DIFFERENT LAWS OF INCREASING OF STELLAR DISPERSION: OBSERVATIONAL FLAWS OR NATURAL PROPERTY OF STELLAR POPULATION?

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Abstract. Observations show that in the solar neighborhood the velocity dispersions of disk stars increase with their age. In this work we present the results of a critical analysis of the existing interpretations of the data, as well as of previous theoretical explanations of the heating phenomenon. It is shown that different relaxation mechanisms based on star-cloud collisions can result in a wide set of age–velocity dispersion relations (AVDR). Thus the observed differing power laws of the heating of the stellar component can be a consequence of the different relaxation mechanisms.

The choice of a model of the motions of individual stars is crucial for a broad circle of astrophysical problems such as the dynamics and structure of galactic disks, their chemical evolution, and so on. Currently an agreement does not exist between different groups of investigators who have tried to construct the AVDR. (*e.g.* Wielen *et al.*, 1992, Meusinger *et al.* 1991).

The different constructions of the AVDR were done by different techniques. Thus the first possibility of explaining the disagreement in derived AVDRs is a simple choice between them. But the different results were also based on different disk-star samples. Thus a second possible explanation is that the different heating mechanisms, each of which has its own relaxation law, are more or less effective for different stellar classes or at different stages of relaxation. In this case the disagreement might not be the result of an error but might reflect instead the intrinsic properties of the system considered. In a recent paper (Fridman & Khoruzhii 1994) we show that star–cloud collisions can lead to various mechanisms of relaxation, each characterized by its own law of heating, and consequently the second possibility should be discussed.

Based on our analysis, main conclusions are as follows. (For details see Fridman & Khoruzhii 1994.)

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1. Star collisions with giant molecular clouds can be primarily responsible for the heating of the stellar population.
2. Different relaxation mechanisms based on these collisions exist, which can result in a wide set of age–velocity dispersion relations. So the observed various power laws of the heating of the stellar component can be a consequence of the different relaxation mechanisms.
3. These can cause two kinds of heating scenarios—saturated and unsaturated.
4. Saturated heating can occur both in a non-rotating collisional star–cloud system and in a differentially rotating one, independently of geometry, be it a mixture of stars and clouds or a thin layer of clouds and a thick layer of stars. Also this kind of heating can be caused by viscous stress in a differentially rotating stellar disk.
5. Mechanisms connected with differential rotation have not yet been studied. The classical works of Spitzer and Schwarzschild (1953) and Lacey (1984) take into account the effect of differential rotation only in words; the quantitative consideration in both works is inconsistent and describes only the "Maxwellianization" effect.
6. Unsaturated heating can be caused by at least two mechanisms: a) the friction due to the relative rotation of the gaseous and stellar disks, b) the heat transfer due to the spatial diffusion of stars.
7. The last two mechanisms are exemplified by the same characteristic time scale $\tau \simeq 10^{10}$ years and the same exponent of the age–velocity relation $p = 1/2$, that is consistent with Wielen's scenario (Wielen *et al.* 1992).
8. The relaxation mechanisms responsible for saturated heating (second scenario) are exemplified by similar values of the characteristic time scale $\tau \simeq 5 \cdot 10^7$–10^8 years, while the exponents in the age–velocity dispersion relations are very different: $p = 1/6$, $p = 1/5$, $p = 1/4$, $p = 1/3$, depending on the relaxation mechanism.

The main conclusion: Every stellar class can have its own intrinsic law of heating (relaxation), and this law need not be a power law with a unique exponent.

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