

Enigmatic emission structure around the narrow-line Seyfert 1 galaxy Mrk 783

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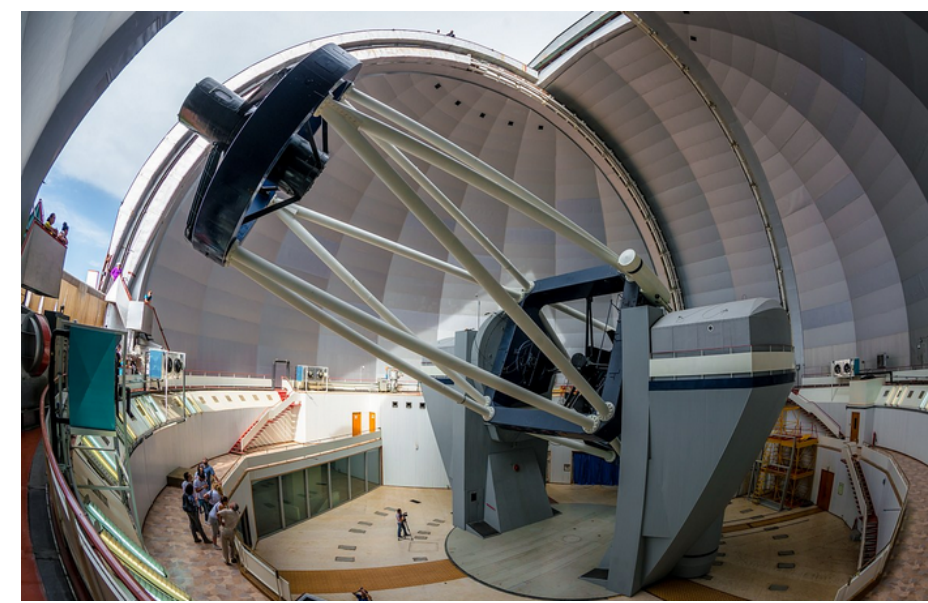
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The SAI MSU 2.5-m telescope and mt. Elbrus

