DYNAMICAL HISTORY OF THE SOLAR NEIGHBOURHOOD

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INTRODUCTION

The dynamical evolution of the solar neighbourhood is des-
cribed by an accretion model in which the gas accretion rate decays
exponentially with time. Stars form at a rate proportional to
the local gas volume density and their velocity dispersion is
increased after birth by star-cloud collisions. The present mass
density distribution of stars and of gas perpendicular to the
galactic plane (Oort 1965) and the observed increase of stellar
velocity dispersion with age (Mayor 1974; Mayor and Martinet 1977)
are reproduced for an e-folding time of 3×10^9 y of the gas
accretion rate and a characteristic star formation time scale of
2.8×10^9 y.

MODEL

The model is identical to that discussed by Vader and de Jong
(1979) except for the treatment of the velocity dispersions of the
gas and the stars. A gas velocity dispersion
$\sigma_g = \max (6, 100 \exp(-t/2t_d)$ km s^{-1} is chosen to simulate the
initial collapse of the galactic disk on a free-fall time scale
$t_d = 1$ Gyr (Figure 2): energy considerations suggest that σ_g is
roughly constant thereafter. The stellar velocity dispersions
σ_s increase by star-cloud collisions (Spitzer and Schwarzschild
1953) according to:

$$d\sigma^2(t) = (2\pi G^2 M_c^2 n_c \ln\Lambda/\sigma_s) \, dt$$

where the product $M_c n_c$ of the cloud mass and number density is
proportional to g_0, the gas volume density in the galactic plane.
The high velocity dispersion of the old disk stars requires the
acceleration, and therefore g_0 (Figure 1),to have been larger
in the past and this in turn requires a rapidly decaying gas infall
rate. The total mass surface density has been adjusted so as to
reproduce the local density of 0.15 M$_\odot$pc^{-3} of gas and stars (Figure 3).

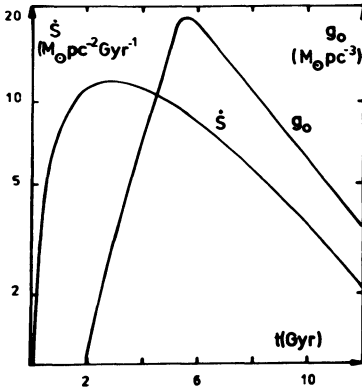FIG. 1. TOTAL STAR FORMATION RATE Ṡ VERSUS TIME.
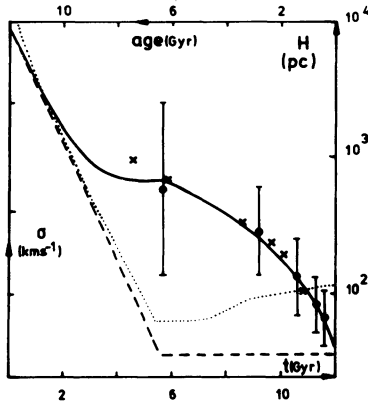CAS DENSITY g_0 AT z = 0 VERSUS TIME.

FIG. 2. .... GAS SCALE HEIGHT H VERSUS TIME
---- GAS VELOCITY DISPERSION σ_g VERSUS TIME
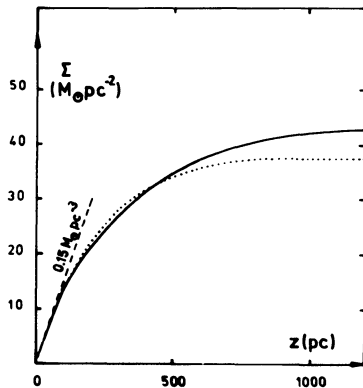— STELLAR VELOCITY DISPERSION σ_* VERSUS AGE
● MAYOR 1974; × MAYOR AND MARTINET 1977

FIG. 3. MASS SURFACE DENSITY Σ (IN HALF A COLUMN) VERSUS
DISTANCE z FROM THE GALACTIC PLANE.
—— THIS MODEL
.... OORT 1965

REFERENCES

Mayor, M.: 1974, *Astron. Astrophys.* 32, 327.
Mayor, M. and Martinet, L.: 1977, *ibid*. 55, 221.
Oort, J.H.: 1965 in A. Blaauw and M. Schmidt (eds.) *Galactic Structure*, University of Chicago Press, Chicago, Chap. 21.
Spitzer, L. and Schwarzschild, M.: 1953, *Astrophys. J.* 118, 106.
Vader, J.P. and de Jong, T.: 1979, to be published in the Proceedings of the 22nd Liege Symposium on "Les éléments et leurs isotopes dans l'univers".

DISCUSSION

   COHEN: Where is your accretion from? Is it from the halo, or is it from outside the galaxy?
   VADER: From the halo. It's from the remaining protogalactic collapse.