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GALACTIC POTENTIAL MODELS: PROBLEM OF CHOICE

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Abstract. We review a set of galactic potential models taken from literature. Possible methods for estimations of parameters are discussed (rotation curve, local kinematics of stars, coordinate and velocity distributions of different objects etc.). One new approach is to use the geological history data (impacts, mass extinctions, geomagnetic inversion flashes etc.). We compare a set of galactic models and try to choose the best one.

1. INTRODUCTION

The Galaxy potential models are important from different points of view. First, one can use the model in order to study the orbits of various objects (stars, gaseous clouds, star clusters etc.) in galactic field. Second, gravitational field reflects the distributions of different kind objects in the Galaxy. Third, regular galactic field is important for investigation of the dynamics of dwarf galaxies in vicinity of the Milky Way (members of so-called Local Galaxy Group). So, realistic Galaxy model constructing is extremely important for solving various problems of the galactic astronomy.

Initially let's enumerate the data which one can use constructing the model of Galaxy. Those are distribution and kinematics of stars (Cepheids, RR Lyrae variables, red giants, RHB stars etc.); structure and kinematics of gaseous subsystem (H II regions, H I disk, molecular clouds); distribution and kinematics of open and globular clusters in the Galaxy; changes of orbital periods of binary pulsars; microlensing events, et cetera.

A number of statistical methods are used for model constructing. Those are maximum likelihood estimations; Monte Carlo modeling; different fitting procedures; some applications of optimization theory, and others.

Let's note a few recent publications (Gerhard, 2002; Famaey and Dejonghe, 2003; Bissantz et al., 2003; Kaempf et al., 2005) devoted to Milky Way model constructing and estimations of Galaxy parameters (masses of components, Oort constants, solar distance from galactic center, LSR velocities, circular velocity at solar radius etc.).

We consider the following main components in our Galaxy: disk (thin+thick), halo, bulge, central bar and spiral arms. The parameters of these components are of interest

for galactic astronomy because they determine the structure, kinematics, dynamics and evolution of the Galaxy.

When we suggest a model of the Milky Way potential, we need to check how this model corresponds to the observed data. Usually different objects are used for this aim in the literature. For example, the following approaches are applied in the papers mentioned above: local galactic parameters (solar distance from center of Galaxy, LSR velocity, Oort constants, surface and volume mass densities etc.); total optical depth found from microlensing event measurements; positions and motions of globular clusters and galactic satellites; statistics of stellar orbits.

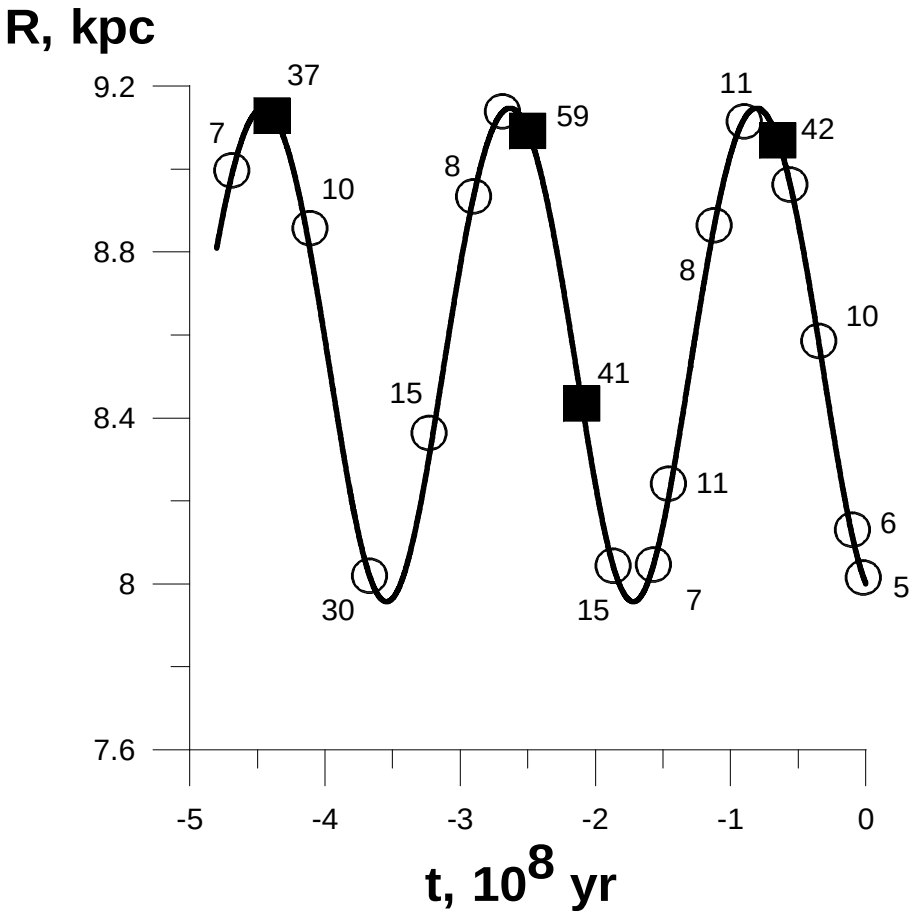

Figure 1: Solar orbit in projection on galactic plane in Allen and Martos (1987) model. Numbers indicate the percentage of biological species dying out, black squares correspond to great extinctions.

2. EARTH'S HISTORY AND MILKY WAY MODEL

Besides the above traditional approaches to test the galactic regular potential model we could suggest a new non-traditional approach to the galactic potential parameter estimations. We suggest to use the solar motion in the Galaxy and the data concerning disastrous events on the Earth. Those are mass extinctions of species, impact events on the Earth surface, flashes of geomagnetic inversions and maybe some other effects.

As an example, we show in Fig. 1 the solar motion in the Allen and Martos (1986) model in projection on the Galactic plane. Numbers indicate the percentage of species dying out, squares correspond to four great extinctions when more than about 40% of species died. We could see that great extinctions are concentrated near the apocenter of the solar orbit in the Galaxy. Maybe those are connected with solar passages through spiral arms or molecular ring near the solar orbit apocenter.

We find also a recurrency step of extinctions of 183 ± 3 Megayears. This is in agreement with anomalistic period in the Allen-Martos model. So this Galactic model could reflect the properties of solar motion in the Galaxy and extinctions in the Earth.

In conclusion, we can formulate two hypotheses:

1) Disastrous events on the Earth took place during solar passages through galactic plane and/or spiral arms.

2) One can use the dating of these events for estimations and controlling the Milky Way model parameters.

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