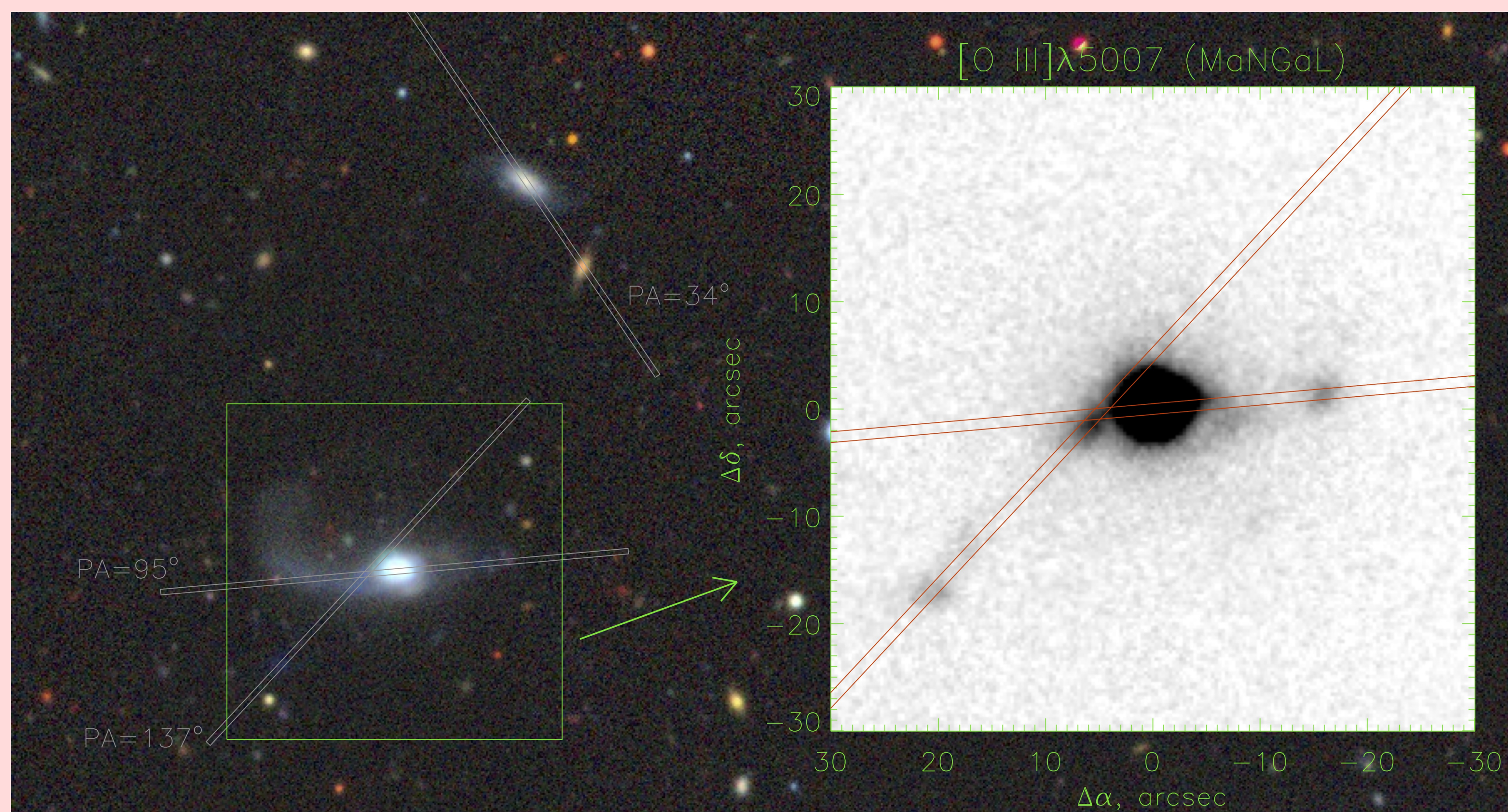
Mrk783 is a narrow-line Sy1 galaxy ($z=0.0673$, scale $1.35 \text{ kpc}''$), that holds the small-scale jet and the large-scale radio emission that are not aligned. Congiu et al. (2017a) concluded that the extended radio emission observed in Mrk783 might be a relic and that the source might be in a quiescent period of its activity cycle. The optical images reveal low surface brightness extended structures detected on both sides of the galaxy nucleus and looks like tidal tails observed in interacting galaxies. The emission in $[\text{OIII}]$, $\text{H}\beta$ and $\text{H}\alpha$ lines were tracked along the radio jet direction up to $\sim 35 \text{ kpc}$ from the nucleus according the Magellan spectroscopic observations (Congiu et al. 2017b). All this facts inspired us to do more in-depth research of the ionized gas in this Seyfert galaxy.



