

## NEWLY DISCOVERED FOOTPRINTS OF GALAXY INTERACTION AROUND SEYFERT 2 GALAXY NGC 7743

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### ABSTRACT

It has been suggested that only the most luminous AGNs ( $L \gtrsim 10^{45}$  erg/s) are triggered by galaxy mergers, while less luminous AGNs ( $L \sim 10^{43}$  erg/s) are driven by other internal processes. The lack of merging features in low luminosity AGN host galaxies has been a primary argument against the idea of merger triggering of low luminosity AGNs. But a merger, especially a rather minor one, might still have played an important role in low luminosity AGNs, as minor merging features at low luminosities are more difficult to identify than major merging features. Using SNUCAM on the 1.5 m telescope at Maidanak observatory, we obtained deep optical images of NGC 7743, a barred spiral galaxy classified as a Seyfert 2 AGN with a low bolometric luminosity of  $5 \times 10^{42}$  erg/s. Surprisingly, we discovered a merging feature around the galaxy, which indicates past merging activity in the galaxy. This example indicates that the merging fraction of low luminosity AGNs may be much higher than previously thought, hinting at the importance of galaxy mergers even in low luminosity AGNs.

*Key words:* galaxies: active – galaxies: interactions

### 1. INTRODUCTION

Active Galactic Nuclei (AGNs), one of the most energetic light sources in the universe, are known to be astronomical objects triggered by accretion onto Super Massive Black Holes (SMBHs) in the center of galaxies. Recent studies indicate that there are two scenarios to trigger AGN activity; galaxy mergers (Sanders et al., 1988) and internal mechanisms (Kormendy & Kennicutt, 2004). Observationally, Treister et al. (2012) shows that only a few percent of AGNs with luminosity of  $L < 10^{43}$  erg/s show merging features, while merging features are much more commonly found in 50% or more of luminous AGNs with  $L > 10^{45}$  erg/s.

NGC 7743 is a barred spiral galaxy classified as a Seyfert 2 AGN. It has a low bolometric luminosity of  $L = 5 \times 10^{42}$  erg/s measured from [OVI] line and a low Eddington ratio of 0.0076 (Diamond-Stanic & Rieke, 2012). Although NGC 7743 is a low luminosity AGN hosted by a barred spiral galaxy, there is possible observational evidence for past interaction with other galaxies. Katkov et al. (2011) shows that there is a distinguishable angle of  $\delta = 34^\circ \pm 9^\circ$  or  $77^\circ \pm 9^\circ$  between the stellar and inclined gaseous disks in the center, which could be caused by galaxy interactions, which can trigger AGN activity in the center of the galaxy. Hence, what mechanism triggered the AGN activity of this low luminosity AGN is still under debate.

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In order to find possible footprints of past merging activity, we obtained deep multi-band images of NGC 7743 covering an  $18' \times 18'$  field of view.

### 2. OBSERVATIONS AND DATA

The observations of NGC 7743 were carried out as a pilot program for SNU-Maidanak Imaging of Galaxies in Optical (SMIGOL), which aims to provide deep, wide-field imaging of nearby galaxies at high resolution. The images were obtained with the Seoul National University 4k x 4k Camera (SNUCAM; Im et al. 2010) on the 1.5 m telescope of the Maidanak observatory, Uzbekistan, which can cover a field of view of  $18' \times 18'$ . For deep imaging, the following observation of NGC 7743 in *B*, *V* and *R* filters were carried out with a seeing of  $\sim 1.2$  arcsec. The total exposure times per pixel are 180, 175 and 215 minutes, respectively.

Since the readout systems of SNUCAM are divided into four, there are variances in the bias images between them. To correct the differences, we did sky correction between four chips with IRAF tasks. The  $5\text{-}\sigma$  detection limits of the images are deep enough to observe interaction features; 25.1, 25.1 and 23.0 mag (Vega) in *B*, *V* and *R* filters, respectively.

For comparison of image depth, we used optical images from the Sloan Digital Sky Survey (SDSS) DR10 data.

