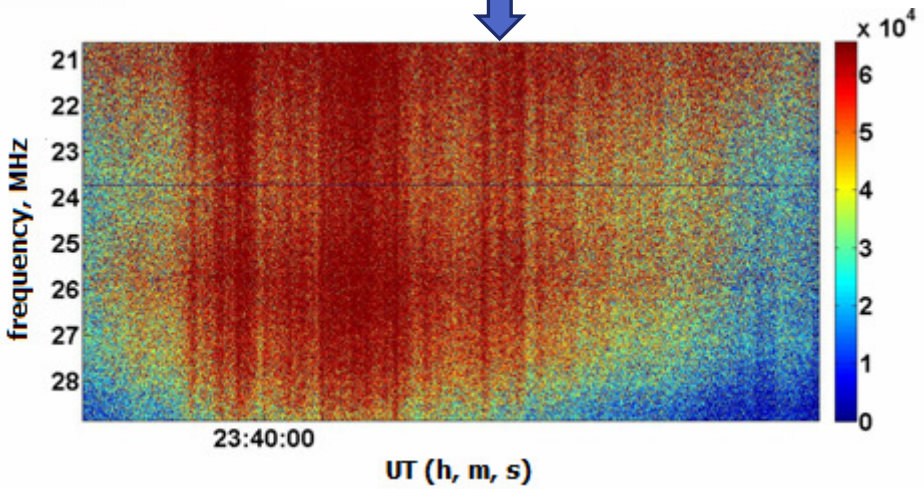


Fig. 5. An example of registration of interplanetary scintillations. UTR-2 radio

Ukrainian low frequency radio telescopes on the map of Europe

Outward appearance of Ukrainian low frequency radio telescopes

UTR-2, 8 – 32 MHz (Kharkiv)

URAN-2, 8 – 32 MHz (Poltava)

URAN-4, 8 – 32 MHz (Odesa)

URAN- 1, 8 – 32 MHz (Zmiev)

URAN- 3, 8 – 32 MHz (Lviv)

GURT, 8 – 80 MHz (Kharkiv)

Figure 8.

The parameters of the solar wind

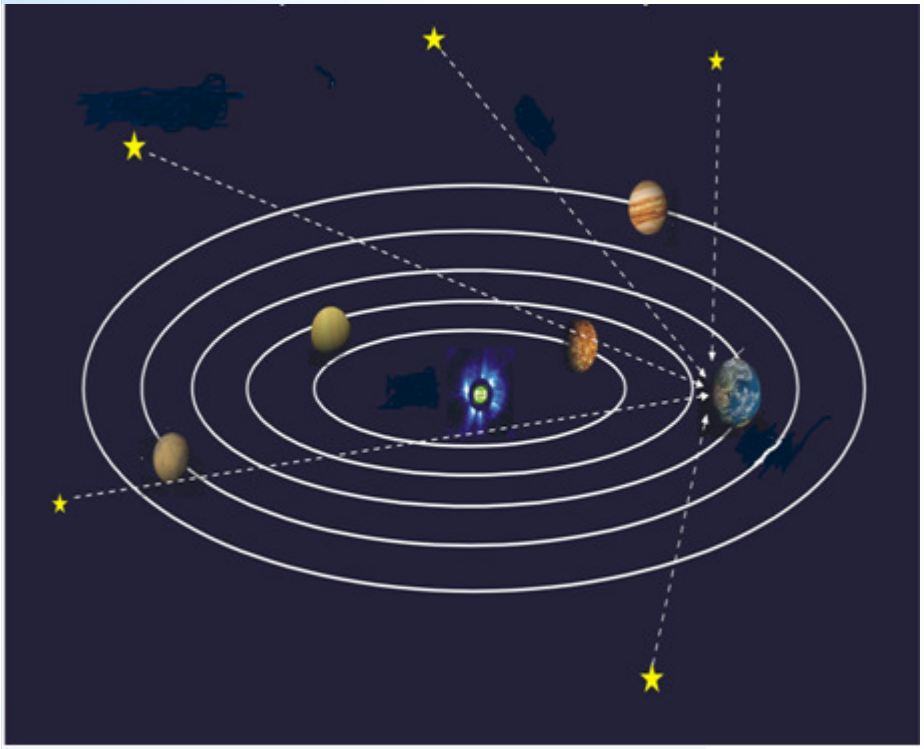


Figure 9. IPS observations

Analysis of IPS data allows us

a) to estimate :

-the speed of the solar wind;
- the dispersion of the solar wind speed;
- the spectral index of spatial spectrum of electron density fluctuations;
- the electron density.

б) to find :

large – scale disturbances of the solar wind associated with coronal holes and coronal (solar) mass ejections.

Harmful effects

* relatively high level of interference, especially at day time
* ionospheric effects

