Gas-rich minor mergers and S0 galaxies

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Abstract

A significant percentage (~20 %) of S0 galaxies show hints of rejuvenation, such as prominent outer rings in ultraviolet imaging. Their origin is still debated, and might be connected with secular evolution (e.g. bar instability) or/and with environmental effects (e.g. gas refuelling or minor mergers). I discuss the results of recent Nbody/SPH simulations of minor mergers involving a S0 galaxy and a gas-rich dwarf galaxy. I show that minor mergers can drive the formation of inner and outer star-forming rings in S0 galaxies.

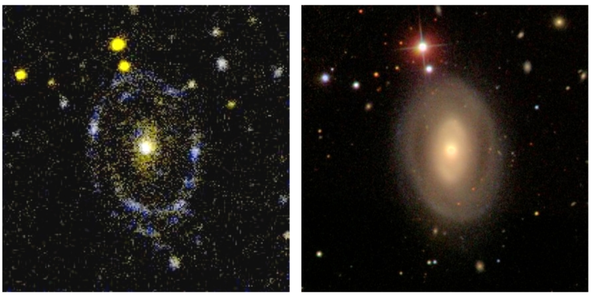


Fig. 1: Left panel: GALEX NUV-FUV image of NGC 2962; right panel: SDSS *g-r-i* image of the same galaxy (from Marino et al. 2011, see also Kannappan 2009; Salim & Rich 2010).

Many nearby S0 galaxies, especially in galaxy groups, show (inner and outer) rings with active star formation (Fig. 1). Here we investigate the hypothesis that such rings are produced by MINOR MERGERS (20:1) of a gas-less disc galaxy and a gas-rich intruder (Fig. 2). We made a suite of 30 N-body/SPH runs with different parameters (encounter speed, impact parameter, inclination angles).

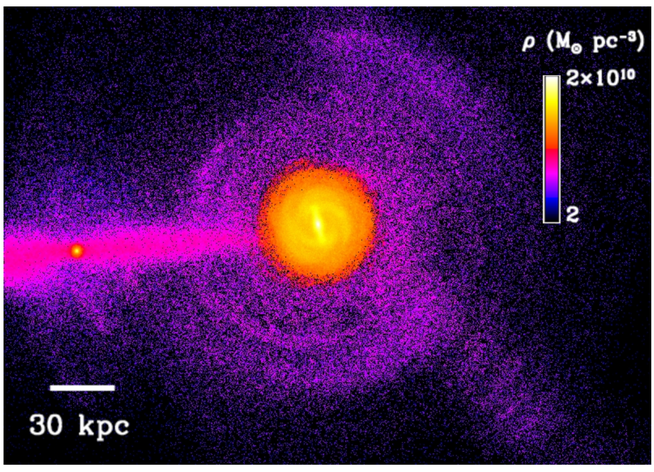


Fig. 2: Stellar density of the target and the intruder galaxy 3 Gyr after the first pericentre passage of the intruder. Note the presence of shells and tides.

KEY RESULTS:

1) In all our simulations, the interaction induces the formation of a stellar BAR in the target galaxy (in the first Gyr after the first pericentre passage). The same model target galaxy evolved in isolation is stable against bar formation (Fig. 3).

2) In most simulations the gas stripped from the intruder ends up into a RING, whose radius and strength are connected with RESONANCES induced by the barred potential (Fig. 3 and Mapelli et al. 2012a, 2012b).