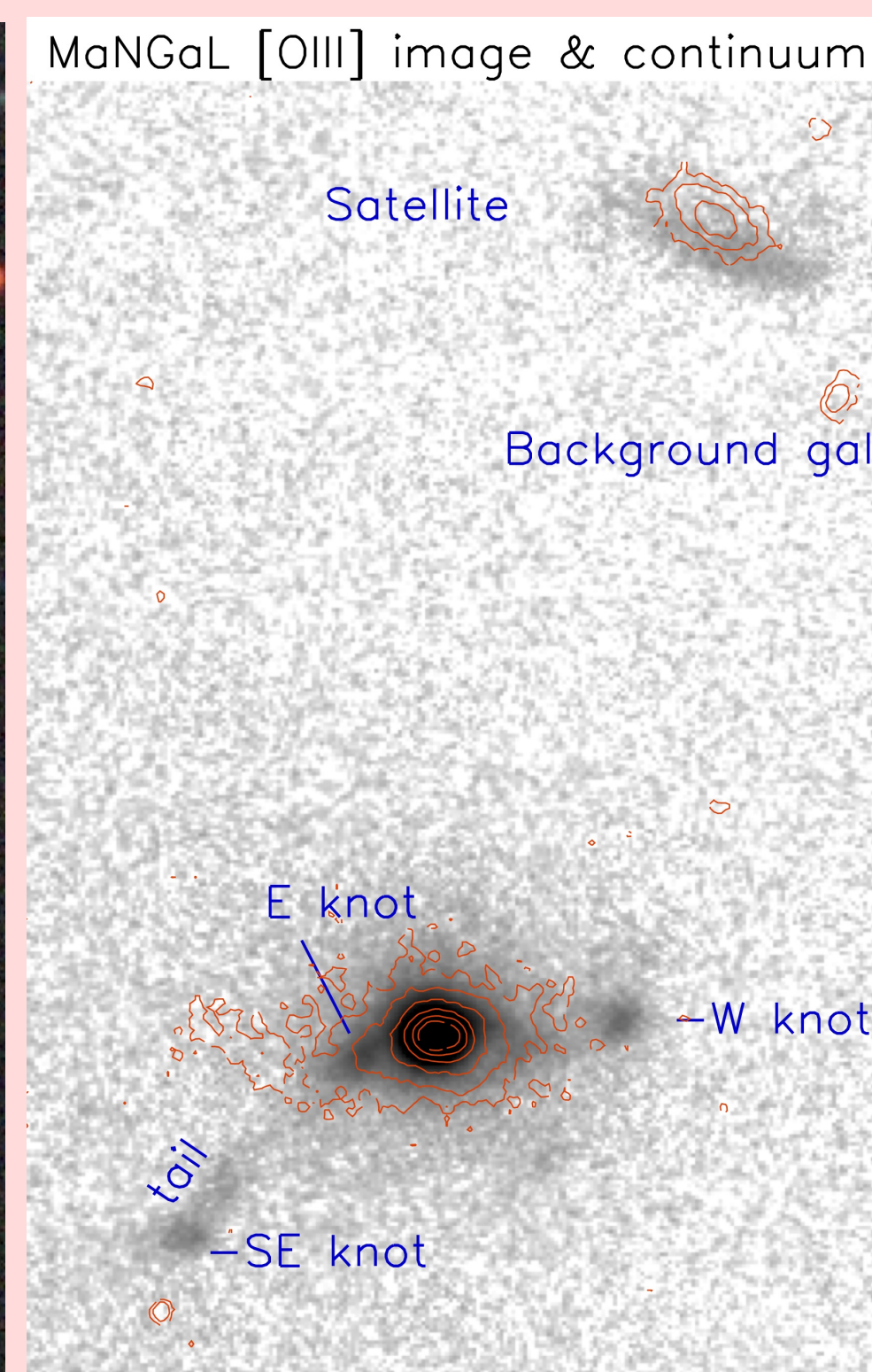
The SAO RAS 6-m telescope

Observations

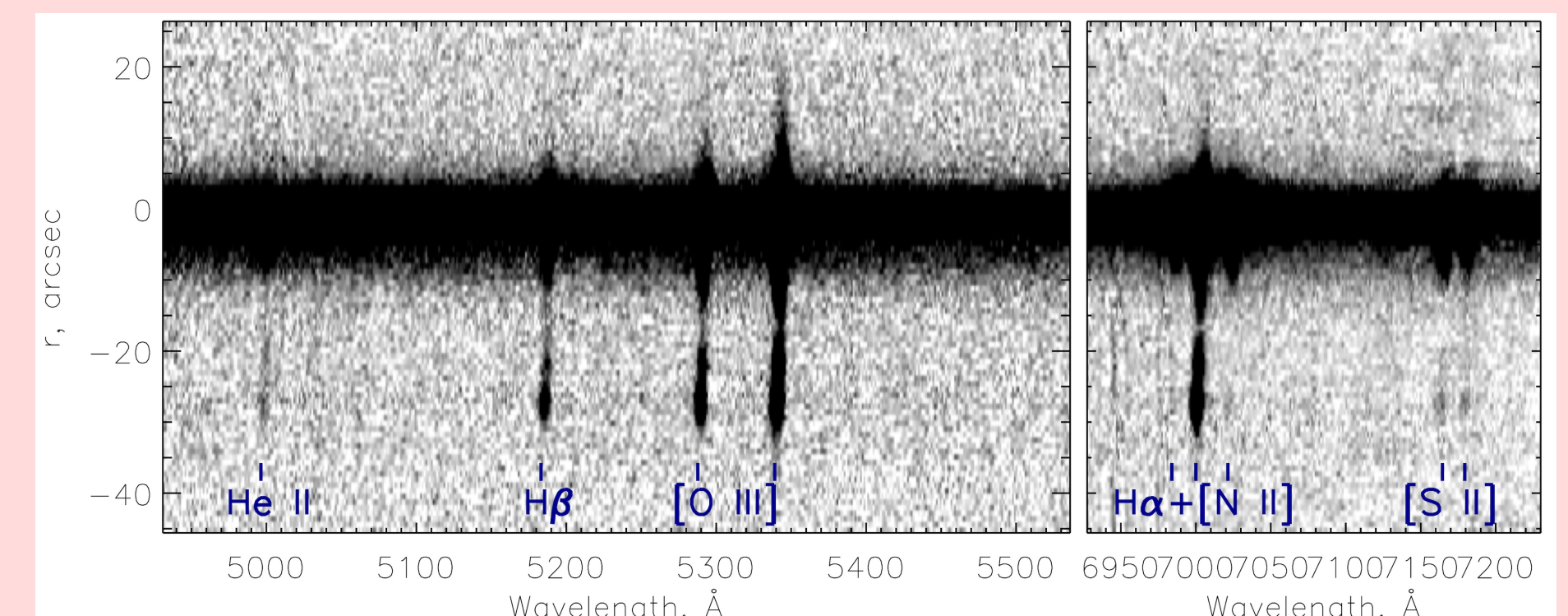
Image in the $[\text{O III}]\lambda 5007$ emission line was obtained at the 2.5-m telescope of the Caucasus Mountain Observatory of SAI MSU with the tunable filter photometer MaNGaL (Mapper of Narrow Galaxy Lines, Moiseev et al. 2020). We have mapped $[\text{O III}]\lambda 5007$ emission up to the surface brightness level $3.6 \cdot 10^{-17} \text{ erg s}^{-1} \text{ arcsec}^{-2}$ ($\text{S/N} > 3$). The MaNGaL image reveals an extended system of emission knots and diffuse ionized gas surrounding the main galaxy (see figures). Also a significant line emission was detected in the galaxy SDSS J130257.20+162537.1 located at 95 kpc projected distances to the north of Mrk 783. Spectral observations of the most interesting emission regions were performed with the SCORPIO-2 multi-mode focal reducer 6-m telescope of the SAO RAS (Afanasiev & Moiseev 2011). Slits positions is displayed on the figures below.