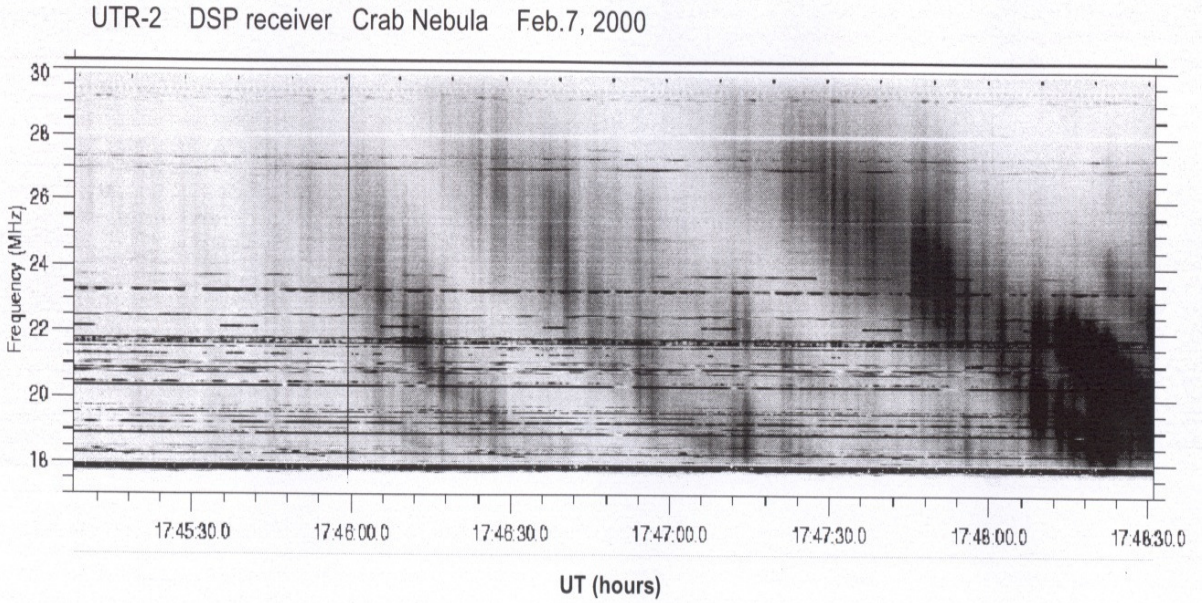
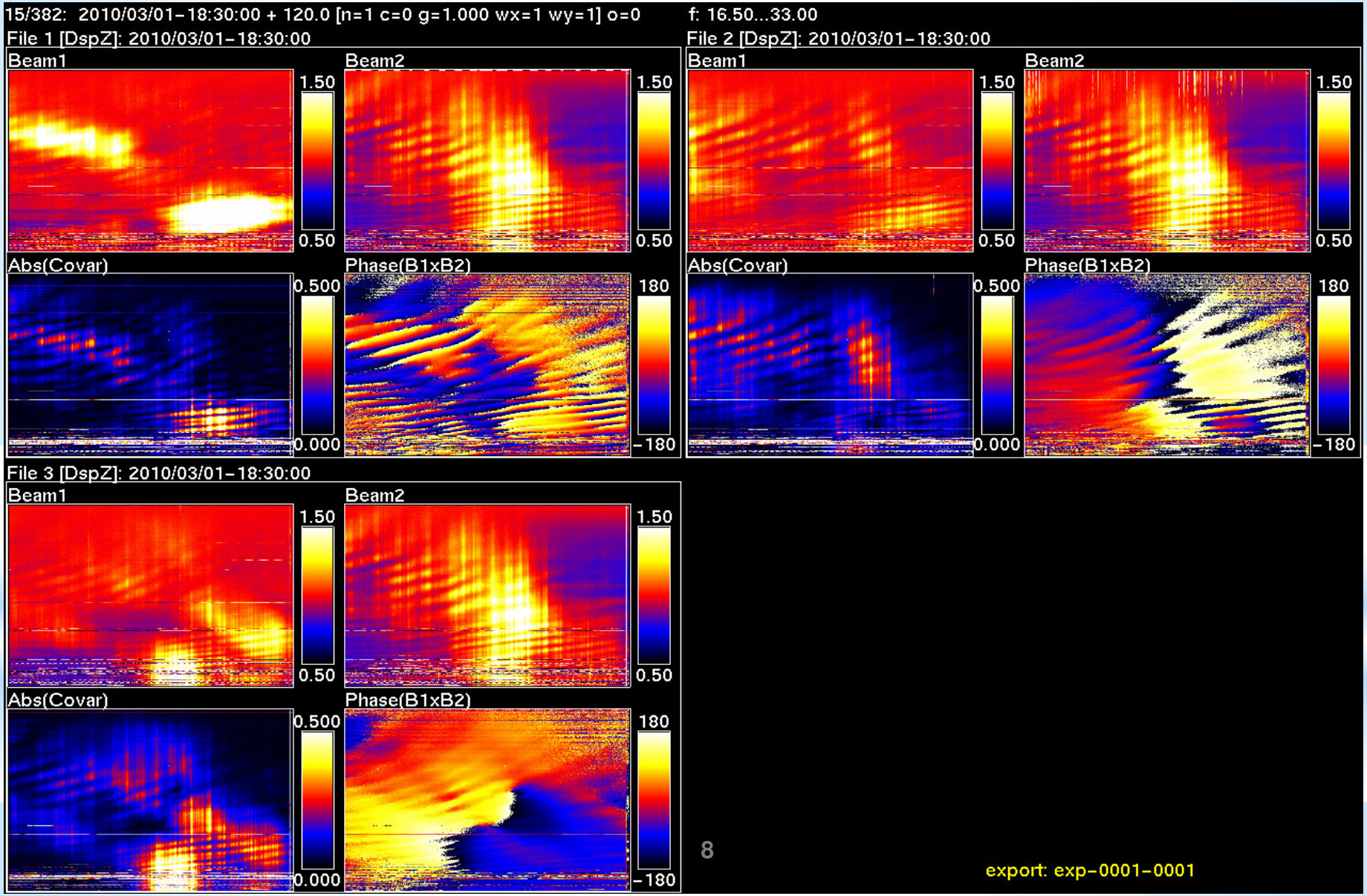
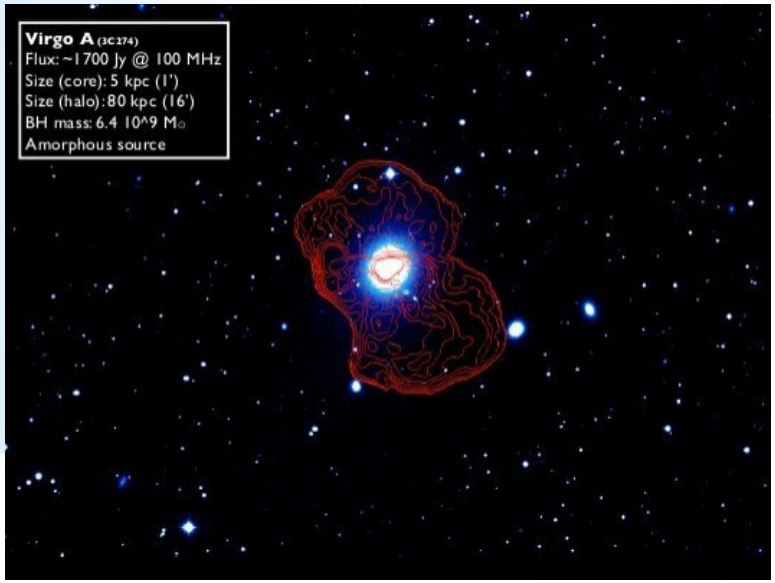


Figure 10. Dynamic spectrum of Crab Nebula scintillations.

