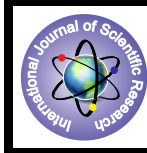


Study of Interacted Galaxies arp 97



Astronomy

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ABSTRACT

In the present work, the interaction of galaxies Arp 97 is studied by simulating the components of this system of the galaxies. In the simulation IGMS code is used for understanding the construction that explains how the two galaxies of the system affect each other. Through the simulation it is shown that how the arms of the southern galaxy are constructed. The image which is taken from the Hale telescope is in a good agreement with the snapshot of the shape of this peculiar galaxy that was obtained from the simulation at $t=400\text{ Myr}$.

INTRODUCTION

The interactions between galaxies are important events in astronomy because they give other types of galaxies. Arp classified 338 of these peculiar galaxies in his atlas (Arp 1966). The mutual interactions that include tidal distortion by gravity and transferring of mass between the interacted galaxies are important in developing these galaxies. As a result of the interactions arms may construct through these interactions.

The early explanation of the dynamic of galactic arms (Toomer & Toomer 1972) gives a better understanding of this type of galaxies. Since the kinematics of the interaction especially in internal disk which causes perturbation of the disc is a difficult process, therefore, the disturbances of interacting galaxies play the main role in reshaping galaxies (Hunter & Toomre 1969, White 1978; Schwarz 1985, Struck 1999; Alonso et al. 2004; Woods & Geller 2007; Darg et al. 2010; Stierwalt et al. 2014).

Arp 97 (MGC+5-29-10/-11/-12) is one of the peculiar galaxies which consists of just two interacting galaxies, MGC+5-29-10 and MGC+5-29-11 that classified in Arp atlas.

From Arp's image with the 200" Hale Telescope it becomes clear that the southern galaxy **MGC+5-29-11** which is a spiral type has two arms, the lower arm has a tidal of arced shape, meanwhile the upper arm seems as a bridge with the northern galaxy **MGC+5-29-10** which is an elliptical galaxy as shown in fig.1.

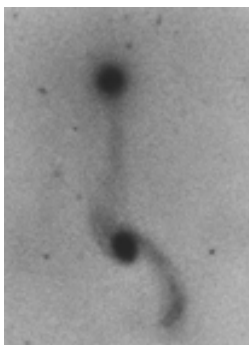


Fig.1: The image of Arp 97 with the 200" Hale Telescope.

Many Arp galaxies are simulated for understanding their properties (Miskolczi 2011; Torrey et al. 2012, Patton et al. 2013, Ji et al. 2014).

METHOD

From the first computer simulation of interacted galaxies (Toomer & Toomer 1972), the codes made are able to explain many of the ongoing interactions between observed galaxies, and this allows us better understanding of the kinematics of abnormal galaxies.

There are several models for simulating the interacted galaxies (Perly, 2000, Springle 2005 I, Karl et al. 2010). Some of the simulations show how the features of the systems like the tidal tail, form and evolve during the interaction.

In the present work the Intergalactic Gravitational Motion Simulator-IGMS code (Perly, 2000) is used for simulating galaxy pair Arp 97 IGMS code which depends on N-body technique is suitable for explaining the interaction of the two galaxies. The code based on Newton's law of gravitation and other classical laws of motion.

The initial conditions that assumed for simulating the two interacted galaxies in the present work are: For the small galaxy, the halo radius = 3.26 kpc. While for the big galaxy the halo radius = 8.1 kpc. The inclination which is the angle that the orbital plane of the small galaxy makes with the rotation plane of the big galaxy = 45° . The distance between the two centers of the two galaxies = 21 kpc and the eccentricity = 0.5.

RESULTS AND DISCUSSION

Figure 2 represents the time ($t=0$) of the beginning of the interaction between the two galaxies. The two galaxies are in the beginning of interaction, the rings and the particles which represent gas and stars are distributed on the rings of the two galaxies.



Fig.2: The two interacted galaxies at $t=0$.

In fig.3 at time ($t=50\text{ Myr}$), the disturbance appears slightly in the disk of the two galaxies. In this stage the gravitational force begins to affect between the two galaxies because of their motions toward each other.



Fig.3: The two interacted galaxies at $t=50\text{ Myr}$.

