Cosmological simulations and galaxy formation: applications to GIRAFFE

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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 these systems in relation to disk galaxy formation.

Observations:

### - The VLT large program « IMAGES »

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 $M_J(AB) \leq -20.3$. 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.

- General properties of J033239.72-275154.7

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).

- A giant bar induced by a merger event at z=0.4?

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.

HST

GIRAFFE

B-V-z color map

Velocity field

J033239.72-275154.7
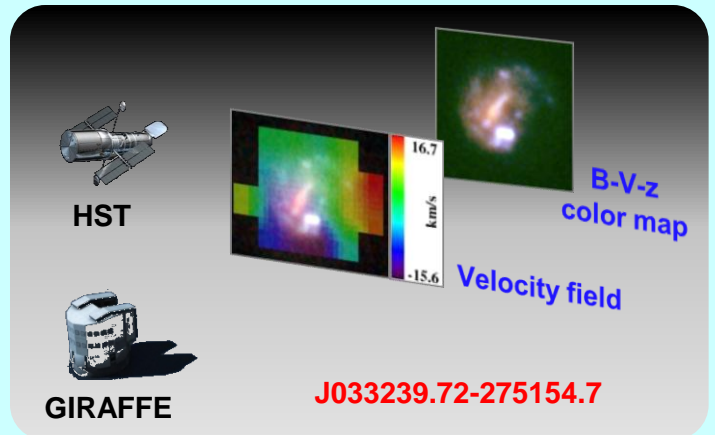
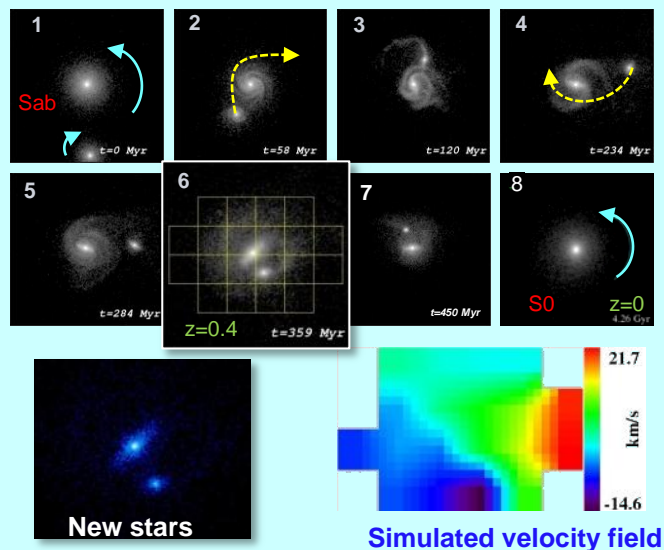## Simulations:

- Numerical method

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.

- Results

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.

- Conclusions and perspectives

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.

1 Sab   t=0 Myr
2   t=58 Myr
3   t=120 Myr
4   t=234 Myr
5   t=284 Myr
6 z=0.4   t=359 Myr
7   t=450 Myr
8 S0   z=0   4.26 Gyr

New stars

Simulated velocity field

References:
- Peirani et al. 2009, A&A, 496, 51, « A giant bar induced by a merger event at z=0.4 ? »
- ESO press release, march 2009, « Hubble and ESO's VLT provide unique 3D views of remote galaxies »
- see also : Puech et al. 2009, A&A, 493, 899 - Hammer et al. 2009, A&A, 496, 381