Ionospheric scintillations in 3-beam operation mode of UTR-2



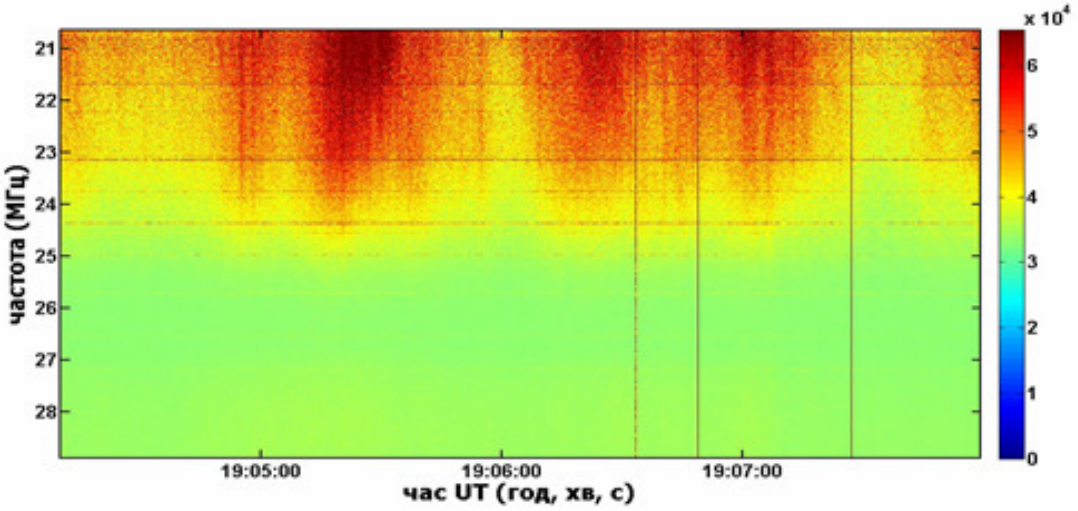
Observations of January 2016



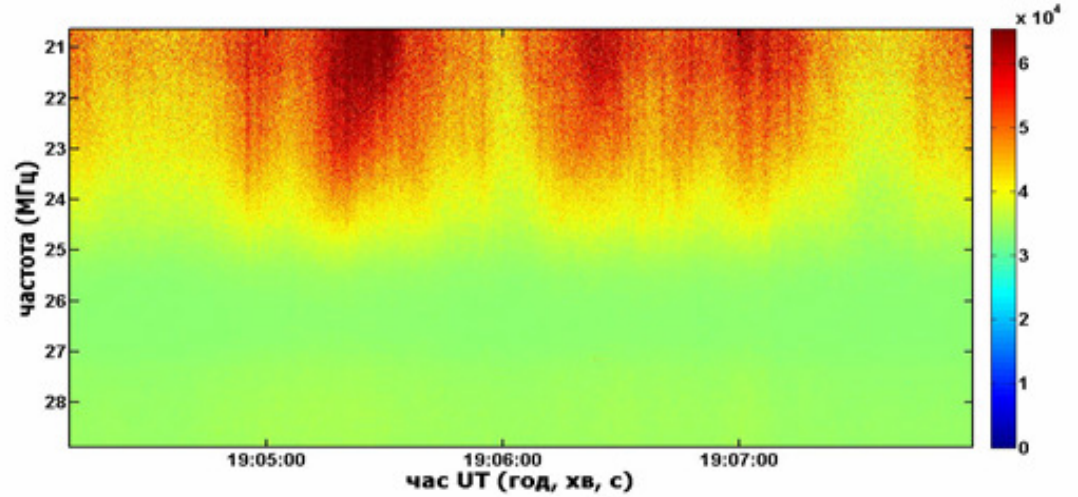
Virgo A (3C274) and Crab nebula (3C144)

Fig. 11

Cleaning of dynamic spectra



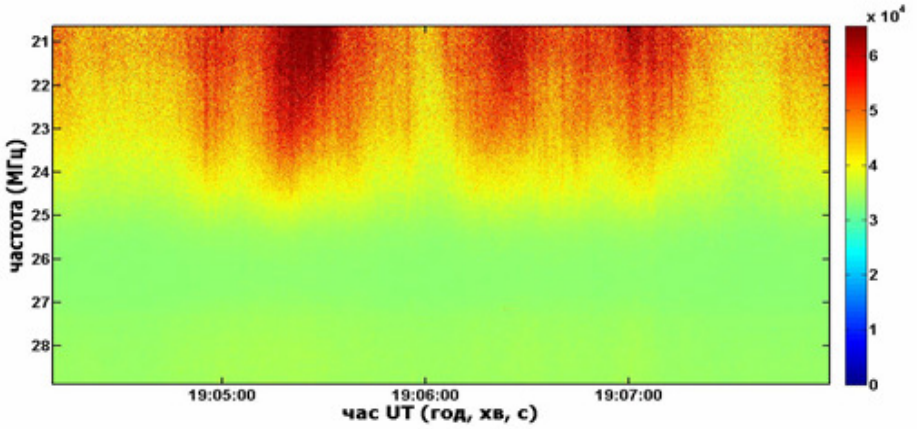
а)



б)

Fig. 12

Alignment of dynamic spectra



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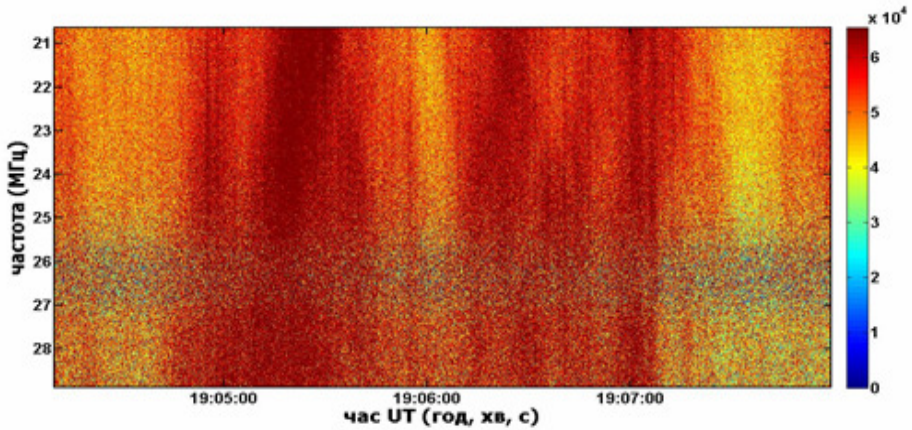
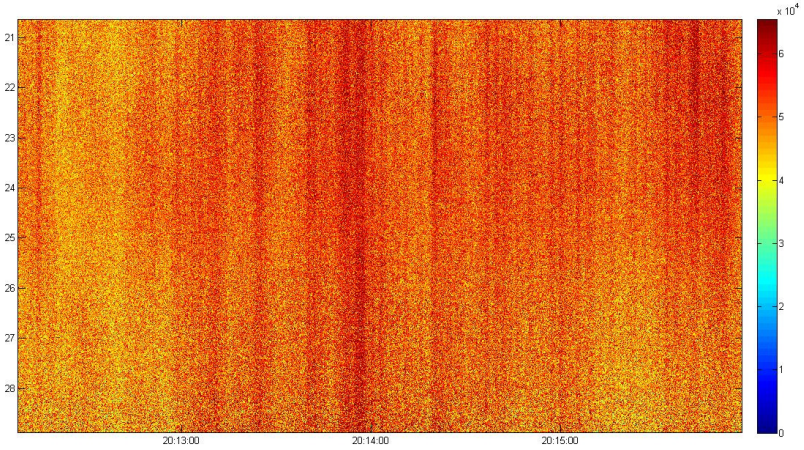