At time ($t=100\text{Myr.}$) the disturbance of the outer rings of the big galaxy appears clearly as shown in fig.4.



Fig.4: The two interacted galaxies at $t=100\text{ Myr.}$

At time ($t=150\text{Myr.}$) the disturbance of the outer rings of the big galaxy appears clearly which is the start of constructing an arm near the other galaxy first, as shown in fig.5.



Fig.5: The two interacted galaxies at $t=150\text{Myr.}$

Figure 6 shows the interaction of the two galaxies at time ($t=200\text{Myr.}$). In this case the upper arm of the southern galaxy has constructed more than the lower arm because the particles of the southern galaxy in the upper edge are nearer than the other particles.



Fig.6: The two interacted galaxies at $t=200\text{Myr.}$

In fig.7 of the simulation which indicates the time ($t=250\text{Myr.}$) constructing the lower arm of the southern arm is appeared slightly while the upper arm strengthens more.



Fig.7: The two interacted galaxies at $t=250\text{Myr.}$

In fig.8 the snapshot of the simulation at time ($t=300\text{Myr.}$) is shown. The simulation shows that the upper arm strength more and extended to the northern galaxy, while the lower arm arced more.



Fig.8: The two interacted galaxies at $t=300\text{Myr.}$

Figure 9 shows the peculiar galaxy at time ($t=400\text{Myr.}$) is constructed. The galaxy MGC+5-29-10 is in the northern, While the galaxy MGC+5-29-11 is in the south with two arms.

So At time ($t=400\text{Myr.}$) the two interacted galaxies appeared very clearly so the peculiar galaxy which classified by (Arp 1966) as Arp97 is constructed as a result of interacting of the two galaxies. The snapshot of our simulation in this stage of interaction is in good agreements with the images of taken by telescopes.



Fig.9: Arp 97

CONCLUSION

In the present work the galaxy pair Arp 97 is simulated, and the simulation explained that the Arp 97 galaxy is constructed as a result of interacting two galaxies during 400 Myr. Through the interaction between the two galaxies appeared that the two tidal arms have been constructed from the southern galaxy as a result of rotating and gravitational force. The upper arm strengthens toward the companion in the north, and appears as a bridge with it, while the lower arm took the shape of arc. The image which is taken from Hale telescope is in good agreement with the snapshot of the morphology of this peculiar galaxy obtained from the simulation at time

$t= 400\text{Myr.}$

REFERENCE

- Alonso, M. S., Tissera, P. B., Coldwell, G., & Lambas, D. G. 2004, MNRAS, 352, 1081. [Arp H., 1966, Atlas of Peculiar Galaxies, ApJS 14, 1.] Darg, D. W., et al. 2010, MNRAS, 401, 1552. [Hunter C., Toomre A., 1969, ApJ 155, 747.] Ji, L., Peirani, S., & Yi, S. K. 2014, A&A. [Karl, S. J., Naab, T., Johansson, P. H., Kotarba, H., Boily, C. | M., Renaud, F., & Theis, C. 2010, ApJ, 715, L88.] Miskolczi, A., Dominik J. Bomans, and Ralf-Jürgen DettmararXiv:1102.2905v2 [astro-ph.GA] 26 Sep 2011. [Patton, D. R., Torrey, P., Ellison, S. L., Mendel, J. T., & Scudder, J. M. 2013, MNRAS, 433, L59.] Perley, D., 2000, Tidal structure in interacting galaxies Phase II, research report. Schwarz U. J., 1985, A&A 142, 273. [Springle, V., 2005, MNRAS, 364, 1105-1134.] Stierwalt, S., Besla, G., Patton, D., Johnson, K., Kallivayalil, N., Putman, M., Privon, G., & Ross, G. 2014. [Struck, C. 1999, Phys. Rep., 321, 1. [Toomer, A. and Toomer, J., The Astrophysical Journal, 1972, 178, 623-666.] Torrey, P., Cox, T. J., Kewley, L., & Hernquist, L. 2012, ApJ, 746, 108]. White, S. D. M. 1978, MNRAS, 184, 185. Woods, D. F., & Geller, M. J. 2007, AJ, 134, 527.]