

# Optical, radio and X-ray properties of J1159+5820

Dorota Koziel-Wierzbowska<sup>1</sup>, Marek Jamroz<sup>1</sup>, Staszek Zola<sup>1,2</sup>, Łukasz Stawarz<sup>1,3</sup>,  
C.C. Cheung<sup>4</sup> & Greg Stachowski<sup>2</sup>

<sup>1</sup>Astronomical Observatory, Jagiellonian University, ul. Orła 171, PL-30244 Krakow, Poland

<sup>2</sup>Mt.Suhora Astronomical Observatory, Pedagogical University, ul. Podchorążych 2, PL-30-084 Krakow, Poland

<sup>3</sup>ISAS, Japan Aerospace Exploration Agency, Japan

<sup>4</sup>NRL/NRC (USA)

**Abstract:** We present a progress report on investigation of unique radio galaxy J1159+5820, an object which shows three signs of episodic nuclear activity: a recurrent activity in the form of double-double lobes morphology, X-shape radio structure and fingerprints of galaxy merging process at the same time. In this work we present recently taken optical observations revealing a complex and disturbed structure of the host galaxy CGCG292-057. We also show new radio images from our dedicated low-frequency GMRT observations. Using the radio data, we estimated the inclination angle of the inner radio lobes to the line-of-sight to be about 80 degrees. From the optical image of the host it seems, however, that this is a galaxy seen almost face-on. Finally, we compare our optical images with the new X-ray Swift detections which show a faint extended source.

## Optical observations

Radio galaxy J1159+5820 is identified with optical galaxy CGCG 292-057. In order to obtain deeper images of the host galaxy surroundings than those provided by SDSS we observed J1159+5820 with the 60cm telescope at Mt. Suhora Astronomical Observatory and to picture the inner regions of the galaxy we performed series of observations with the 2m Faulkner Telescope North operated by the Las Cumbres Observatory Global Telescope Network.

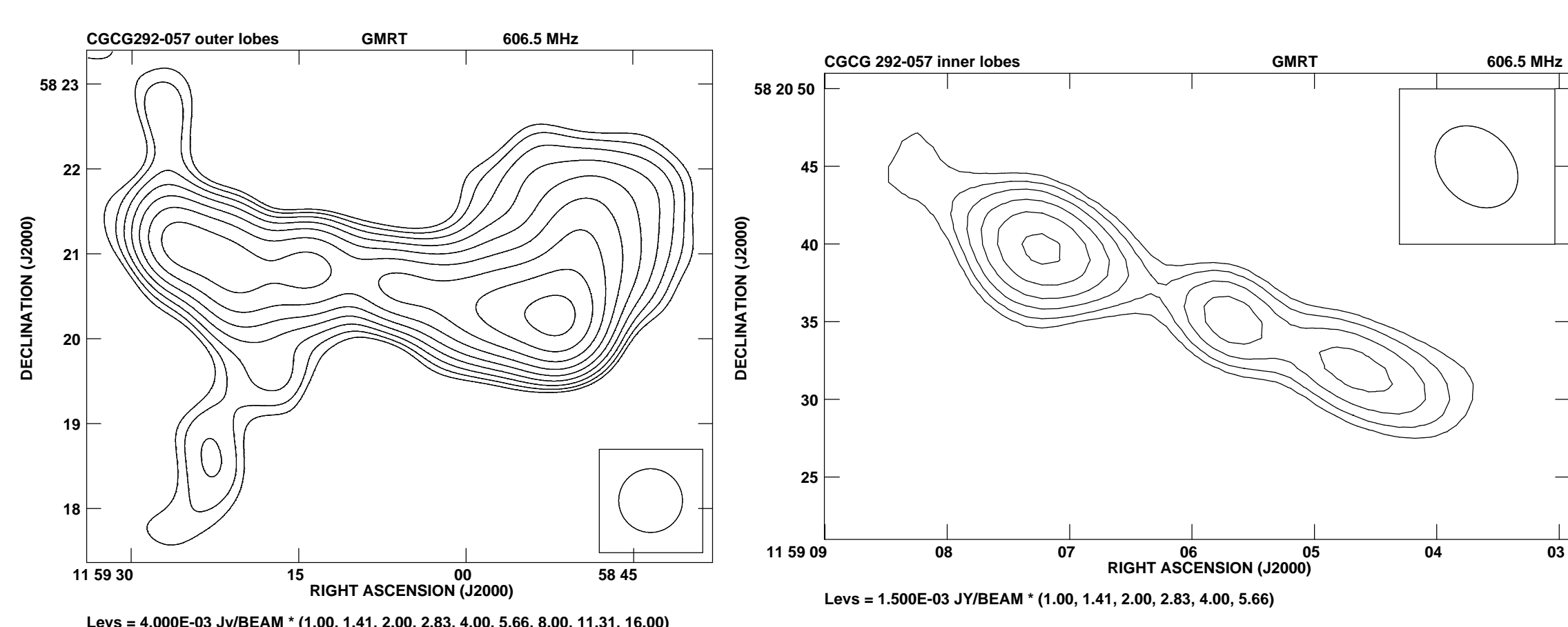
The results of Mt.Suhora and the LCOGT observations, combined into separate color images are shown in Fig.1. CGCG292-057 is observed "face-on" and undeniably it is a merger galaxy. The low spatial resolution but good sensitivity image (Fig. 1, right panel) shows expanded, faint arms and diffuse, scattered emission. The left image shows nucleus and the surroundings with a better resolution. None of these images reveal a companion.