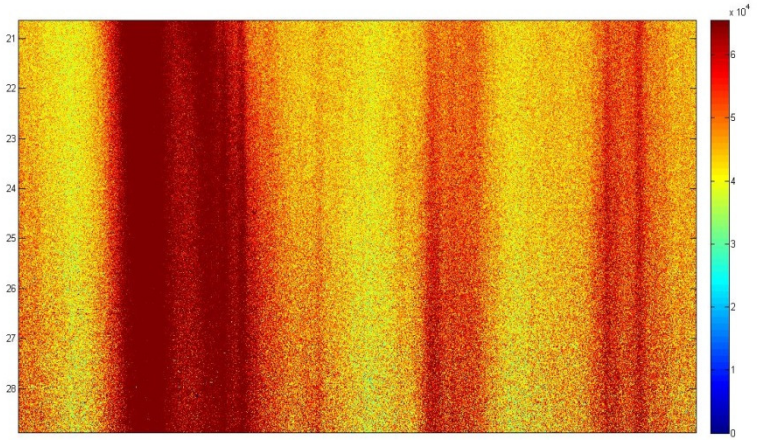
в)

Fig. 13

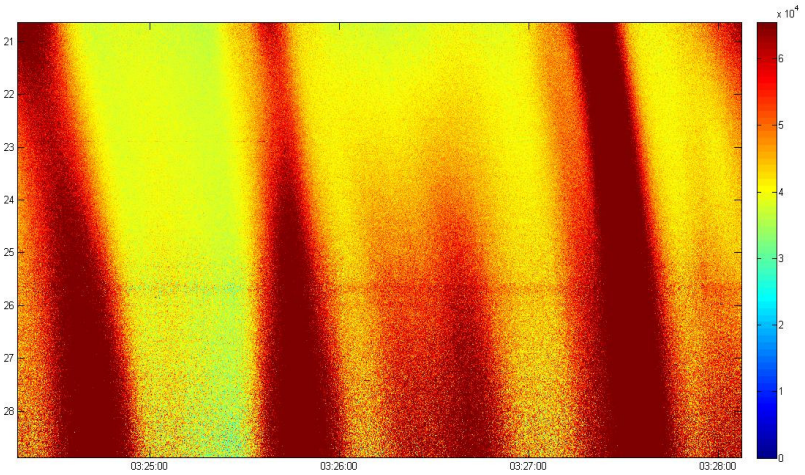
Dynamic spectra of 3C144 and 3C274 scintillations



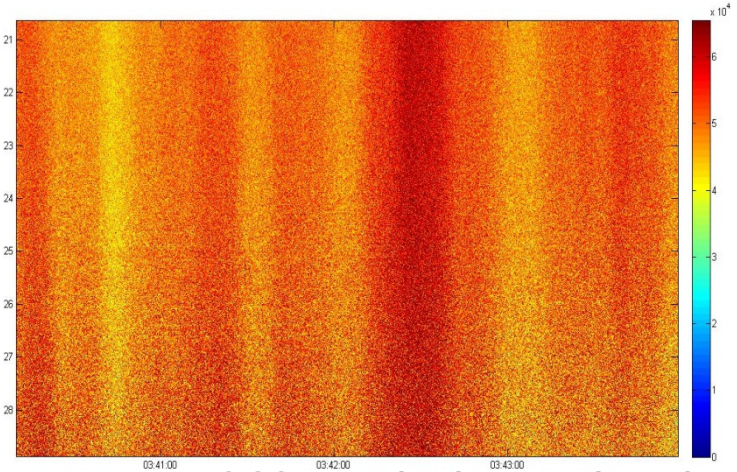
Crab nebula (3C144) (weak influence of the ionosphere)



Crab nebula (3C144) (strong influence of the ionosphere)



Virgo A (3C274) – low-correlated scintillations



Virgo A (3C274) – high-correlated scintillations

Fig. 14

Spatial cross-correlation

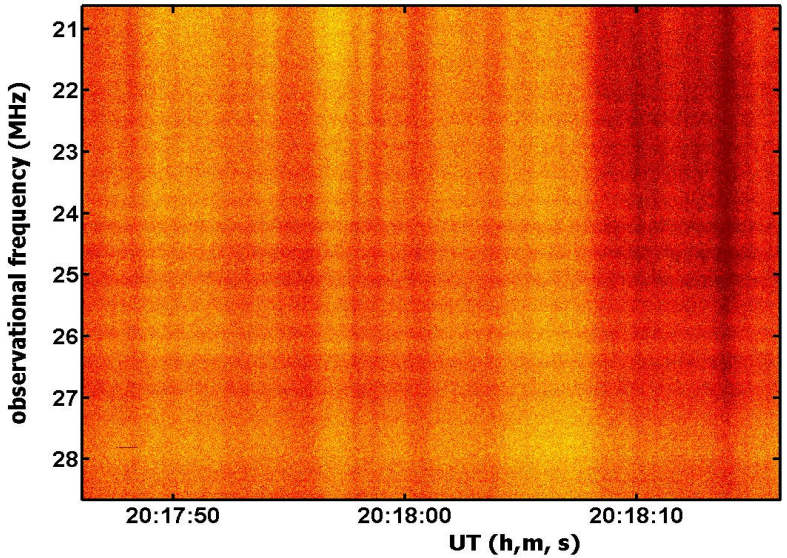


Fig. 22. 3C144 (UTR-2)

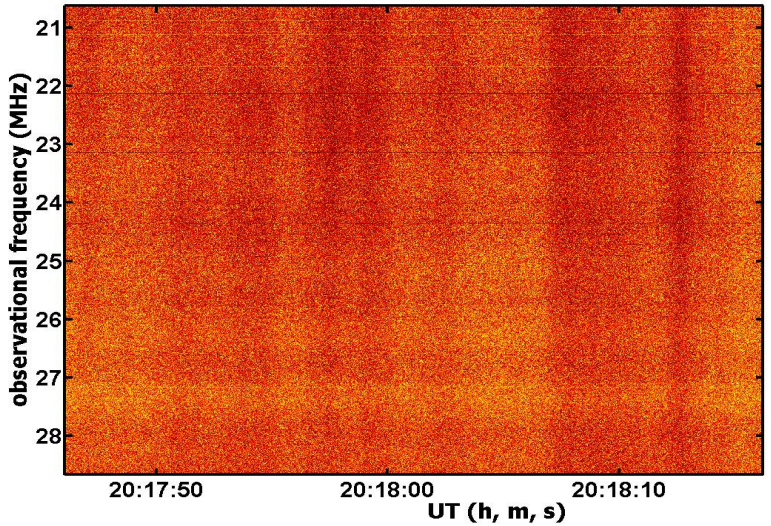


Fig. 23. 3C144 (URAN-2)

