

Simulation of NGC 3769 and its companion NGC 3769A

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Abstract— In this paper two interacted galaxies NGC 3769 and NGC 3769A are simulated by using Intergalactic Gravitational Motion Simulator IGMS code. Through the simulation, the effects of the attraction between the two galaxies are explained how the companion galaxy NGC 3769A moves around the main galaxy NGC 3769. At the time ($t=850$ Myrs.) the situation of the companion comparing to the main galaxy would be in a good agreement with the situation of the two galaxies observed by telescope.

I. INTRODUCTION

The galaxy NGC 3769 and its companion NGC 3769A are classified by H. Arp as Arp 280 in the list of peculiar galaxies (Arp1966){1}. They are the two unequal mass interacting galaxies situated in Ursa Major constellation about 50 Mly away from the earth. The companion is a dwarf which has a small irregular-shape with very short tail but it is does not appear in most of the images of the galaxy.

Since the last century, the arp galaxies were studied by simulation (Toomre &Toomre1972;Kojima & Noguchi 1997 ; Sellwood & Carlberg 2014; Kotarba et al. 2010){2}{3}{4}{5}.The simulation of interacted galaxies have a great contribution in understanding different properties of the interaction at different epochs (Canalizo et al.2007;Cisternas et al.2011) {6} {7}. Galaxy interaction causes the distortion of shapes of galaxies as well as contraction of tails in one or both of the two galaxies (Georgakakis et al. 2009; Bessiere et al. 2012) {8} {9}.

Figure 1 shows the primary galaxy NGC 3769 and the companion 3769A of Arp280 .

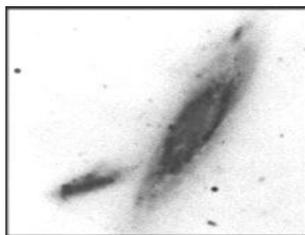


Fig.1: The image of Arp 280 observed by telescope.

II. METHODOLOGY

There are several models for simulating the interacted galaxies (Springle 2005 ; Karl et al. 2010) {10} {11}. In the present work IGMS code (Perly 2000) {12} is used for simulating the two galaxies.

In simulating the interacted galaxies it is important to obtain the properties of the galaxies that agree with that observed by telescopes. Therefore, it is important to assume suitable initial conditions of the galaxies. The initial conditions assumed in the present work are:

The mass of NGC3769 = $1.5 \times 10^{10} M_{\text{sun}}$ and the halo radius=5.5kpc, while the mass of its companion NGC3769A = $0.5 \times 10^{10} M_{\text{sun}}$ and the halo radius= 1.94kpc. , the distance between the two galaxies=13kpc., and the inclination which is the angle that the orbital plane of NGC 3769 galaxy makes with the rotation plane of NGC3769A galaxy = 60° .

III. RESULTS AND DISCUSSION

Figure 2 (a, b, and c) shows the two galaxies NGC 3769 and its companion NGC 3769A affected on each other because of the gravitational force between them. In fig.1a, which represents the time ($t=100$ Myrs.) of the attraction between the two galaxies, at time ($t=150$ Myrs.) as shown in fig.1b it is shown that how the companion galaxy is attracted by the main galaxy. In fig.1c which represents the time ($t=250$ Myrs.) it is clear that the companion galaxy moves more and more towards the main galaxy.

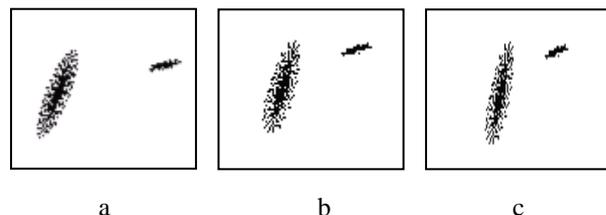


Fig.2: the main galaxy and its companion at:
a=100Myrs. b=150Myrs. c=250Myrs.

In fig.3 (a, b, and c) it is shown that the component passes in front of the main galaxy until it situates the south east of it. Figure 3a represents the time (t=300Myrs.) at which the companion galaxy began to move in front of the main galaxy, and the two galaxies are enough far from each other that cannot merge. In fig.3b, the companion appears in the other side of the main galaxy at time (t=350 Myrs.). In fig.3c the companion appears in the south east of the main galaxy at time (t=450 Myrs.).

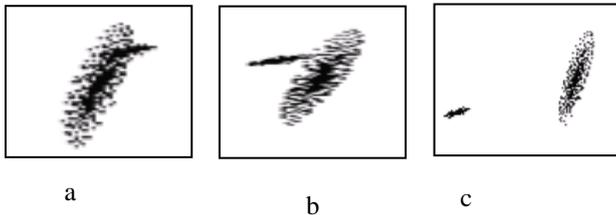


Fig.3: the main galaxy and its companion at: a=300Myrs. b=350Myrs. c=450Myrs.

In fig.4 (a, b, and c) it is shown that the companion moves gradually toward the main galaxy because of the attraction force between them. Fig.4a shows the beginning of moving the companion galaxy toward the main galaxy at time (t= 600Myrs.). Figure 4b which represents the interaction between the two galaxies at time (t=850Myrs.) which is in a good agreement with the image of the two galaxies observed by telescopes. In fig 4c, the companion galaxy is shown at time (t=1000 Myrs.) at which the companion galaxy moves in front of the main galaxy toward the other side.

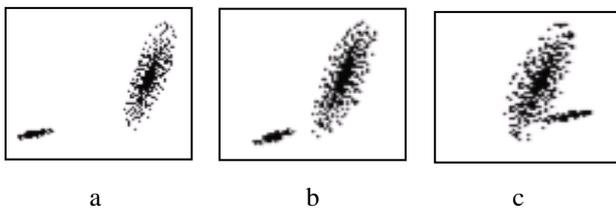


Fig.4: the main galaxy and its companion at: a=600Myrs. b=850Myrs. c=1000Myrs.

Figure 5(a, b, and c) shows different epochs of the interaction between the two galaxies after the companion passes in front of the main galaxy. In fig.5a the companion galaxy is shown at the snapshot of the simulation at time (t=1250Myrs.) at which it moves under the influence of the gravity to the upward in the left side of the main galaxy , while in fig.5b which represent the time(t=1300Myrs.) the companion appears in a continuous moving upward . In fig 5c at time (t=1600Myrs.) it is clear that the companion galaxy begins to go toward the main galaxy to repeat moving around the main galaxy.

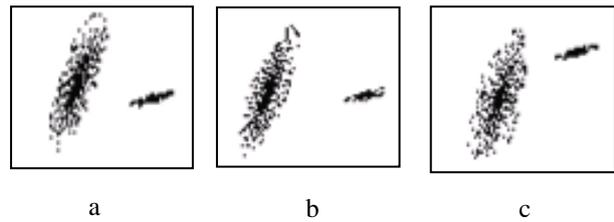


Fig.4: the main galaxy and its companion at: a=1250Myrs. b=1300Myrs. c=1600Myrs.

IV. CONCLUSION

From simulating NGC 3769 and its companion NGC 3769A, this paper concluded that the companion galaxy moves around the main galaxy under the influence of the attraction force. At time (t=850Myrs.) the snapshot of the simulation is in good agreements with the image of the two galaxies captured by telescopes. The paper also discovered that the IGMS code is suitable for describing the history of the interaction between the two galaxies, and the initial conditions assumed for the two galaxies are suitable for obtaining the situation of the two galaxies with each other in the present day.

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