SF2A 2009
M. Heydari-Malayeri, C. Reylé and R. Samadi (eds)

COSMOLOGICAL SIMULATIONS AND GALAXY FORMATION: APPLICATIONS TO GIRAFFE

Peirani, S.[1], Hammer, F.[2], Flores, H.[2], Yang, Y.[2] and Athanassoula, E.[3]

Abstract. We compare the morphological and kinematic properties of massive galaxies at z=0.4-0.75 obtained by the GIRAFFE spectrograph, to those derived from the merger of two spiral galaxies described by N-body simulations, including a star formation prescription. The study of these systems is particularly interesting to the understanding of the connection between mergers and bars, as well as the properties and fate of this system in relation to disk galaxy formation.

1 Observations

The VLT large program entitled IMAGES ("Intermediate-Mass Galaxy Evolution Sequence", Yang et al. 2008) is gathering high quality kinematics for a representative sample of ~ 100 massive galaxies at $z = 0.4 - 0.75$ and with $MJ(AB) \leq -20.3$. Using the GIRAFFE spectrograph at the VLT, the kinematic properties of 65 of these galaxies, for instance J033239.72-275154.7, a galaxy we study here, have been derived.

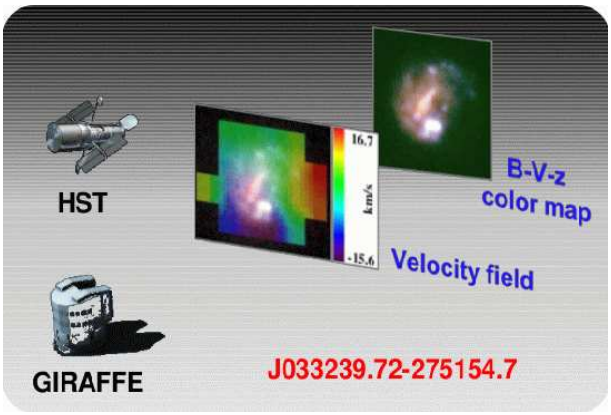

Fig. 1. Sketch of the observations of J033239.72-275154.7 through The HST and the GIRAFFE spectrograph.

This galaxy lies at $z = 0.41$, has a stellar mass of $2.0 \times 10^{10} M_{\odot}$, a K-band magnitude of $M_K = -20.94$ and its center is dominated by an elongated structure, most likely a giant thin bar of semi-major axis 6 kpc. This bar is embedded within a diffuse region, which is probably a disk. At the bottom of the galaxy, there are two bright adjacent knots, which dominate the rest-frame UV light. And have the color of a pure starburst. The velocity field (VF) is obviously complex since the kinematical major axis is almost parallel to the bar and it is offset by more than one GIRAFFE pixel from the bulge, towards the prominent blue knots (in the bottom).

Could merging of the two bright knots with J033239.72-275154.7 be compatible with the formation of a giant bar with a relatively blue color? It's what we propose to investigate with a numerical study.

[1] Institut d'Astrophysique de Paris, 98 bis Bd Arago, 75014 Paris, France -
Unité mixte de recherche 7095 CNRS - Université Pierre et Marie Curie.
[2] GEPI, Observatoire de Paris, CNRS, University Paris Diderot, 5 place Jules Janssen, 92190 Meudon, France
[3] LAM, UMR6110, CNRS/Université de Provence, Technopôle de Marseille-Etoile, 38 rue Frédéric Joliot Curie, 13388 Marseille Cédex 20, France

2 Numerical Simulations and results

We use idealized hydrodynamical N-body simulations of the merger of two spiral galaxies using the code GADGET2 (Springel et al. 2005) with added prescriptions for cooling, star formation and feedback from Type Ia and II supernovae.

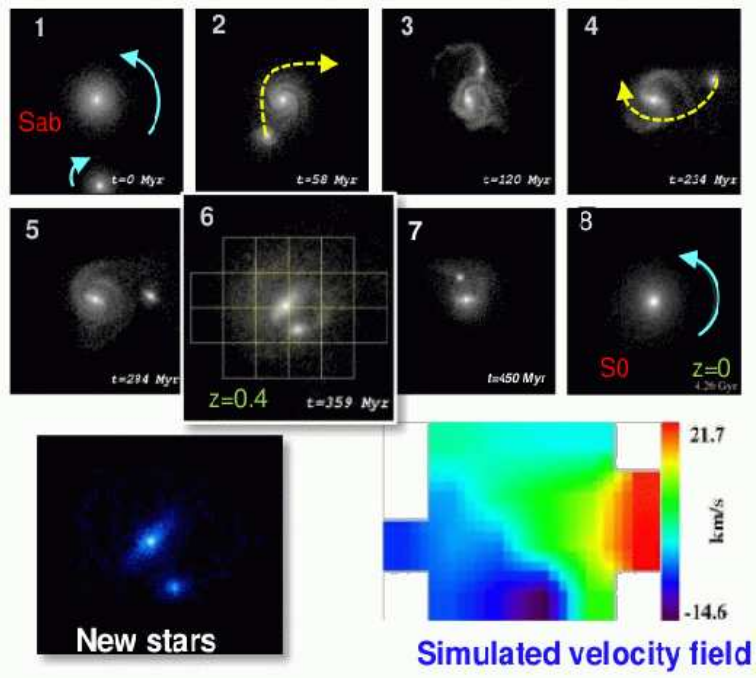

Fig. 2. Time evolution of the projected star number density. The light blue arrows indicate the specific rotation of each galaxy, while the yellow dashed lines show the motion of the satellite. In panel 6, we superposed the GIRAFFE grid. Each frame is 40 kpc × 40 kpc in size. The lower left panel shows the projected distribution of newly formed stars at $t = 0.36$ Gyr whereas the lower right panel shows the simulated velocity field.

In Peirani et al. 2008, we found that the general morphological shape and most of the dynamical properties of the object can be well reproduced by a model in which the satellite is initially put in a retrograde orbit and the mass ratio of the system is 1:3. In such a scenario, a bar forms in the host galaxy after the first passage of the satellite where an important fraction of available gas is consumed in an induced burst. In its later evolution, however, we find that J033239.72-275154.7, whose major progenitor was an Sab galaxy, will probably become a S0 galaxy. This is mainly due to the violent relaxation and the angular momentum loss experienced by the host galaxy during the merger process, which is caused by the adopted orbital parameters.

This result suggests that the building of the Hubble sequence is significantly influenced by the last major collision. In the present case, the merger leads to a severe damage of the disk of the progenitor, leading to an evolution towards a more bulge dominated galaxy. The main objective is now to extend this kind of analysis to the whole sample of galaxies observed in order to compare with closer galaxies and draw a complete picture of the evolution of galaxies over the past six to eight billions years, that is, over half the age of the Universe.

References

Peirani, S., Hammer, F., Flores, H., Yang, Y., & Athanassoula, E. 2009, A&A, 496, 51
Springel, V. 2005, MNRAS, 364, 1105
Yang, Y., et al. 2008, A&A, 477, 789