The formation of boxy/peanut bulges in young stellar discs

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Goals & Results

We have made N-body simulations with and without a gaseous component, and star formation/feedback recipes, to shed some light on the conditions under which boxy and peanut-shaped (B/PS) bulges form in chemodynamical simulations.

In our pure N-body collisionless simulations, like in many previous studies, the B/PS is due to the classical break in the z-mirror symmetry. Initially *asymmetrical* with respect to the equatorial plane, the bar finally tends towards *symmetry* with a timescale of roughly a Gyr .

When a gaseous component and star formation recipes are added to the simulations, the bulge growing mechanism is quite different from pure N-body ones. The young stellar population that is born in the thin gaseous disc, rapidly populates vertical resonant orbits triggered by the combined effects of the horizontal and vertical ILRs. A B/PS bulge, made of a young stellar population, grows *symmetrically*.

The morphology and extent of young B/PS bulges are significantly different from the classical B/PS bulge. Such young B/PS bulges might be difficult to detect. Using Bruzual & Charlot (2003 release) synthesis population models, we have calibrated our chemodynamical simulations and produced mock images in B and V bands. We show that young B/PS bulges could be found thanks to the colour of their stellar population.

We predict that two populations of B/PS bulges could exist and even coexist in the same galaxy.

Simulations

(simple) Chemodynamical simulations

- N-body = PM scheme
- hydro = SPH
- star formation (instantaneous):
  - λ=1.4 (Kennicutt 1990)
  - SFE = 0.1
  - creation of new stellar particles (remnants)
- feedback (instantaneous recycling):
  - SNII
  - mechanical fraction of energy = 0.1
- Maeder's yields (1992) → metallicities
- cooling with solar abundances (Bohringer & Hensler 1989)

$$Q_i^g = \frac{s_i \kappa_i}{\pi G \Sigma_i^g} \leq \lambda$$

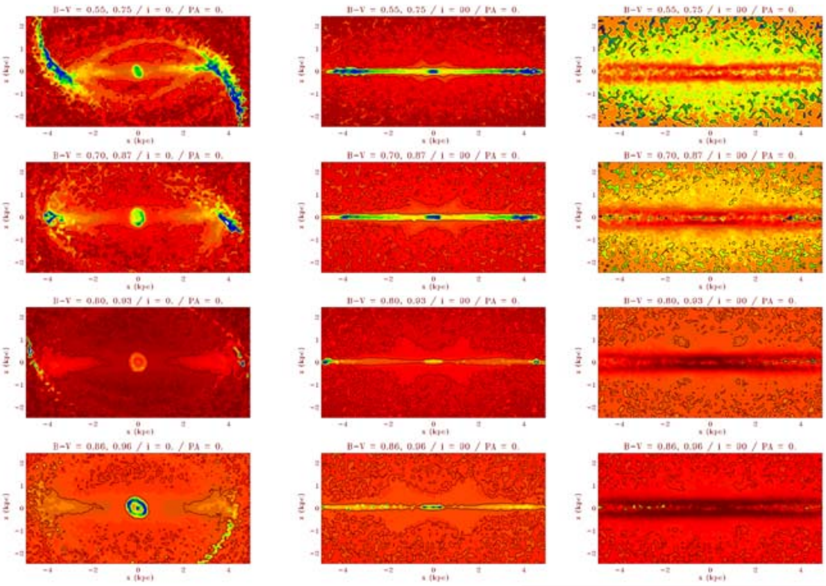
Simulations parameters & calibration

- 5-6 10^5 stellar particles (initial pop.) → ~ 1.2 10^6 at the end
- 1-5 10^4 SPH particles
- $M_g / M_\star \sim 0.1 - 0.3$
- initial disc scalelengths : 3.5 to 5.5 kpc
- initial disc scaleheights: 0.5 to 1 kpc
- Photometric calibration
  - SSP from Bruzual & Charlot (2000 release)
  - Salpeter IMF 0.1 to 100 $M_\odot$
  - Z of initial stellar pop = 0.004
  - initial age (4.4 to 10.4 Gyr) leads to z=0 at the end of the simulation

Calibrated simulations (B-V colour maps)

Face-on dust free | Edge-on dust free | Edge-on dusty

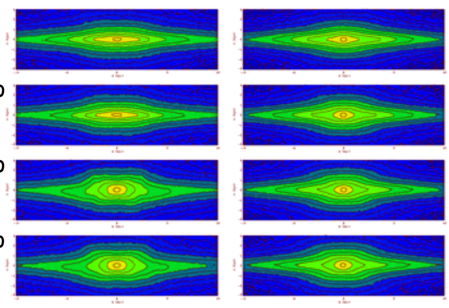
600 Myr
1000 Myr
1500 Myr
2000 Myr



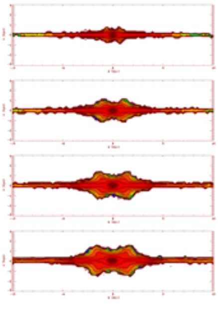
Mass distribution

pure N-body simulation | chemodynamical simulation (initial population only)

600 Myr
1000 Myr
1500 Myr
2000 Myr

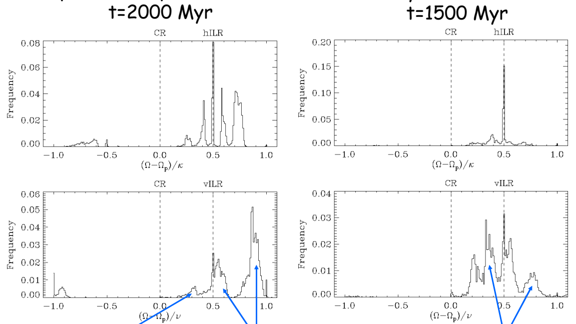


chemodynamical simulation (young population only)

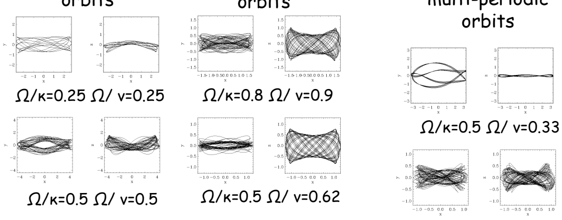


Resonances (work in progress)

pure N-body simulation t=2000 Myr | chemodynamical simulation t=1500 Myr



Asymmetrical orbits | Symmetrical orbits | Symmetrical multi-periodic orbits



Ω/κ=0.25 Ω/ ν=0.25
Ω/κ=0.8 Ω/ ν=0.9
Ω/κ=0.5 Ω/ ν=0.33
Ω/κ=0.5 Ω/ ν=0.5
Ω/κ=0.5 Ω/ ν=0.62
Ω/κ=0.7 Ω/ ν=0.8

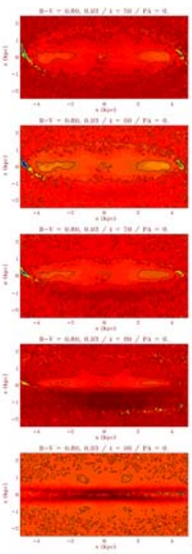
References

Wozniak H., Michel-Dansac L., 2007 MNRAS submitted (dynamical linear analysis)
Michel L., Dansac L., 2007 A&A submitted (detectability with colour maps)
Wozniak H., Michel-Dansac L., 2007 MNRAS in preparation (dynamical non-linear analysis)

Viewing angle effects

Inclination with dust

i=50°
i=60°
i=70°
i=80°
i=90°



Position-angle dust free | Position-angle with dust