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The history of star formation in galaxies. Insights from SPH simulations of triaxial collapsing systems

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Abstract. We performed smooth particle hydrodynamic (SPH) simulations including star formation and self-consistent chemo-photometric evolutionary population synthesis (EPS) predictions from far-UV to 1 mm, of isolated collapsing triaxial systems initially composed of dark matter (DM) and gas. The dependence of the system evolution on some parameters so far unexplored, such as its total mass, initial geometry, dynamical state and the effects of different baryonic to DM mass ratios have been investigated. We find important connections between dark and luminous matter.

Key words. galaxies: evolution – galaxies: halos

1. Introduction

The initial configuration, i.e. the density distribution, the spin parameter, λ (Barnes & Efstathiou 1987), the triaxiality ratio, τ of the halo as detached by the Hubble flow in a CDM scenario, are built up as described in Curir & Mazzei (1999); τ =0.58 is our fiducial value but also the effect of a slightly oblate halo (τ=0.45) and of a prolate halo (τ=0.84) has been investigated. Several simulations with the same value of λ, 0.058 our fiducial value, have been performed, however different values are also considered to give insight into the role of the dynamical state of the halo on the evolution of the baryonic matter. The initial number of particles ranges between 2000 to 20000 with $N_{DM} = N_{gas}$. The system is evolved up to 15 Gyr, the final number of particles ranges from 10000 to 200000 (Mazzei & Curir, in preparation).

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2. Results

By constraining the system to the same initial density, we find that the star formation rate (SFR) depends both on M_{tot} and on the dynamical state of the halo whose initial geometry influences the results further. For a given value of the M_{bar}/M_{tot} ratio, 0.1 our fiducial value, in the more massive halos the star formation (SF) onset arises before and the SFR achieves higher values than in the less massive ones (Fig.1a: M_{tot} = 500, dot-dashed line, M_{tot} = 20 dashed line, M_{tot} = 10 continuous line).

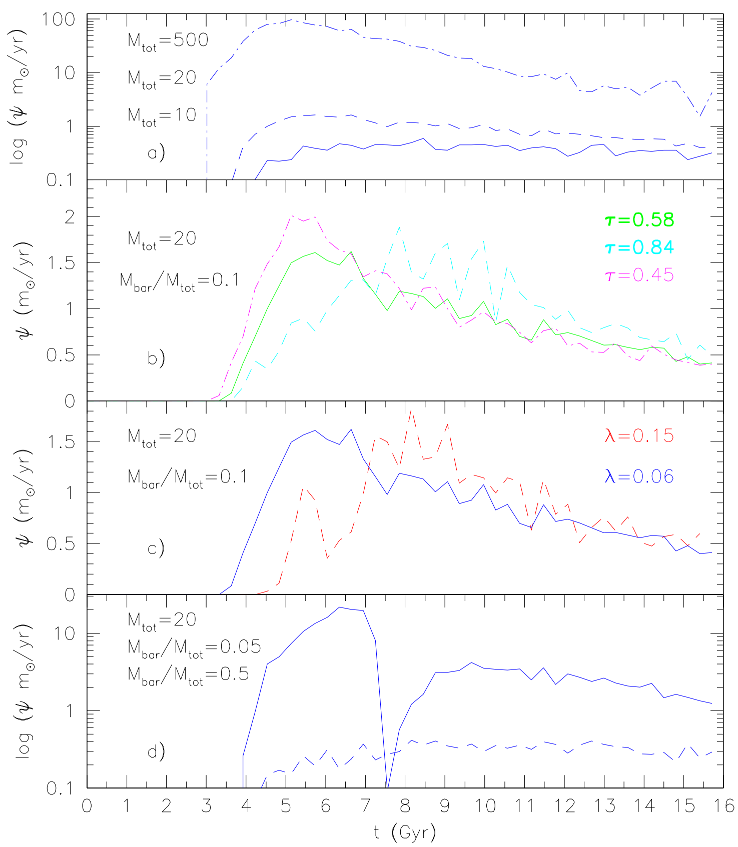

Fig. 1. Time behavior of the SFR, ψ, for systems with different initial properties (panels a, b and c; see text for more details) and different M_{bar}/M_{tot} ratios in panel d

Simulations with higher τ (Fig.1b: dashed line $\tau = 0.84$, dot–dashed line $\tau = 0.45$) and/or higher spin (Fig. 1c, $\lambda = 0.15$ dashed line) show a delayed onset of the SF which achieves lower values than in the fiducial case. Therefore inside prolate halos less favorable conditions to the SF occur. After 15 Gyr the more massive systems with fiducial M_{bar}/M_{tot} ratio are Elliptical like, the less massive ones are Spiral like as far as are concerned colors, luminosities, morphologies of stars as so as dynamical and physical properties of the residual gas. Moreover for a given M_{tot}, the lower the DM mass the stronger the burst of star formation (Fig.1 panel d) so that by increasing M_{bar}/M_{tot} the final galaxy properties are Elliptical like. Spiral galaxies arise only in systems with $M_{tot} \leq 10^{12}$ $M_\odot$ and require a short range of M_{bar}/M_{tot} values around 0.1. Thus we find that the properties of the whole system lead the SFR and the evolution of the baryonic matter.

References

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