DECaLS DR10 color image of Mrk783 together with the MaNGaL/2.5m $[\text{O III}]\lambda 5007$ map. The SCORPIO-2 slit positions are shown by grey and red lines.

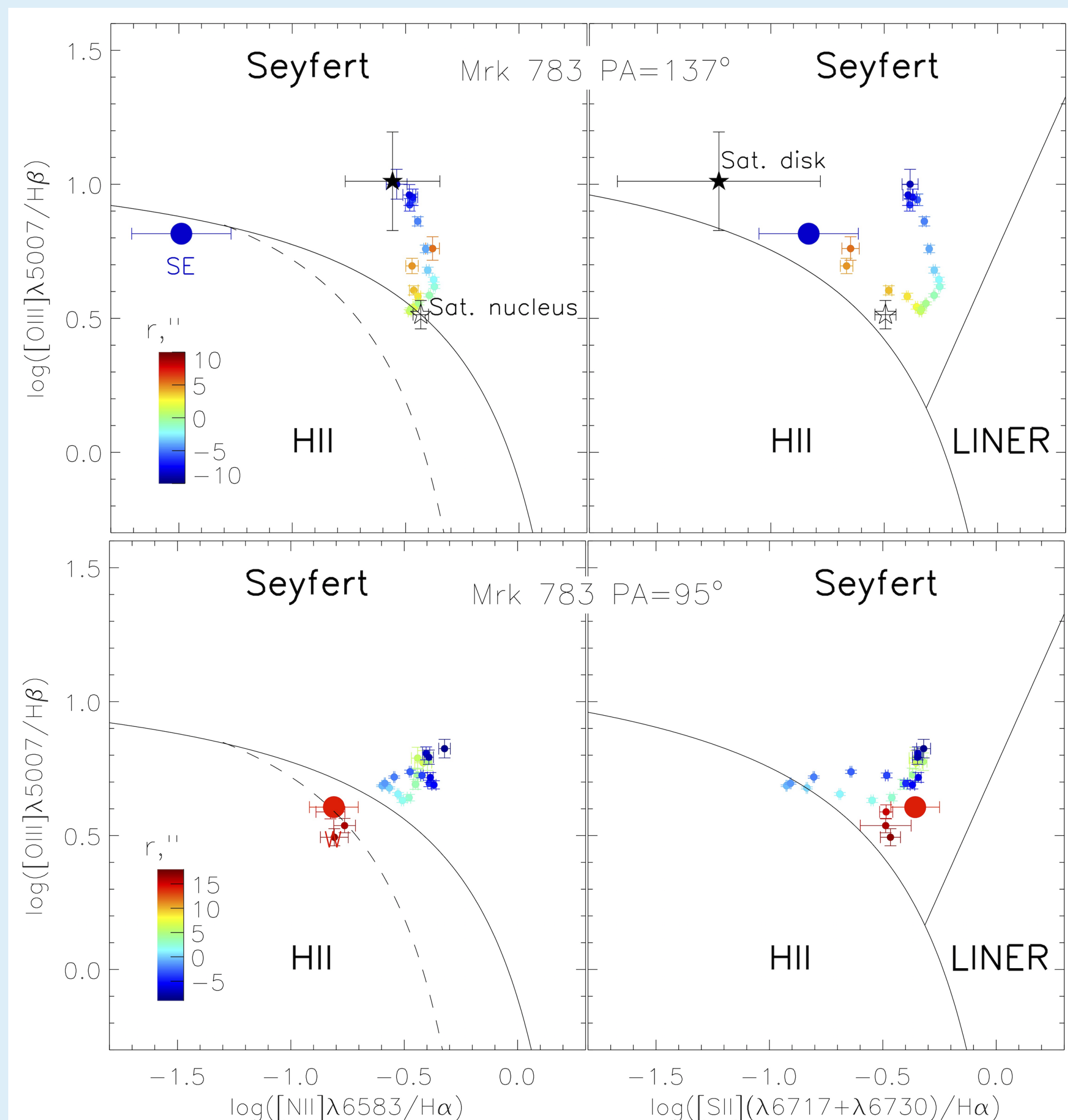


Mrk 783 with the satellite SDSS J130257.20+162537.1: the $[\text{O III}]\lambda 5007$ emission line image with contours of image in the continuum. It is clearly seen that highly ionized gas in satellite placed asymmetrically relative its nucleus — we can observe it mostly on the side nearest to the Mrk 783.



Fragments of the 2D spectrum with $\text{PA} = 137^\circ$. In the most distant ($r=26-29''$ or $35-39 \text{ kpc}$) SE knot we detected the HeII line that is indicative of direct AGN ionization together with the high-excitation $[\text{OIII}]$ doublet. Low excitation $[\text{NII}]$ and $[\text{SII}]$ lines and hydrogen Balmer lines are also visible.

