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DISCUSSION OF HYPOTHESES AND DYNAMIC MODELS FOR STELLAR SYSTEMS

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1. Galactic model

1.1. Basic assumptions.

A) The Galactic system is interpreted as a coexistence of several stellar components, like inner and main bulge, thin and thick disk, stellar halo, corona, etc. It is not clear if these stellar components are composed of one or more stellar populations (*King, 1993*), but in order to benefit the mutual understanding we can *refine* the classification criterion up to identify components and populations. Then, we can name component to a stellar group with similar astrophysical properties and, in particular, from a kinematical viewpoint, to a group that has reached a kind of statistical equilibrium so that their velocity distribution can be assumed of normal type. Then using Chandrasekhar's notation:

$$f(\mathbf{Q}+\sigma) = e^{-\frac{1}{2}(\mathbf{Q}+\sigma)}. \qquad (1)$$

B) The dynamic behaviour of the Galactic system is described in nearly all the regions according to the following conservative dynamic system: Generally the stellar components moves under the effect of a gravitating potential $U(t, \mathbf{r})$ and the phase space distribution function $f(t, \mathbf{r}, \mathbf{V})$ satisfies the collisionless Boltzmann equation for each component:

$$\frac{df}{dt} = \frac{\partial f}{\partial t} + \mathbf{V} \cdot \nabla_{\mathbf{r}} f - \nabla_{\mathbf{r}} U \cdot \nabla_{\mathbf{v}} f = 0 . \qquad (2)$$

Thus, since this is a linear differential equation for f, the superposition principle can be applied in order to obtain the shape of the potential and the kinematical parameters of each stellar component involved in f.

1.2. Complementary Hypotheses

In order to simplify in a reasonable way the galactic model (otherwise it is nearly impossible to run in the six-dimensional phase space) there are some hypotheses concerning the symmetry and the time-dependency that must be introduced:

Symmetry hypotheses:

AS) Axisymmetric galactic system and plane of symmetry.
PS) Point-axial symmetry and plane of symmetry.

Time dependency hypotheses:

SS) Stationary galactic system.
SP) Stationary potential function.
TD) Time dependent model.

The detailed models can be found in the following papers: Axially symmetric stellar system: *Sala (1990)*. Point-axially symmetric stellar system: *Sanz-Subirana, Juan (1989)*. Superposition of stellar systems: *Cubarsi (1992)*. Superposition of axially symmetric stellar systems: *Cubarsi (1990a)*.

2. The model consequences

Several experimental facts are in reasonable agreement with some of previous assumptions and hypotheses. For example, by using the (ϖ, θ, z)-cylindric galactocentric coordinates system, the mass distribution in z and the mean z-velocity are nearly symmetric with respect to the galactic plane (*Erickson, 1975; Vandervoort, 1975*). On the other hand, even in the simpler superposition models, the asymmetrical drift in the mean rotation velocity can be described and the rotation curve in the solar neighbourhood can also be approximated (*Sanz, 1989; Cubarsi, 1990b; Juan-Zornoza, 1991*).

However there are other experimental data that only under a specific hypothesis of symmetry or time-dependency can be satisfactory explained. Furthermore, in some cases different hypotheses leads to opposite results. This is the case of the radial or angular mass distribution of the stellar components, the vertex deviation of the velocity ellipsoids associated with each stellar component, or the value of the mean radial velocity or the radial differential movement of stellar components.

We separate the problems concerning the velocity distribution, and these ones concerning to the mass distribution and to the shape or specific values of the potential function.

2.1. Velocity Distribution

In the following scheme we show the model consequences, under assumptions A and B, depending on different subsets of previous hypotheses. It must be pointed out that even one component alone may not have vertex deviation in the galactic plane (v.g. under axial symmetry), the whole set of stellar components may have in general some kind of vertex deviation, expressed through the central second moment $\varpi\theta$ (of course there is not a velocity ellipsoid associate with the composite stellar sample).

Parameter	AS+SS	AS+SP	AS+TD	PS+SS	PS+SP	PS+TD
$\Pi_0(i)$	null	non-null	non-null	non-null	non-null	non-null
$\Pi_0(i)-\Pi_0(j)$	null	non-null	null	non-null	non-null	non-null
Equatorial plane v.d.	no	yes	no	yes	yes	yes
Meridian plane v.d.	yes	no	no	no	no	no
Forbidden moments	no	yes	no	yes	yes	yes

Where: $\Pi_0(i)$:= radial mean velocity of the i-stellar component,

equatorial plane v. d. (vertex deviation):= existence of second central moment$\varpi\theta$,

meridian plane v. d. := existence of second central moment ϖz,

forbidden moments:= existence of non-vanishing central moments with an odd,

number of indices in ϖ or θ.

2.2. Mass distribution

The shape of the mass distribution depends basically on the symmetry hypotheses, although it is also related with the form of the potential function and the covariances of the velocity distribution (remember the first-order hydrodynamic equations). Obviously, the mass distribution has the corresponding symmetry that has been adopted for the model. However it depends on the obtained potential and in the specific values of their parameters. For these reasons only some simulations can be done (*Ninkovic, 1987; Cubarsi, 1993; Sanz-Subirana, 1993; Petrovskaya, 1993*) without introducing new qualitative knowledge but contrasting the consistency of some hypotheses. It also depends on the assumption of an autogravitating model: In a PS models, we obtains axial potentials and θ-depending stellar densities (the self-consistence hypothesis is not included).

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