Rojas-Niño, A.; Valenzuela, O.; Pichardo, B.
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Instituto de Astronomía
Distrito Federal, México

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A POSSIBLE LOCAL DIAGNOSTIC FOR THE MILKY WAY DARK
MATTER HALO TRIAXIALITY

A. Rojas-Niño, O. Valenzuela, and B. Pichardo

RESUMEN

En este estudio proponemos restringir a través de la cinemática estelar local la forma global del halo de materia
oscura de la Vía Láctea. El principio utilizado es que la forma del halo implica la existencia de familias de
órbitas periódicas que sostienen la forma triaxial. Estas aparecerían como grupos cinemáticos co-móviles de
estrellas en el halo de la Galaxia. Nuestro análisis utiliza simulaciones de la estructura orbital en halos oscuros
con diferentes estructuras. Discutiremos cómo distinguirlos de grupos móviles creados por eventos de acreción
en el pasado de la Galaxia.

ABSTRACT

In this study we propose to constrain through the local stellar kinematics, the overall shape of the Milky Way
dark matter halo. We base on the principle that the shape of the halo implies the existence of families of
periodic orbits that support the triaxial shape. These groups would appear as kinematic co-mobile stars in the
halo of the Galaxy. Our analysis uses simulations of the orbital structure in dark halos with different structures.
We will discuss how to distinguish them from mobile groups created for accretion events in the Galaxy past.

Key Words: dark matter — Galaxy: kinematics and dynamics

1. INTRODUCTION

The triaxiality of the Milky Way dark matter
halo is of great interest to the galactic formation
theories. It is considered as a test for the LCDM
scenario. There has been some strategies to deter-
mine its shape, for instance the Sagittarius stream
(Law et al. 2009) or the hipervelocity stars (Gnedin
et al. 2005). However none of this strategies is con-
clusive. The aim of this work is to introduce a new
diagnostic for the shape of the Galaxy dark matter
halo based on local kinematics of the stars. This may
complement the evidence previously presented of its
triaxiality.

In § 2 we will describe our halo model and the
numerical calculations that we carried out to obtain
the orbital structure generated by its potential.

In § 3 we will discuss our results and the work we
are planning to do.

2. HALO MODEL AND NUMERICAL
SIMULATIONS

Our model assumes that the Galaxy is sur-
rounded by a dark matter halo with a NFW den-
sity profile. The generated potencial and the orbital
structure depends on the shape of the halo. If the
halo has a triaxial shape, there will be resonant or-
bits, but this will not happen if the halo has spher-
ical simetry. This is the key of our analysis. In
order to explore the orbital structure generated by
our halo, we developed a code that simulates a tri-
axial halo with main axes $a = 1.47$, $b = 1.22$ and
c = 0.74, which correspond to a common shape in
cosmology simulations. Then we let $8 \times 10^6$ par-
ticles with random velocities between zero and the

Fig. 1. Phase space proyection on the x-y plane in the
solar position.
escape velocity to evolve in its potential for $2 \times 10^9$ years, time enough for the system to relax. Figure 1 shows the resulting kinematic distribution of stars after performing the simulation in different places. The gathering along the main axis suggests that the stars form kinematical groups that maintain the triaxial shape of the halo over a long period of time. We also simulate the fall of a satellite in the halo potential that is trapped in a resonant orbit and analyze the resultant phase space. We observe that the stars remain in the orbit for a long time and tend to form kinematical groups.

3. CONCLUSIONS AND FUTURE WORK

Our work suggests that if the Galaxy dark matter halo is indeed triaxial, then the resonant orbits are allowed and this induces the kinematical groups to form. There are other mechanisms that produce kinematical groups such as tidal disruptions of globular clusters, but these groups will be made of highly homogeneous stars, while the groups associated with the halo shape will have mixed stars. If this strategy to determine the Galactic dark matter halo shape is successful, it might be benefited by the data from the astrometric satellite GAIA and the follow-ups.

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REFERENCES