Gas ionization state



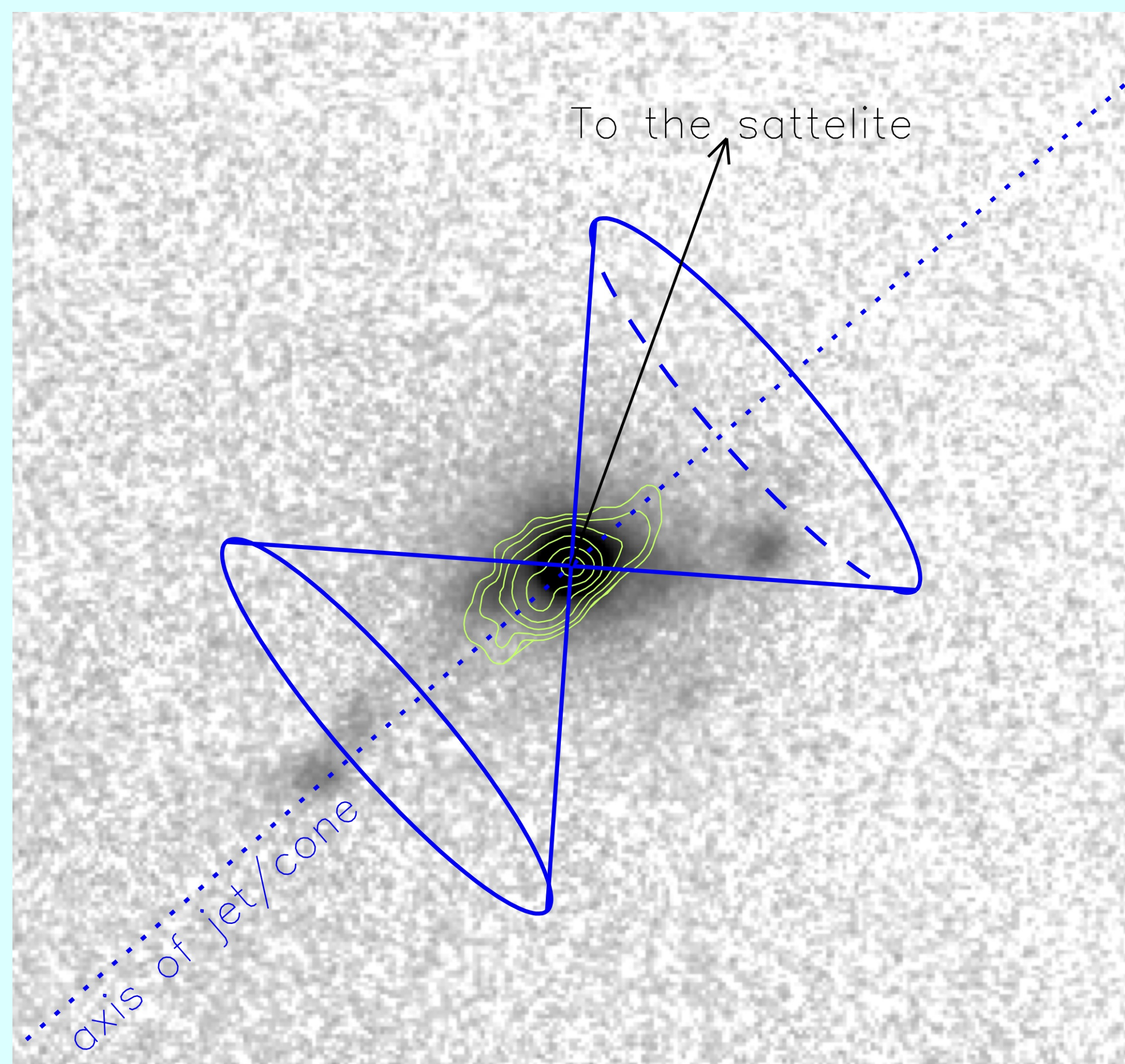
Line ratio (BPT, after Baldwin et al. 1981) diagrams along two position angles in Mrk 783. The line ratios for the nucleus and external areas of the satellite gaseous disk are also shown by open and filled stars. The ionization state in W and SE knots as well as the satellite outskirts seem to be caused by AGN radiation.

References

- Afanasiev V. L. & Moiseev A. V., 2011, *Balt. Ast.*, 20, 363
 Baldwin, J.A., Phillips M.M., & Terlevich R., 1981, *PASP*, 93, 5
 Congiu et al. 2017a, *A&A*, 603, 1
 Congiu et al. 2017b, *FrASS*, 2017, 4, 27
 Oparin D.V. & Moiseev A.V., 2015, *Astroph. Bull.*, 70, 392

Conclusion

- Mrk 783 forms a gravitationally bound pair with SDSS J130257.20+162537.1. This follows from: (i) the difference of their systemic velocities is about 60 km s^{-1} ; (ii) the projected distance is 95 kpc; (iii) the stellar mass derived from r- and z-band photometry is about 1/5-1/8. We can't detect tidal features between the galaxies, but the tail at east side of the Mrk783 can be an evidence of its interaction. At the same time, external regions of the satellite gaseous disk at the nearest side to Mrk 783 falls into the ionizing cone from Mrk 783 active nucleus.
- Most of the gaseous structures detected in the emission lines are ionized by the AGN radiation, but not the radio jet. This is indicated by lines ratio at BPT diagrams, the presence of relatively bright $\text{HeII}\lambda 4686$ line and dynamically cold gas (the range of line of sight velocities is $\pm 100 \text{ km s}^{-1}$, the velocity dispersion $< 100 \text{ km s}^{-1}$).
- Part of the gas, illuminated by the cone, belongs to the stellar tidal structure, but the most distant SE-knot is a part of external gaseous structure without stellar counterpart. Gas in this region has a low metallicity ($0.1-0.2 \text{ Z}$) according to $[\text{NII}]/\text{H}\alpha$ line ratio.



The $[\text{O III}]\lambda 5007$ emission line image with contours of radio continuum at 5 GHz according Congiu et al. 2017a. Proposed orientation of the ionization cone is shown.