CONTRIBUTED PAPERS

3D GAS DYNAMICS IN TRIAXIAL SYSTEMS

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1. INTRODUCTION

Depending on the nature of the various components (stars, gas) present in triaxial stellar systems (elliptical galaxies, bulges and bars), the dynamics is expected to be rather different. The stars are collisionless, dissipationless, and dynamically hot; they are mainly trapped by quasi-periodic or chaotic orbits. On the contrary, the gas is collisional, dissipational, and dynamically cold; the cold or warm gas ($\lesssim 10^4$ K) is a powerful orbital tracer, however shocks prevent it from following self-crossing orbits. The hot gas ($\gtrsim 10^6$ K) is influenced by "repulsive" pressure forces which prevent in close encounters the flow from being strongly shocked; it rather follows chaotic trajectories. By means of fully self-consistent 3D simulations with stars and gas using PM (Pfenniger & Friedli 1992) and SPH (Friedli & Benz 1992) techniques, we investigate the response of gaseous components in the following situations: 1) slow or fast pattern speed Ω_p, 2) direct or retrograde gas motion with respect to the stars, and 3) warm or hot gas temperature T. Initial parameters and final characteristics of each runs are reported in Table I.

TABLE I

For all models, the total mass $M_t = M_g + M_* = 2 \cdot 10^{11}\, M_\odot$, with M_g the gas mass and M_* the star mass. The number of gas and star particles are $N_g = 10^4$ and $N_* = 10^5$ respectively.

	Direct warm gas		Retrograde warm gas		Hot gas	
Rotation	Slow	Fast	Slow	Fast	Slow	Fast
Figures	1a-b	2a-b	–	3a-b	4a-b	–
$t_{\rm fig}$ [Myr]	400	1600	300	1200	1000	2000
$\Omega_{\rm p}$ [kms^{-1}kpc^{-1}]	5	28	7	22	5	20
$T_{\rm beg}$ [K] (center)	5000	5000	5000	5000	$2.5 \cdot 10^5$	$2.5 \cdot 10^5$
$T_{\rm end}$ [K] (center)	5000	5000	5000	5000	$7 \cdot 10^6$	$3 \cdot 10^6$
M_g/M_t	0.10	0.05	0.01	0.05	0.05	0.05

2. MAIN RESULTS

1) The warm gas is a tracer of the galaxies' gravitational potential and of its related resonances. Due to shocks, it cannot remain on self-crossing trajectories including (a) quasi-periodic or chaotic orbits, (b) periodic orbit families with loops, (c) different periodic orbit families devoid of loops but having mutually crossing orbits.
2) The warm gas is sensitive to vertical resonances associated with triaxial shapes. It can leave the galactic plane to follow 3D orbit families and can be found at large distances in z ($\gtrsim 1$ kpc). Its detection well above the galactic plane in nearly edge-on spiral galaxies will be a reliable observational test of the presence of a bar.

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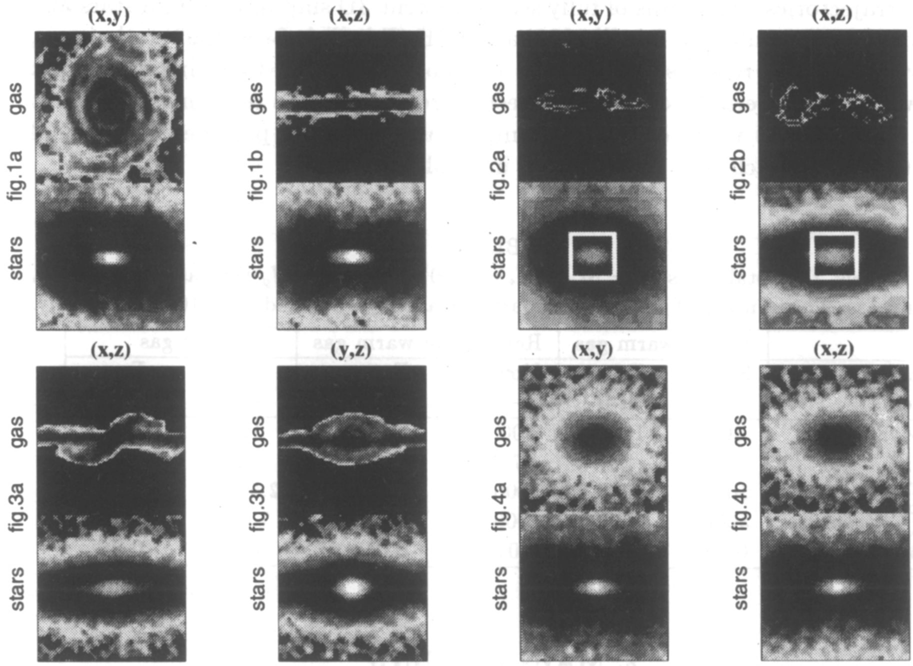
3) *Warm direct gas.* (a) Slow Ω_p: the gas will follow the x_2 family (A, associated to the ILR), more circular than the x_1 (B) family. Spiral arm features can be noticed. As predicted by Udry (1991), no vertical resonance appears on this family (Fig. 1). (b) Fast Ω_p: the gas will follow the x_1 family; Ω_p is too high to allow the presence of an ILR. Near the center, the gas can leave the galactic plane to follow the ABAN orbit family (2/1 vertical resonance; Pfenniger & Friedli 1991; Fig. 2).
Warm retrograde gas. (a) Slow Ω_p: at a given energy interval the gas will be trapped by one of the branches of the anomalous orbit families ANO_x or ANO_y (1/1 vertical resonance; Pfenniger & Friedli 1991) bifurcating from the retrograde plane x_4 (R) family which is depopulated. (b) Fast Ω_p: the gas will be trapped by one of the branches of the anomalous orbit families ANO_x (Fig. 3). This can explain the present distribution of inclined retrograde gas observed in some SB0 galaxies.
Hot gas. The contribution of the pressure forces is high and dominates the dynamics. The gravitational potential contributes only to the general (triaxial) shape of the gas density (Fig. 4) and hot gas is not sensible to the detail of the orbital structure.



Figs. 1–4. Gas and star projected density. Frames are 20 kpc wide except for the warm direct gas where they are 6 kpc wide (corresponding to the square in the star panel).

References

Friedli, D., Benz, W., 1992, A&A, in press
Pfenniger, D., Friedli, D., 1991, A&A 252, 75
Pfenniger, D., Friedli, D., 1992, A&A, (submitted)
Udry, S., 1991, A&A, 245, 99