**Figure 1:** Optical R-band deep images of the host galaxy of J1159+5820. The left picture shows the detailed inner structure obtained at the LCOGT and the right panel shows the deep imaging obtained with the 0.6m telescope at Mt.Suhora Observatory.

## Radio observations

The extended ( $\sim 4'3$ , which corresponds to 270 kpc) radio morphology of J1159+5820 resembles an FR II-type (Fanaroff & Riley 1974) radio galaxy, though with some unusual features. It shows an X-shape structure, which is characterized by two low-surface-brightness lobes oriented at an angle to the high-surface-brightness radio lobes, giving the entire source its characteristic shape. The two pairs of lobes pass symmetrically through the position of the host galaxy.

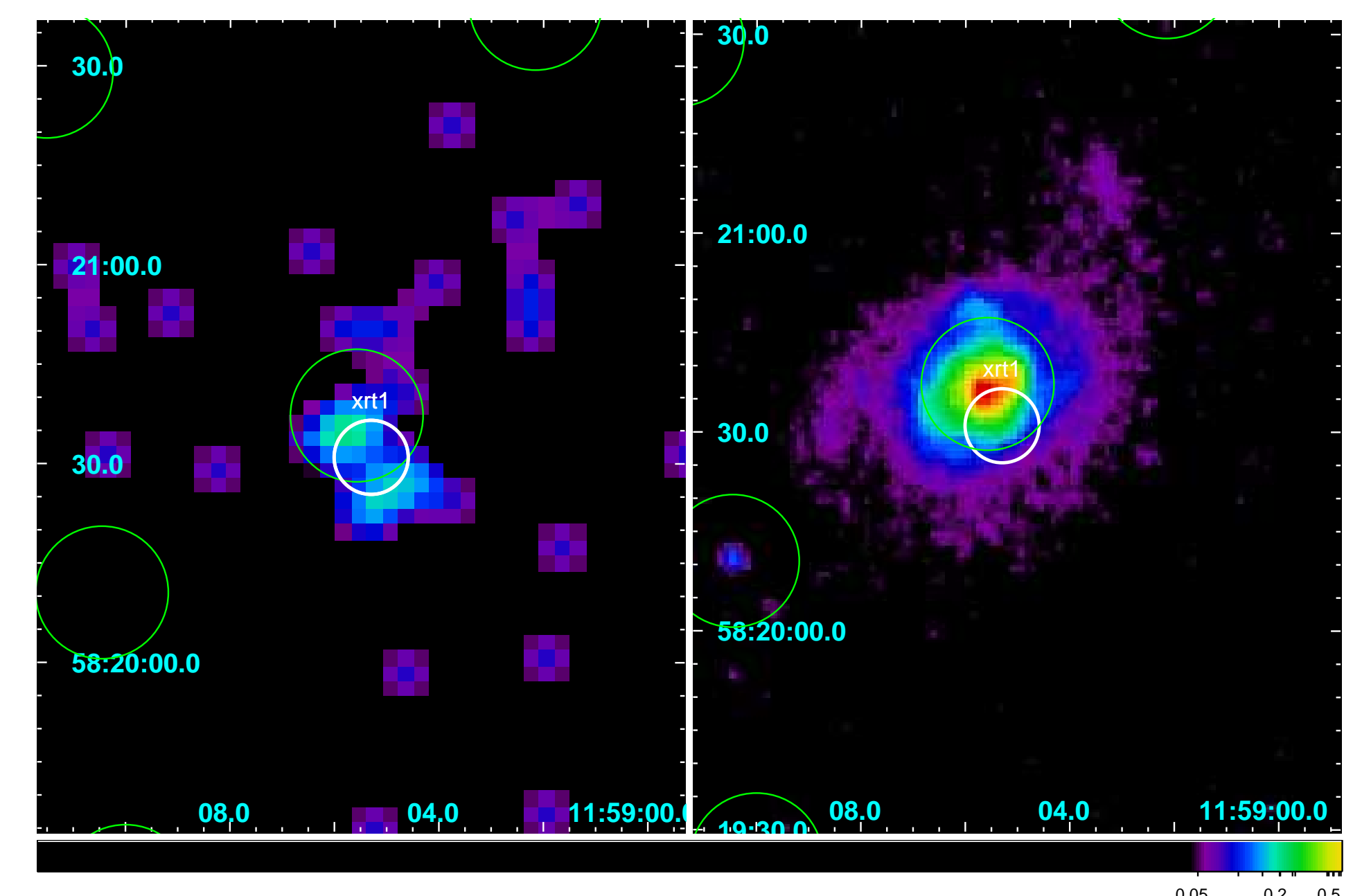


**Figure 2:** 600-MHz GMRT images of J1159+5820. (left) The contour map of the entire source. (right) The inner structure.

There is also a second pair of coaxial, smaller lobes, well visible in the FIRST map. Sources with two pairs of lobes have been named double-double radio galaxies (DDRGs; Schoenmakers et al. 2002). of three compact sources visible in the