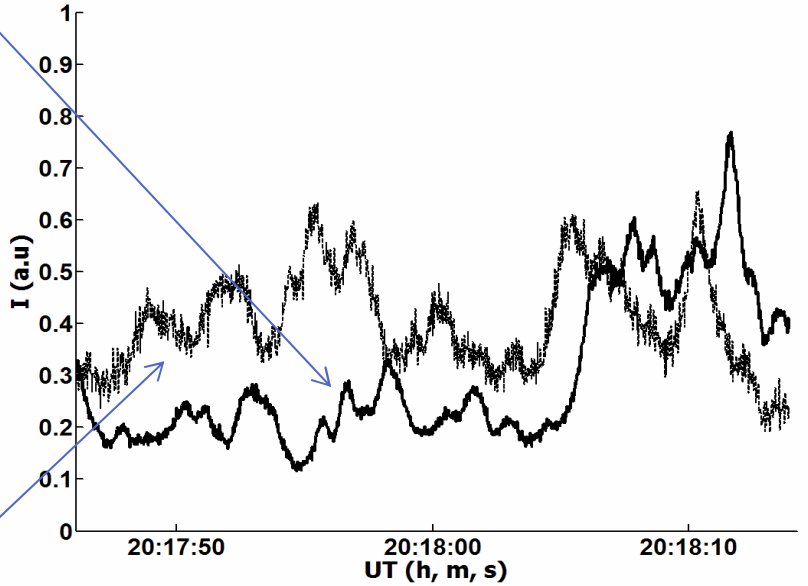


Fig. 10. Cross-sections of dynamic spectra at frequency 25 MHz.

Scintillation index

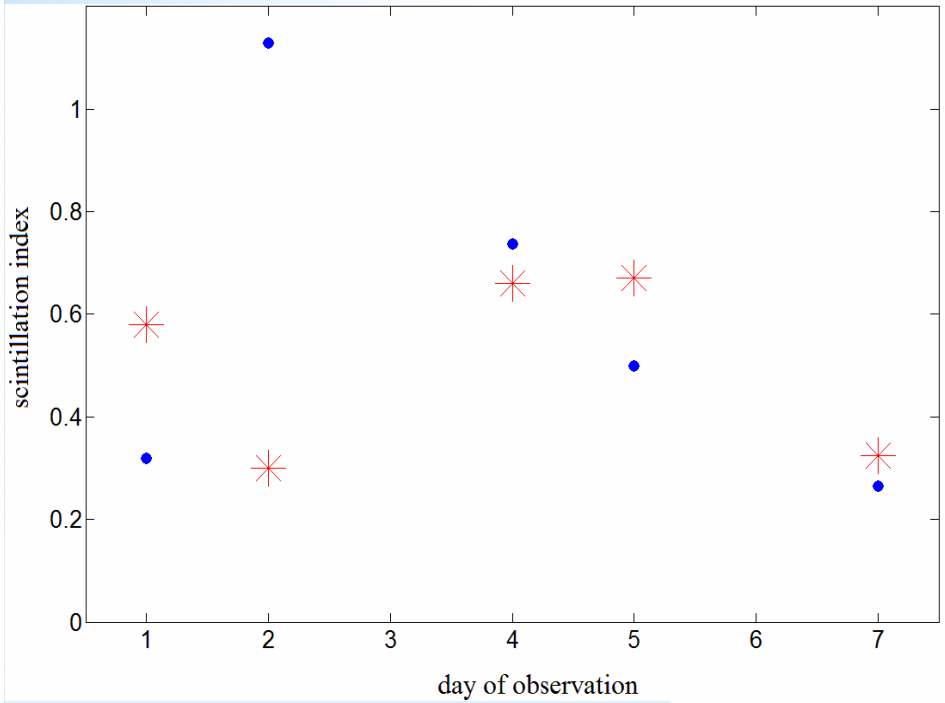


Fig. 15. Scintillation index estimated using all realizations for 7 days of observations:
3C144 (red),
3C274 (blue).

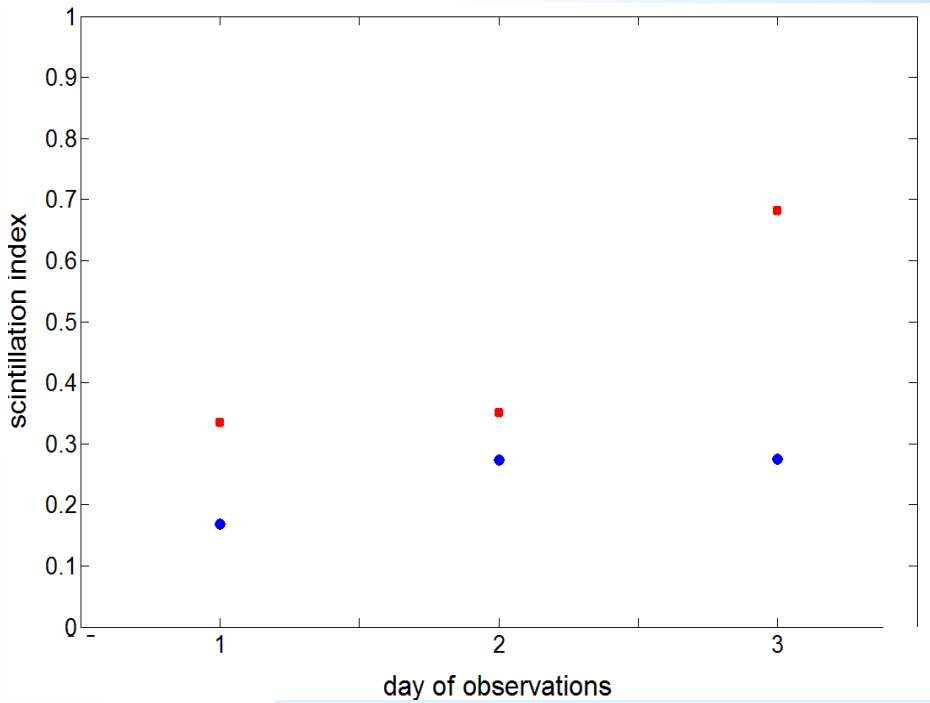


Fig.16. Radio source 3C144.
Red - scintillation index estimated for the time realizations with strong ionospheric influence (low spatial correlation),
Blue – scintillation index estimated for the time realizations with weak ionospheric influence (high spatial correlation)