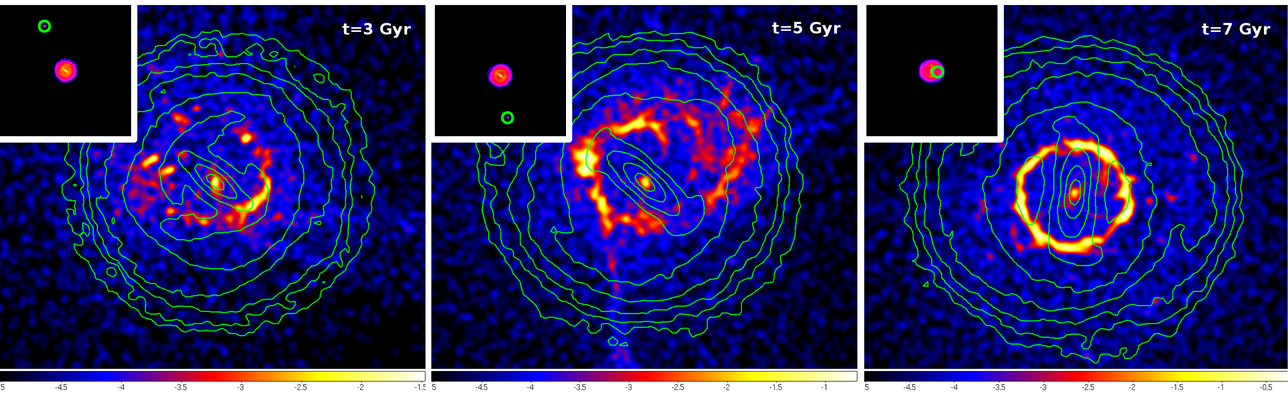


Fig. 3: Retrograde encounter with initial relative velocity V=200 km s^{-1}, impact parameter b=10 kpc, inclination angle $\alpha = 0$ (i.e. the orbital plane of the intruder is the plane of the target disc). From left to right: projected density map of gas 3, 5 and 7 Gyr after the first pericentre passage. The green contours show the projected density of stars (note the strong bar feature). Each panel measures 80x60 kpc.
The insert in each panel shows the stellar density map and measures 300 kpc per edge. The green circle in the inserts marks the position of the intruder galaxy.

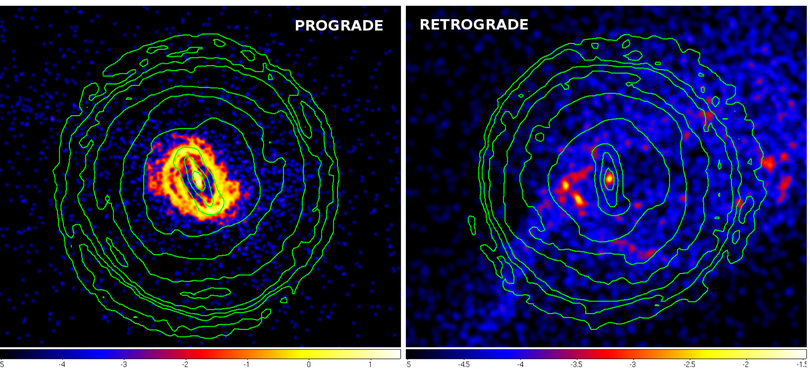


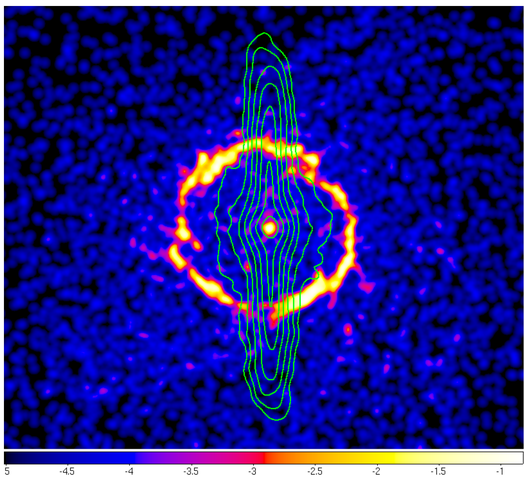
Fig. 4: Projected density map of gas in a prograde (left) and retrograde (right) encounter 2 Gyr after the first pericentre passage. The green contours show the projected density of stars. The encounter parameters are the same as in Fig. 3.

NOTE that in prograde encounters the ring forms before than in retrograde encounters (prograde encounters are more disruptive for intruders).

Fig. 5: Encounter with initial relative velocity V=200 km s^{-1}, impact parameter b=10 kpc, inclination angle $\alpha = 90°$ (i.e. the orbital plane of the intruder is perpendicular to the plane of the target disc). Projected density map of gas 4 Gyr after the first pericentre passage. The green contours show the projected density of stars.

NOTE that a POLAR RING can form if the intruder orbital plane is perpendicular to the target disc plane!

ALL THE GAS RINGS in our simulations (co-planar or polar) form stars at relatively low rate (<0.1 Msun yr^{-1}).



References:
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