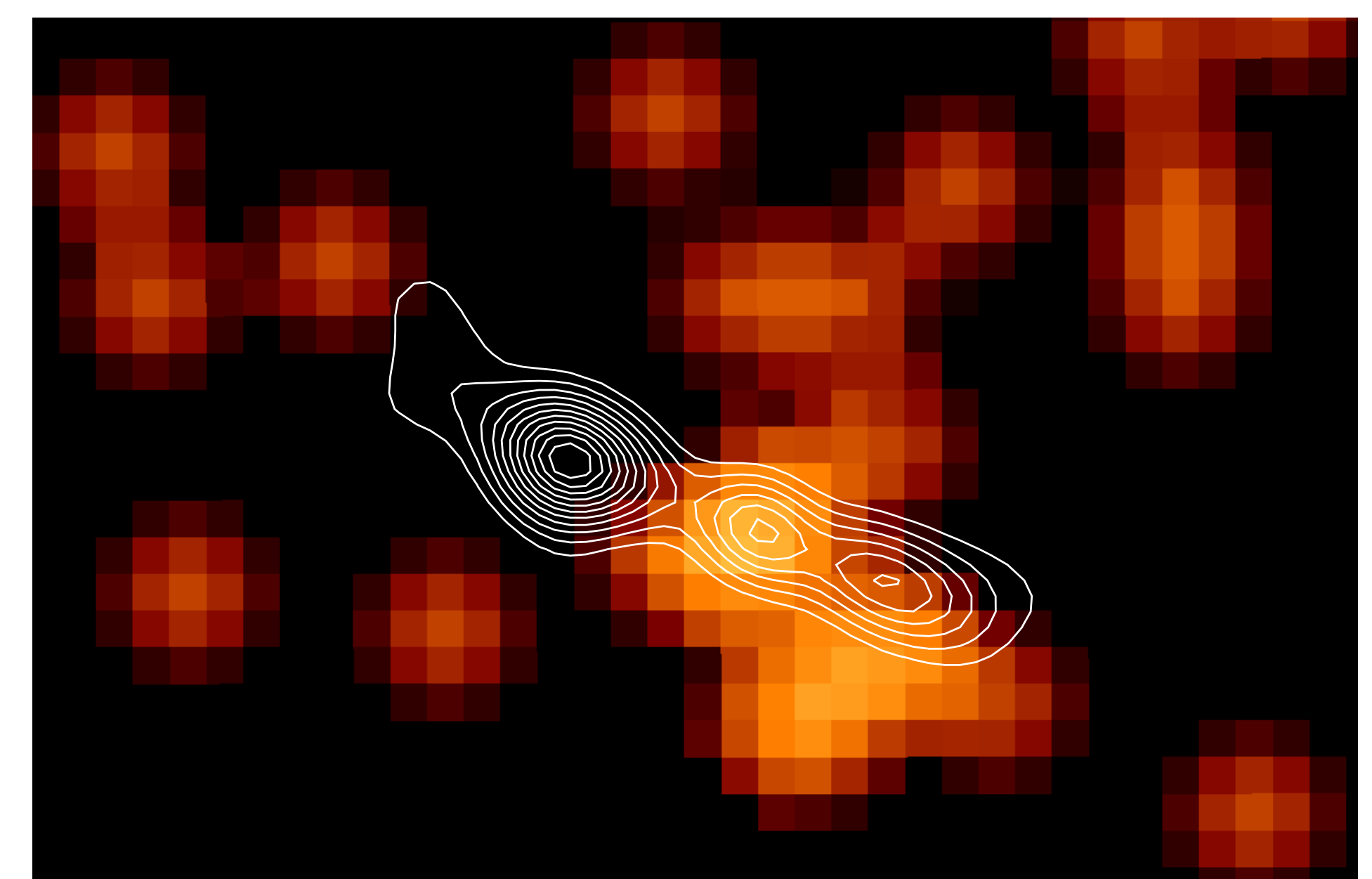
FIRST map is 8.61 mJy. The central radio component coincides well with the centre of the optical galaxy and the two side compact sources are located within the optical boundaries of the parent galaxy. The arm-length ratio of the FIRST central lobes is about 1.54 and its peak-flux ratio is 1.50. This corresponds to the inclination angle of the radio structure to the line-of-sight of about 80 degrees. However, it seems that it is almost a face-on galaxy from the optical image of the host. The new GMRT observations of both outer and inner structures at 600MHz are shown in Fig.2.

## SWIFT X-ray detection



**Figure 3:** Smoothed X-ray events map (left) and the UVOT U-band optical image of J1159+5820 obtained with SWIFT. Green circles indicate positions of optical sources and white circle indicate the X-ray source.

The SWIFT X-ray data of J1159+5820 was obtained on February 20, 2011. The exposure time was 10.5ks. The faint x-ray source, which appears to be extended, was detected. Fig.3 shows the X-ray map smoothed with a Gaussian and the UVOT U-band optical image. The X-ray source position is indicated with the white circle and it is consistent with the center of optical image. But, as can be seen from the figure, the X-ray detection may be composed of 2 sub-clumps. Figure 4 shows white 600-MHz GMRT radio contours superimposed on the X-ray color-scale image. The nucleus of the radio inner structure coincides with one of the X-ray sub-clumps. Observed count rate in 0.3-10 keV ( $1.55e-03 \pm 4.7e-04$ ) gives the unabsorbed flux equal to  $5.6e-14$  erg/cm<sup>2</sup>/s.



**Figure 4:** X-ray image of J1159+5820. 600-MHz GMRT contours showing the inner radio structure are plotted in white.

**Acknowledgements:** This project was funded in part by the Polish MNiSW grant 3812/B/H03/2009/36.