Anti-truncated stellar discs resulting from major mergers

Alejandro Borlaff[1,4,5], M. Carmen Eliche-Moral[1], Cristina Rodríguez-Pérez[1], Miguel Querejeta[2], Trinidad Tapia[3], Pablo G. Pérez-González[1], Jaime Zamorano[1], Jesús Gallego[1], and John Beckman[4,5,6]

[1]Universidad Complutense de Madrid (Spain), [2]Max-Planck-Institut für Astronomie (Germany), [3]Instituto de Astronomía, UNAM (Mexico), [4]Instituto de Astrofísica de Canarias (Spain), [5]Universidad de La Laguna (Spain), [6]CSIC (Spain)

1 - Abstract

Lenticular galaxies (S0s) are more likely to host anti-truncated (Type III) stellar discs than galaxies of later Hubble types. Major mergers are popularly considered too violent to make these breaks. **We have analysed N-body simulations of major mergers in order to investigate if major mergers can result into S0-like remnants with anti-truncated stellar discs.**

Major mergers that result in S0s have a high probability of producing Type III stellar discs ($\sim$ **70%**) and may provide a feasible mechanism to form realistic anti-truncated S0 galaxies.

2 - Objectives, methods and sample

We have analysed 67 relaxed S0 - E/S0 remnants from dissipative N-body simulations of major mergers from the public available GalMer database [2].

We simulated realistic *R*-band images and surface brightness profiles of the remnants to identify those with anti-truncated stellar discs. Their inner and outer discs and the breaks have been quantitatively compared with real data. We compared with data published in the R band ([3],[4]). We transform the mass-density profiles to R band by using the stellar synthesis population models [5] and evolutionary models for the old stellar particles [6]. Typical observational conditions of current surveys have also been reproduced (seeing, limiting magnitude), as well as the methodology used by observers for the analysis of the surface brightness profiles.