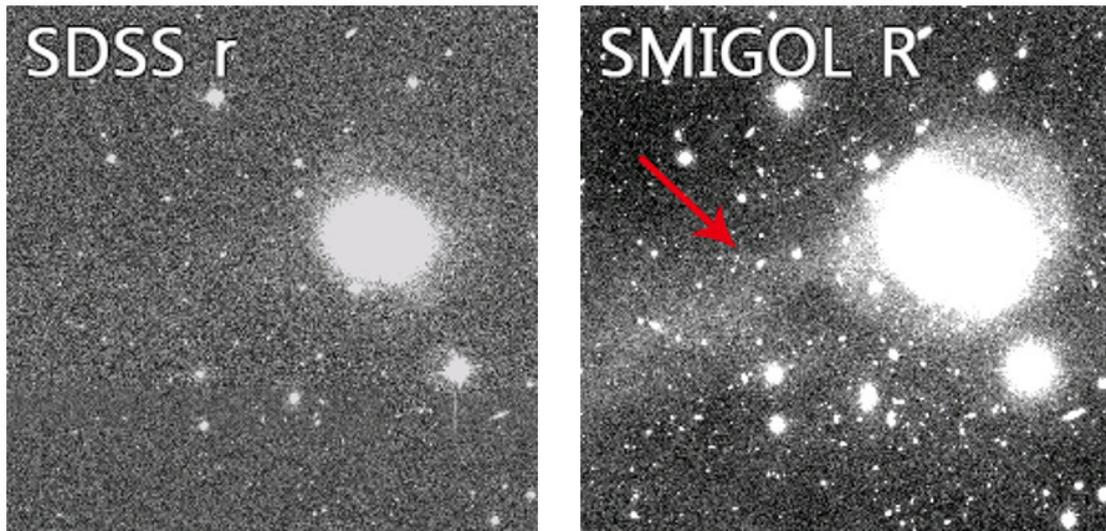


Figure 1. Postage stamp images of the field around NGC 7743 (the biggest object in each image). Interaction feature (*red arrows*) is shown on the lower-left of NGC 7743 on the *R*-band images of SMIGOL data (*right*), while the feature is not shown in SDSS *r*-band images (*left*).

### 3. INTERACTION FEATURE OF NGC 7743

We found an interaction feature around NGC 7743 with our deep optical images. Figure 1 shows postage stamp images of the field around NGC 7743. Note that there is an interaction feature extending towards the lower-left of NGC 7743 on the image in the deep SMIGOL *R*-band image (*right*), while the shallow depth *r*-band image from SDSS has no interaction feature (*left*).

There are three possible origins of the interaction feature. First, a major merger could cause the feature. It is suggested that large merging feature around galaxies remain after the major merger of galaxies. However, there is a barred spiral structure in the center of NGC 7743, which cannot be explained by a major merger because the spiral structure in a galaxy is easily destroyed when a galaxy undergoes a major merger. Second, a minor merger could be another possible origin of the interaction feature. If a satellite galaxy which has mass lower than a quarter of the mass of NGC 7743 is merged with NGC 7743, this minor merger could trigger AGN activities in NGC 7743 without the complete collapse of the barred spiral structure. Unfortunately, the footprints of a minor merger may be too faint to be observed as an extended interaction feature. The third possible origin is not merging but galaxy interaction. NGC 7742, which is an S0 galaxy separated  $\sim 300$  kpc from NGC 7743, might have interacted with NGC 7743 about 1 Gyr ago (Katkov et al., 2011), stimulating tidal interactions to form the interaction feature around NGC 7743. But the matter of the duration of the interaction feature is not yet clear; numerical simulations of the interaction between the two galaxies are needed to prove this.

### 4. CONCLUSIONS

Although the origin of the interaction feature around NGC 7743 is not clearly understood, this example indi-

cates that the merging fraction of low luminosity AGNs may be much higher than previously thought, suggesting the importance of merging as a triggering mechanism for low luminosity AGNs. To constrain the importance of merging for AGN triggering, observations of more fields of low luminous AGNs with deep and wide optical imaging are needed.

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