Power spectrum

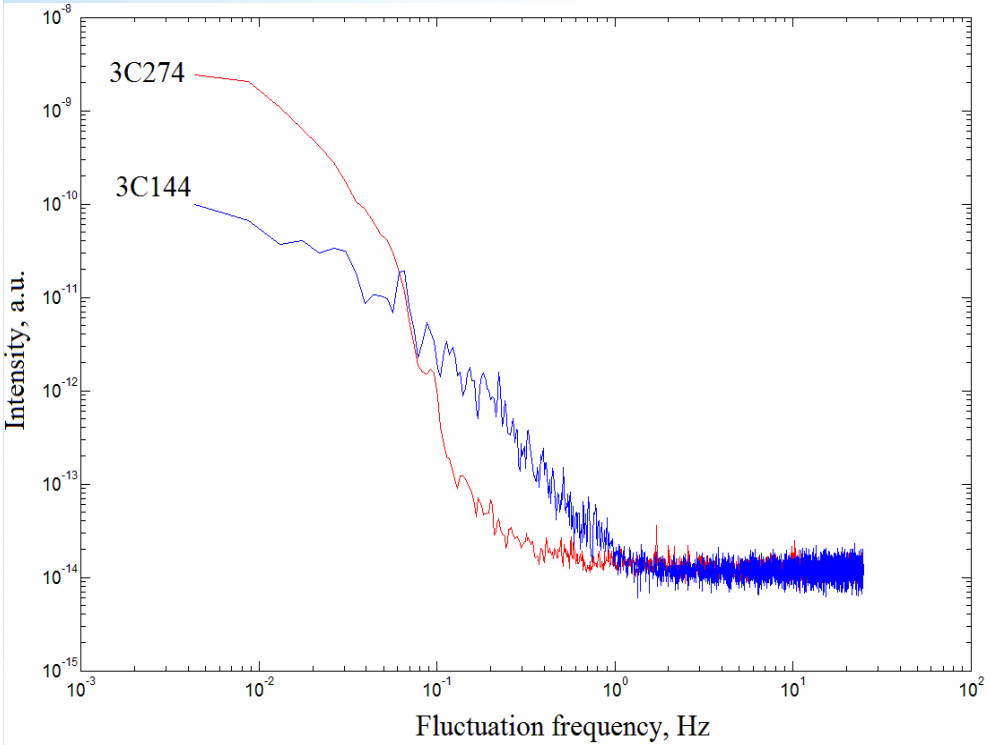


Fig. 17. Power spectra estimated using all time realizations for one day of observations:
red – 3C274, blue – 3C144.

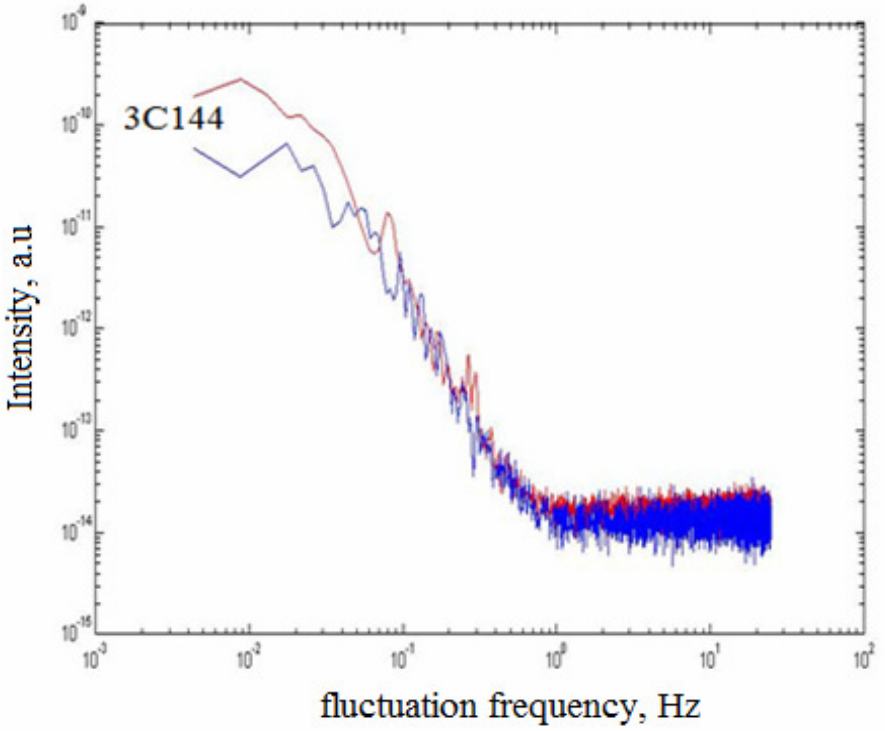


Fig. 18. Radio source 3C144 (One day).
Red – power spectrum estimated for the time realizations with strong ionospheric influence (low spatial correlation),
Blue – power spectrum estimated for the time realizations with weak ionospheric influence (high spatial correlation)