3 - Simulated Type III stellar disc profiles

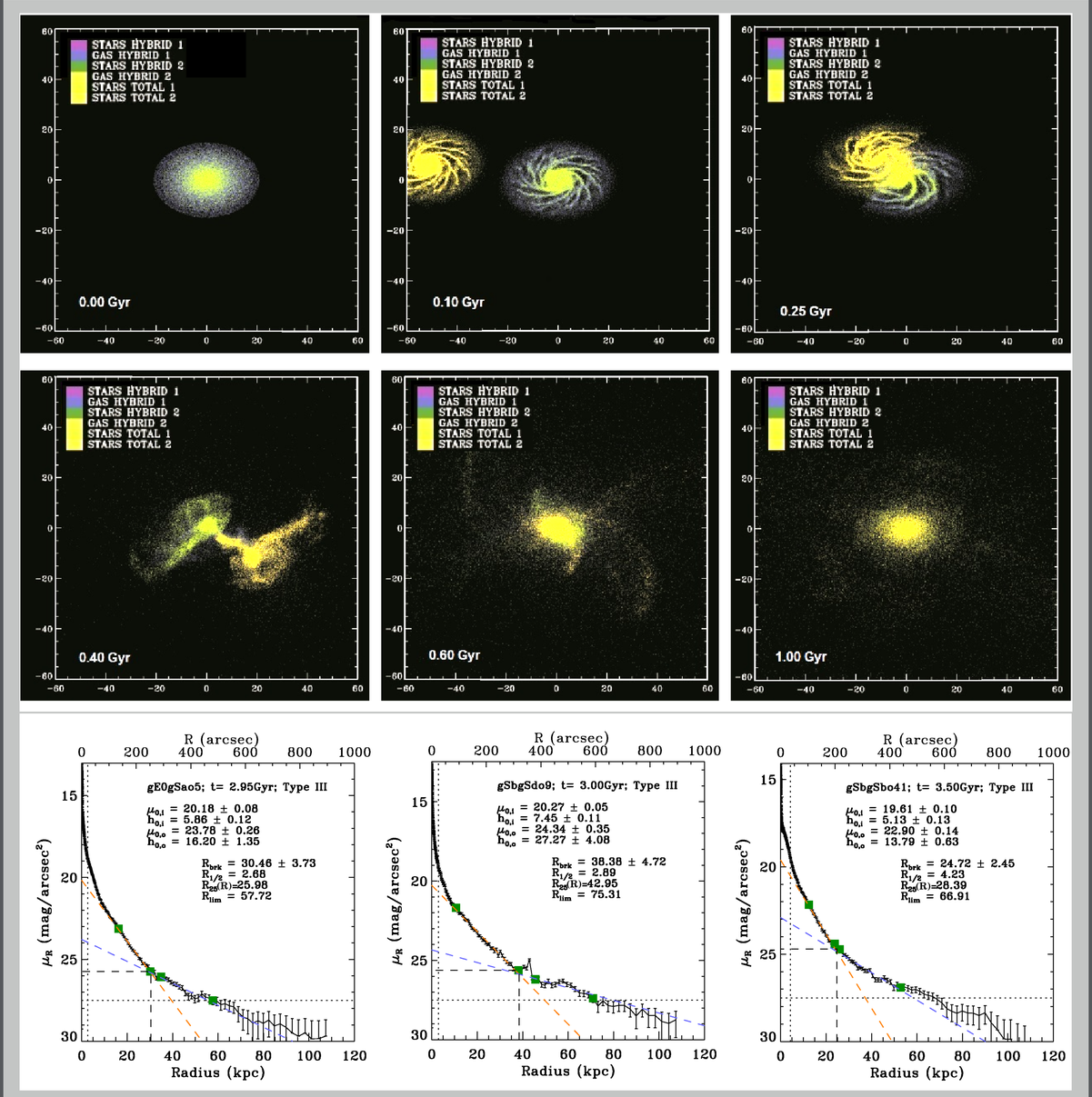

Figure 1: **Upper panels:** Time evolution of the baryonic material in a merger model (gSdgSdo23) Time is given in the bottom left corner of each frame. **Lower panels:** R-band Surface brightness profile for 3 different models. Dashed lines show the linear fits performed to data within the selected radial limits (green squares) of the inner and outer discs, respectively. The photometric parameters of the breaks and the inner and outer discs are shown in each panel.

5 - Conclusions

- 47 of 67 major merger models which ended in E/S0 or S0 type present anti-truncated stellar profiles by the end of the simulation.
- The characteristic parameters of the inner and outer profiles reproduce the ranges and trends observed on real Type III S0 galaxies.
- **Major mergers are a feasible mechanism to produce realistic anti-truncated stellar discs in the case of resulting into S0-like remnants.**

4 - Results

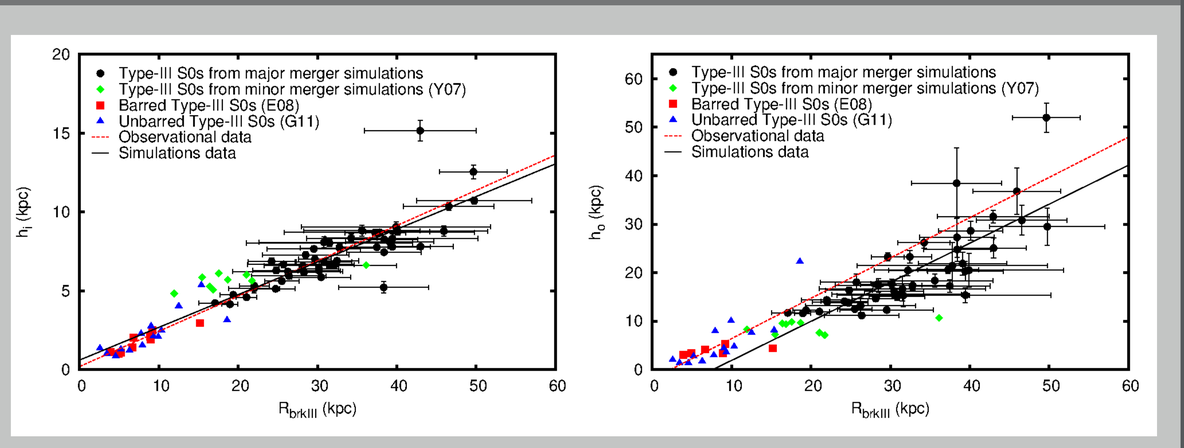

Figure 2: R-band scale-lengths of the inner and outer discs vs. $R_{\rm brkIII}$ for our Type III S0-like remnants, compared to those of real Type III S0 galaxies from [3] and [4] (left and right panels, respectively). The simulated galaxies present higher values of the scale-lengths than real galaxies because they only account for major mergers between giant galaxies. See the legend in the figure.

