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Testing the link between mergers and AGN in the Arp 245 system

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Abstract. Galaxy mergers are known to drive an inflow of gas towards galactic centers, potentially leading to both star formation and nuclear activity. In this work we aim to study how a major merger event in the ARP 245 system is linked with the triggering of an active galactic nucleus (AGN) in the NGC galaxy 2992. We employed three galaxy collision numerical simulations and calculated the inflow of gas through four different concentric spherical surfaces around the galactic centers, estimating an upper limit for the luminosity of an AGN being fed the amount of gas crossing the innermost spherical surface. We found that these simulations predict reasonable gas inflow rates when compared with the observed AGN luminosity in NGC 2992.

Keywords. galaxies: active, galaxies: evolution, galaxies: interactions

1. Introduction

Galactic interactions are among the mechanisms which can cause an inflow of gas towards the galactic center, potentially triggering phenomena such as starbursts, formation of bulges and spheroids and fuel active galactic nuclei (AGN).

Using the library of galaxy collision numerical simulations GalMer (Chilingarian *et al.* 2010), we studied the inflow of gas to the galactic centers in Arp 245, an interacting system consisting of two spiral galaxies: NGC 2992, an active galaxy recently classified as Seyfert 1.8 by Schnorr-Müller *et al.* (2016), and NGC 2993. The system is observed at an early stage of the interaction, about 100 Myr after perigalacticon (Duc *et al.* 2000).

Considering the gas inflow rate at 10 pc around the supermassive black hole (SMBH), we estimated an upper limit for the luminosity of that AGN, comparing it with the bolometric luminosity of the AGN present in NGC 2992.

2. Methods and Results

We applied three different galaxy collision numerical simulations with varying values of orbital angular momentum available at GalMer library and relied on the work of Duc *et al.* (2000) to choose zero orbital energy ($E = 0$) prograde encounters and with galaxies' spin vectors making a 75° angle with respect to each other. Then, we calculated the gas inflow through four different concentric spherical surfaces of radii 1 kpc, 0.5 kpc, 0.1 kpc and 0.01 kpc around galactic centers during the collision. The result is shown in figure 1.

Applying $\dot{E} = \epsilon \dot{m} c^2$, where $\epsilon = 0.1$ is the matter-energy conversion efficiency of a black hole, we estimated the luminosity of an AGN with a positive inflow rate through the spherical surface of radius 10 pc, and then compared it with the bolometric luminosity of NGC 2992' AGN. Results are presented in figure 2.

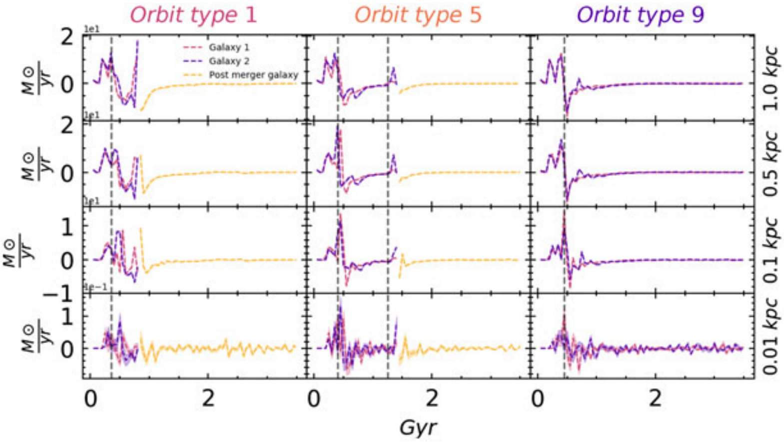

Figure 1. Gas flux through spherical surfaces of radii $r = \{1\ kpc, 0.5\ kpc, 0.1\ kpc, 0.01\ kpc\}$ around galactic centers for each simulation. Orbital angular momentum of the simulations increase from left to right. Vertical dashed lines mark perigalacticons.

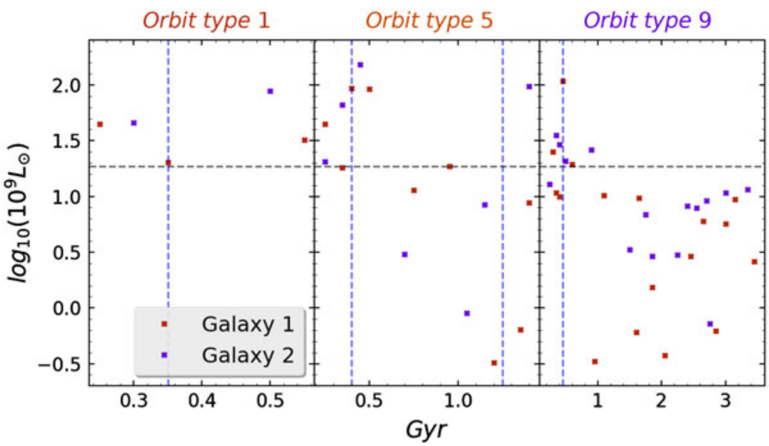

Figure 2. Luminosities of an AGN, considering 100% gas transportation efficiency from $10pc$ down to the SMBH at the centre of the simulated galaxies, compared to the bolometric luminosity of NGC 2992' AGN (horizontal dashed line). Vertical lines mark perigalacticons.

3. Conclusions

Considering the estimated luminosities at 100 Myr after perigalacticon, the simulation with intermediate value of orbital angular momentum ($L = 80.0\,km\,kpc\,s^{-1}$) is the one which better describes the observed NGC 2992 AGN luminosity. However, this would imply a scenario where 20% of the gas at 10 pc is accreted by the black hole. This transport efficiency from 10 pc to the SMBH is slightly larger than expected by current numerical simulations which are able to resolve scales of 0.1 pc (Hopkins & Quataert (2010)). This can probably be attributed both to the lack of AGN feedback and the uncertainty of the parameters used in our model.

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