Frequency cross-correlation

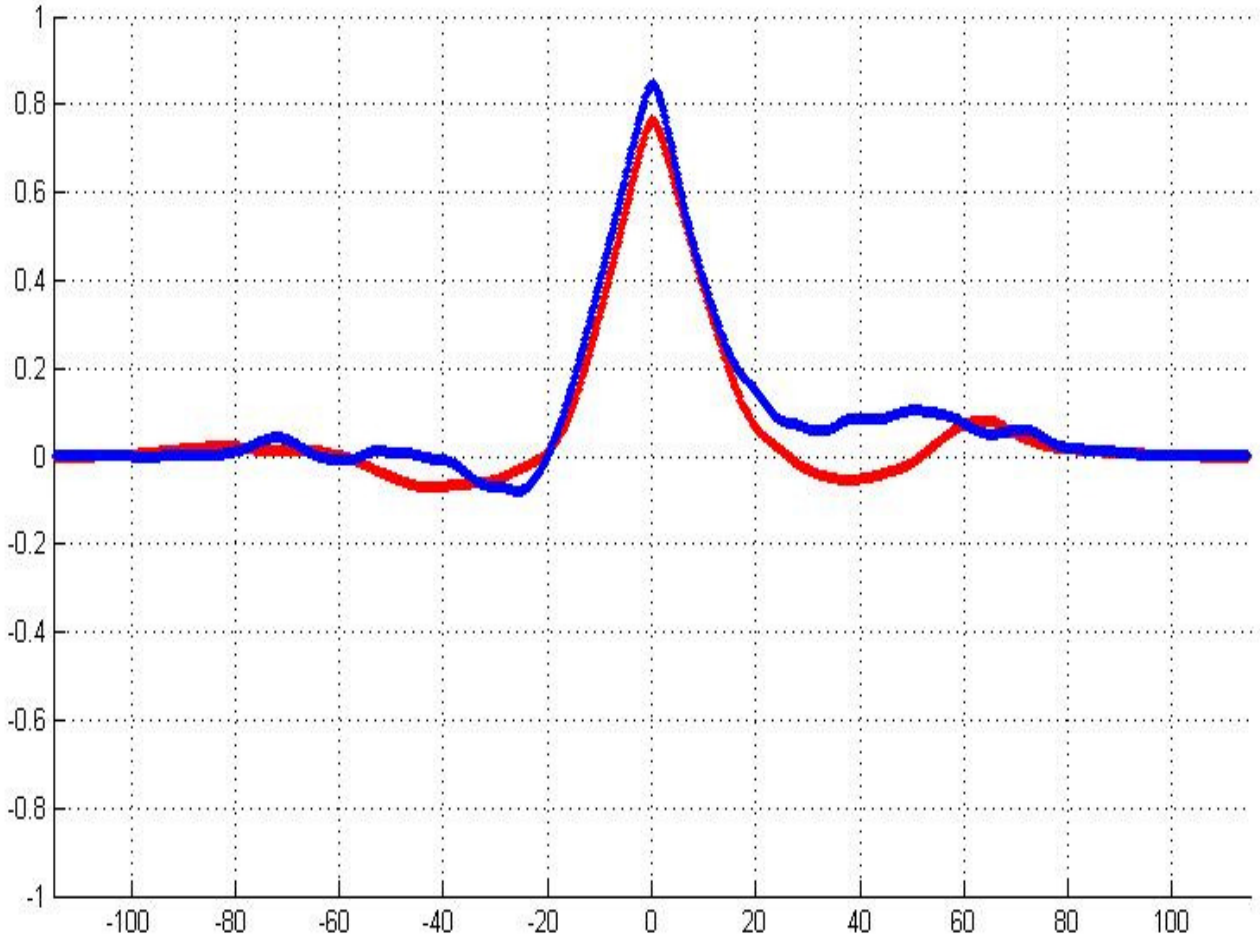


Fig.19. Red – 3C274, blue – 3C144 (for time realizations with weak ionospheric influence, high spatial correlation)

The coefficient of correlation in the frequency band

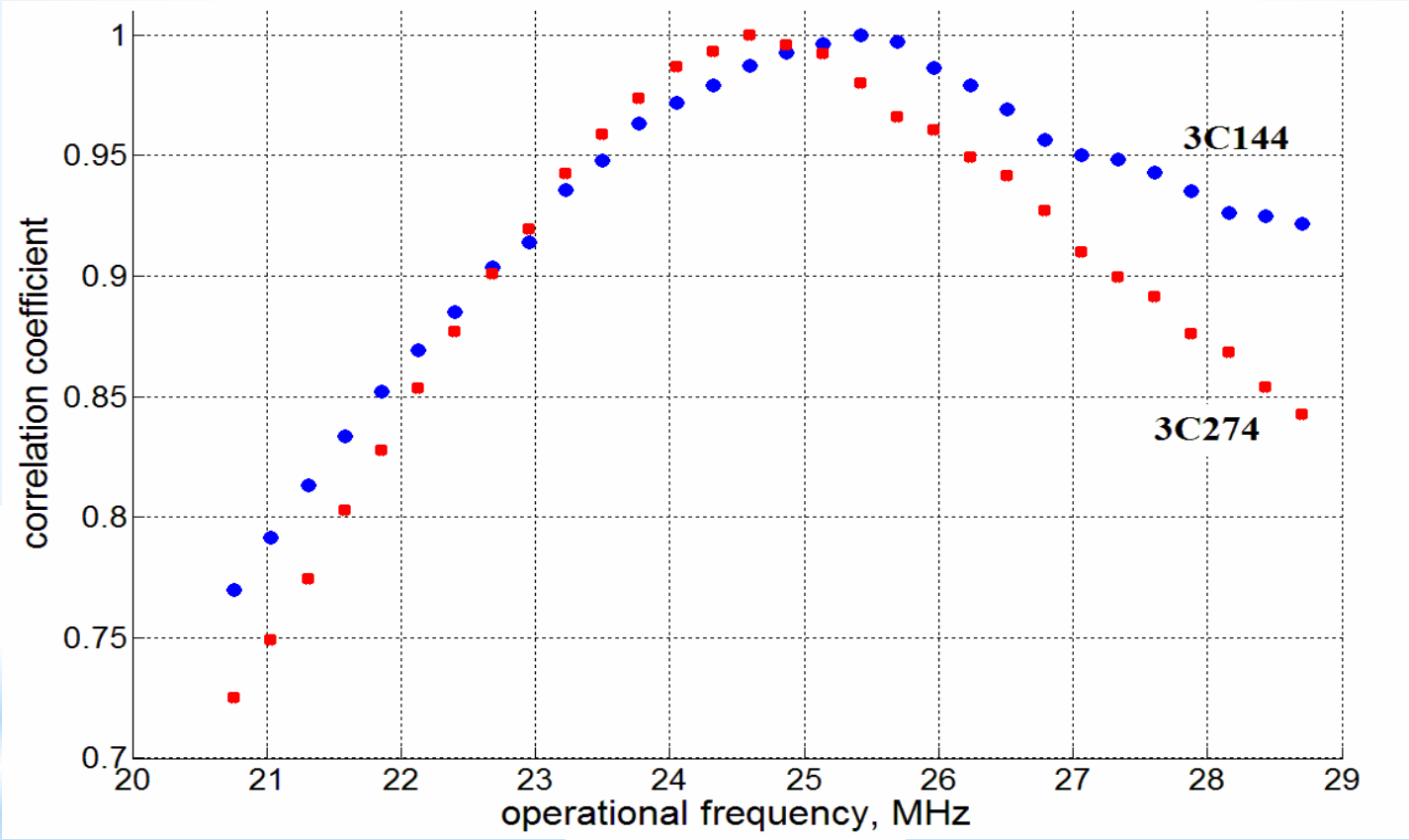
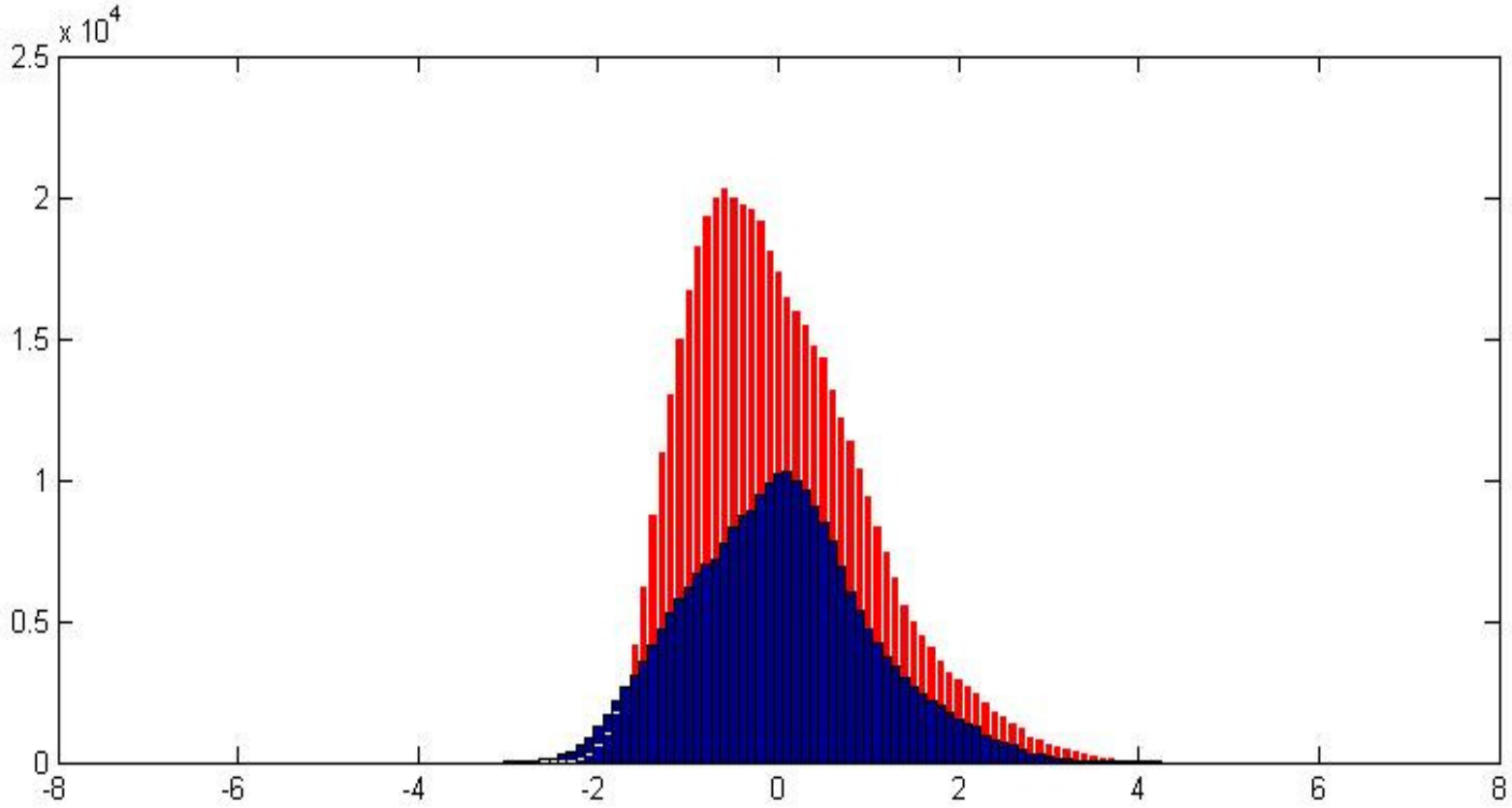