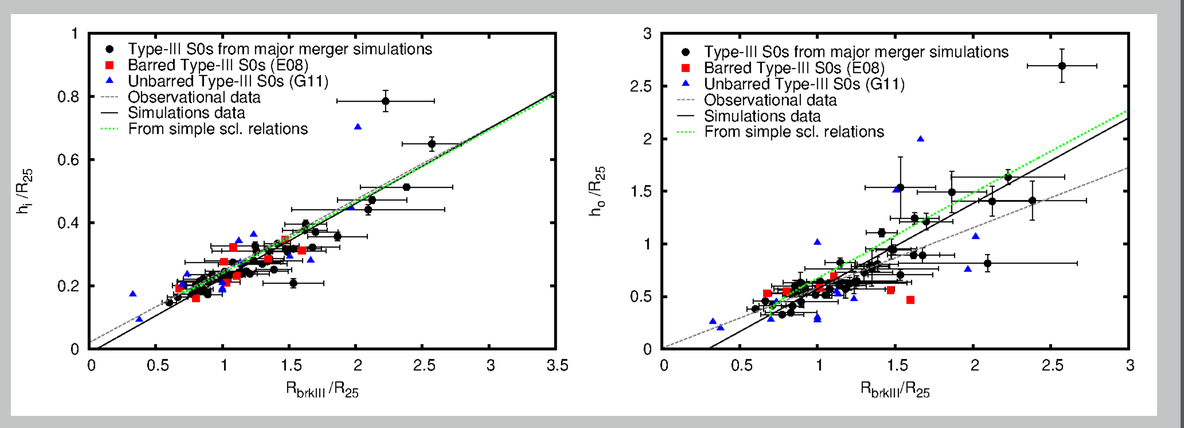

Figure 3: Photometric scaling relations of the scale-lengths of the inner and outer discs with $R_{\rm brkIII}$, now normalized to the optical radius of the galaxy (R_{25}), for our Type III S0-like remnants and real Type III S0 galaxies ([3]; [4]). Note the remarkable agreement between the simulated and observational samples once we take into account the relative size of the galaxy in the trends. Consult the legend in the figure.

We have found that (see Borlaff et al. 2014, [1]):

- Nearly **70%** of the relaxed S0-like remnants in our sample of simulations have clear anti-truncated stellar discs.
- The photometric parameters of the breaks and of the inner and outer discs are compatible with those observed in real Type III S0 galaxies in multiple photometric planes. We only show the $h_{\rm i} - R_{\rm brkIII}$ and $h_{\rm o} - R_{\rm brkIII}$ relations in Figs. 2 and 3. You can see more photometric planes in [1].
- We find strong photometric scaling relations between the parameters of the breaks and of their inner and outer discs in real anti-truncated S0s. These scaling relations imply that the structures of the inner and outer discs in anti-truncated S0s are strongly linked.
- We also find that the scaling relations, trends, and distributions of real Type III S0s in all photometric planes can be predicted from just three basic scaling relations: $h_{\rm i} \propto R_{\rm brkIII}$, $h_{\rm o} \propto R_{\rm brkIII}$, and $\mu_{\rm brkIII} \propto R_{\rm brkIII}$. The Type III S0-like remnants resulting from our major merger simulations reproduce the distributions, trends, and scaling relations of real anti-truncated S0s in all photometric planes analysed.
- We also find that the existence of bars in real Type III S0s does not affect the photometric trends of the anti-truncations. This, and further analysis over different morphological types are presented on Eliche-Moral *et al.* (2015)[7] (see Eliche-Moral et al., EWASS poster SP16.4).

6 - References

[1] Borlaff *et al.* (2014) *A&A* **570**, A103.
[2] Chilingarian *et al.* (2010) *A&A* **518**, A61.
[3] Erwin *et al.* (2008) *AJ* **135**, 20–54.
[4] Gutiérrez *et al.* (2011) *AJ* **142**, 145.
[5] Bruzual *et al.* (2003) *MNRAS* **344**, 1000–1028.
[6] Eliche-Moral *et al.* (2010) *A&A* **519**, A55.
[7] Eliche-Moral *et al.* (2015) *ArXiv 1505.04797*.

Contact Information

Please ask me any question!

- Alejandro Borlaff
- Email: asborlaff@ucm.es / asborlaff@iac.es
- Instituto de Astrofsica de Canarias