Journal of Geometry and Physics 140 (2019) 1–9

Contents lists available at ScienceDirect

Journal of Geometry and Physics

journal homepage: www.elsevier.com/locate/geomphys

Periodic motion in non-axially symmetric galaxies

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ARTICLE INFO

Article history:
Received 11 January 2018
Accepted 7 September 2018
Available online 16 February 2019

2000 Mathematics Subject Classification:
primary 34C10, 34C25

Keywords:
Periodic orbits
Galactic bar model
Averaging theory

ABSTRACT

We apply the averaging theory for proving the existence of twelve families of periodic orbits in a three-dimensional galactic Hamiltonian system.

1. Introduction and statements of main results

In order to study the dynamics of the galaxies we need to have a model describing the properties of their motion. Of course the information for obtaining the dynamical models of the motion of the galaxies comes from observations. In order to simplify the dynamics of their orbits these galactic models usually are axially symmetric or spherical. Spherical models for galaxies were studied in [8,13,19]. Moreover, interesting axially symmetric galaxy models were presented and studied in [1,3,4,7,11,16–18,20].

The potential of our model is

$$V(X,Y,Z) = -\frac{1}{\sqrt{X^2+Y^2+(a+\sqrt{b^2+Z^2})^2}} + \frac{1}{a+b}.$$

In this potential the gravitation constant and the mass of the galaxy is one taking conveniently the unit of mass and of the distance, while a and b are parameters connected to the geometry of the galaxy. When $b \gg a$ the model describes an elliptical galaxy with a and b being the scale-lengths of its semiaxes. See for more details about this potential the articles [5,6,12,21]. The main reason for choosing this potential is that despite of the major part of the galaxies are not exactly axially symmetric, the axial symmetry is a good approximation which simplifies the computations for studying the motion of the galaxy.

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https://doi.org/10.1016/j.geomphys.2018.09.023
0393-0440/