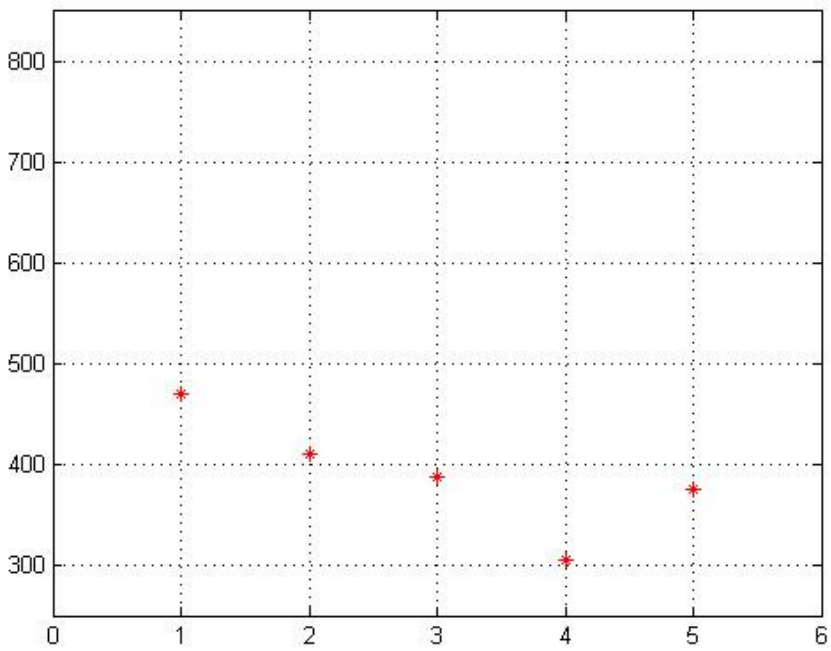
Fig.20. Coefficient of correlation in the operational frequency band (1 day).
Red – estimated for all time realizations of 3C274,
Blue – estimated for the time realizations of 3C144 with weak ionospheric influence (high spatial correlation)

The function of probability distribution

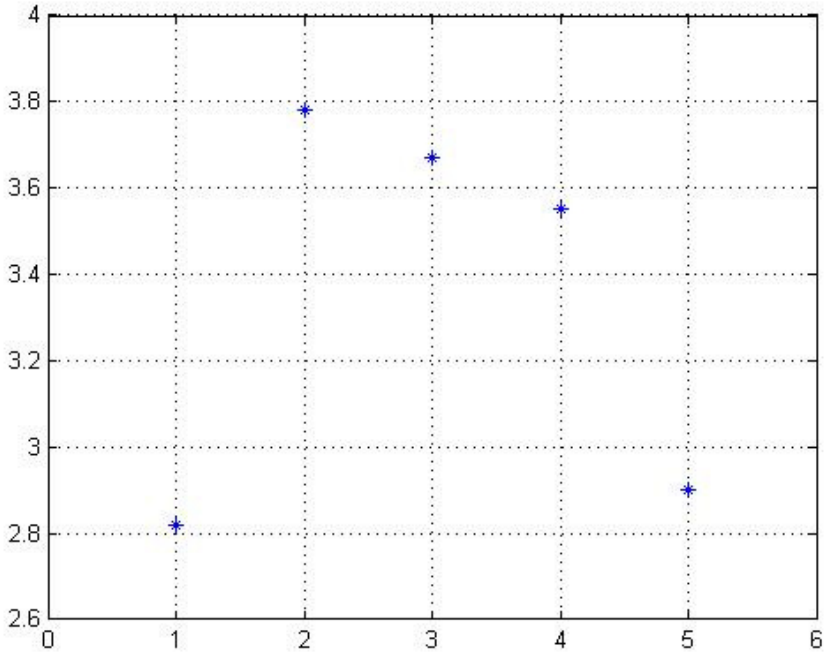


The function of probability distribution.
Red – calculated for all time realizations of 3C274,
Blue – for the time realizations of 3C144 with weak ionospheric influence (high spatial correlation)

Solar wind characteristics



Solar wind speed



Spectral index of spatial spectrum of electron density fluctuations

CONCLUSIONS

1. The observations of the interplanetary scintillations at decameter wavelengths allow conclusions to be made on the solar wind parameters (speed, spectral index of the interplanetary plasma spectrum) and to reconstruct the solar wind parameters at distances up to several a.u., 3-4 a.u.)

2. The statistic characteristics of the interplanetary and ionospheric scintillations are different.

3. These differences can be used for identification of different types of scintillations and for separate investigations of them.